Visvesvaraya Technological University, Belagavi.

PROJECT REPORT
on
"MERCILESS BSF"

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CERTIFICATE

This is to Certify that the dissertation work **"Merciless BSF"** carried out by V Kanaka, Priyam Kashyap, Swati H Patgar, Veena Poornima L, USN:1CR11EC043 , bonafide students of **CMRIT** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** of the **Visvesvaraya Technological University, Belagavi,** during the academic year **2017-18**. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the said degree.

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Above all, We thank the Lord Almighty for His grace on us to succeed in this endeavor.

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Chapter 1

INTRODUCTION

1.1 PROBLEM STATEMENT

The Kargil War, also known as the Kargil conflict, was an armed conflictbetweenIndiaandPakistan.

The cause of the war was the infiltration of Pakistani soldiers and Kashmiri militants into positions on the Indian side of the LOC, which serves as the *de facto* border between the two states. During the initial stages of the war, Pakistan blamed the fighting entirely on independent Kashmiri insurgents, but documents left behind by casualtiesand later statements by Pakistan'sPrime MinisterandChief of Army Staffshowed involvement of Pakistani paramilitary forces.

The Doklam standoff refers to military border standoff between Indian armed force and people liberation army of china over construction road in Doklam. Chinese troop with construction vehicles and road building equipments began extending an existing road southward in Doklam, territory which claimed by both china as well as India's ally Bhutan.

These are one of the most recent examples ofhigh altitude warfare in mountainous terrain, which posed significant logistical problemsfor the combating sides. The border states of India are facing lots of problems including mines, drugs, trespassing, etc.

INDIAN government had to face huge loss because of this war. Human loss , machine loss, aircrafts, tankers. Indian economy decreased by 38%, cost of all commodities increased, taxes increased, overall together we had to face tremendous loss.

The major problem India is facing due to LOC problems are:

Our country youth is getting affected due to drugs. In Punjab 70% of youth are addicted to drugs which are supplied through the borders illegally. Our population is affected because of trespassing in Bangladesh border. And the terrorist entering to our country are causing harm in all the ways to the public as well as government.

1.2 **RESEARCH BACKGROUND**

The military organization now takes robots for the help to carry out many risky jobs of the soldier that cannot be done. The robots are usually employed with the integrated system which are used in military, video screens, sensors, gripper and cameras are also included. The military robots according to the purposes of each robot also have different shapes. Here *to* trace out the intruders the new system is proposed with the help of low power IoT wireless sensor network and automatically the robot will take the necessary action. Thus the proposed system, IoT saves human lives and reduces manual error in defense side using an Intelligent Unmanned Robot. To save human life and protect the country from enemies this is specially designed robotic system. The robots are specially design for human to make our life easier.

1.3 OBJECTIVE OF REPORT

Prevention is better than cure. Our Project is the solution for this at the protected ares and.

This Project is a IR & camera based security system for protected areas & borders, which senses the Intruders, trespassers and transfer video to other end For confirmation

In this Project, we are going to have an IR Sensor which senses any intruders / trespassers and will activate the alarm as well as switch on the guns in that particular place.

In this project we will shoot the intruder when he cross the border, the device is equipped with a GPS facility if the intruder escapes then we can track him with the help of ARM 11 devices or smartphone.

It will also activate the camera, which will start capture the live video and transmit the same to the receiver end, the smart phone

In the same time it will start gives alarm and the data will transferred through the RF transmitter & receiver to the mobile device

The process using the **r**adio - **f**requency spectrum for transmitting and receiving voice, data and video signals by which informations are shared is known as **w**ireless **c**ommunication

We can use this video colour security camerawith audioin the application, smallest wireless colour video camera**.** Camera with transmitter & receiver and video surveillance for security. High resolution - colour wireless & cordless camera with clear audio output

Easy start process, continuous monitoring, excellent resolution

Can gather sensitive information while handling materials, fire fighting, night time operations.

1.4 SCOPES OF THE PROJECT

Design and Construction of mini Robot for Military purpose using mobile devices:

Robots are specially design for human to make our life easier. Robots are design for various purposes like military purpose, industry, for home based application. At border different 52.2.3.5Gtypes of tanks, missiles and guns are used by the enemy. This causes problems and will harm our force or soldiers. To address the above problem a robot is designed and developed for military purpose application to protect our army. The method involves a biped walking robot using parallel leg mechanism i.e. PLM which includes different functions like capturing real world data using digital image processing used to detect its obstacle which is found in its path.

1.5 SIGNIFICANCE OF THE PROJECT

Robots are design for various purposes like military purpose, industry, for home based application. At border different tanks, missile, guns etc are used by enemy. This cause problem and harm our force or soldiers. For this a robot is design and developed for military purpose application to protect the army. Robots used to detect its obstacle which is found in its path. If it finds any obstacle in its path then using gun mechanism it will able to shoot that obstacle. For making it multifunctional robot all the actions perform by user, same actions perform by robot using stretch sensor. All these mechanisms are embedded on the propeller.

Chapter 2

LITERATURE SURVEY

A thorough survey of approaches for hardware deployment for the project has been done. They distinguish between hardware and software, element-level and structure level, and language-based and constraint-based matchers for hardware.

2.1 INTRODUCTION

2.1.1 IOT

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" was Mark Weiser's central statement in his seminal paper [Weis 91] in Scientific American in 1991. There is a sea change in human's daily life as well as in working conditions in organizations after the arrival of IT and ITeS technologies. This is becoming well-known concept across many horizontal and vertical markets including a common man's everyday life in the society, as it has several applications. The development of the Internet of Things [IoT] has been primarily driven by needs of large corporations that stand to benefit greatly from the foresight and predictability afforded by the ability to follow all objects through the commodity chains in which they are embedded. The ability to code and track objects has allowed companies to become more efficient, speed up processes, reduce error, prevent theft, and incorporate complex and flexible organizational systems through IoT. The IoT is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology. They are going tag the each object for identifying, automating, monitoring and controlling. s

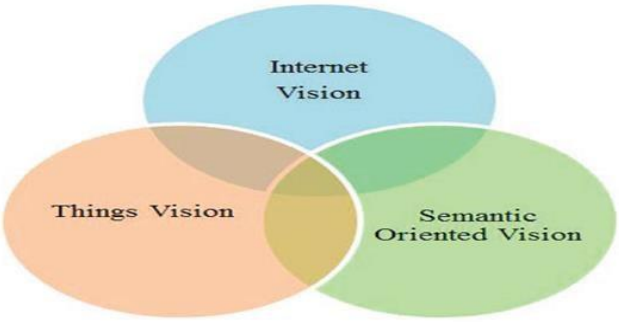

Fig. 2.1.1

2.1.2 WIRELESS

In 1895, Guglielmo Marconi opened the way for modern wireless communications by transmitting the three-dot Morse code for the letter 'S' over a distance of three kilometers using electromagnetic waves. From this beginning, wireless communications has developed into a key element of modern society. From satellite transmission, radio and television broadcasting to the now ubiquitous mobile telephone, wireless communications has revolutionized the way societies function. This chapter surveys the economics literature on wireless communications. Wireless communications and the economic goods and services that utilize it have some special characteristics that have motivated specialized studies. First, wireless communications relies on a scarce resource – namely, radio spectrum – the property rights for which were traditionally vested with the state. In order to foster the development of wireless communications (including telephony and broadcasting) those assets were privatized. Second, use of spectrum for wireless communications required the development of key complementary technologies; especially those that allowed higher frequencies to be utilized more efficiently. Finally, because of its special nature, the efficient use of spectrum required the coordinated development of standards. Those standards in turn played a critical role in the diffusion of technologies that relied on spectrum use.

2.2 LITERATURE REVIEW

Design and Construction of mini Robot for Military purpose using mobile devices:

Robots are specially design for human to make our life easier. Robots are design for various purposes like military purpose, industry, for home based application. At border different types of tanks, missiles and guns are used by the enemy. This causes problems and will harm our force or soldiers. To address the above problem a robot is designed and

developed for military purpose application to protect our army. The method involves a biped walking robot using parallel leg mechanism i.e. PLM which includes different functions like capturing real world data using digital image processing used to detect its obstacle which is found in its path.

Touch Screen Controlled Defence Robot:

The robot system can be built with the existing economic conditions that can be used for different sophisticated robotic applications. The control system consists of Touch screen, object tracking and ZigBee modules, a microcontroller that controls the robot. The system provides continuous visual monitoring through the wireless camera attached to the robot and sends continuous data to the control unit. A multifunctional Robot is been designed according to the specifications made above which uses ZigBee Technology. ZigBee cannot be used to cover very long distance, it can only deal with low complexities and is very slow.

Design and Development of Wireless Multifunctional Robot for Military applications:

The project is presenting an IOT Based Wireless multifunctional robot for military application with SST89E516RD2 microcontroller using MQTT protocol and it is done by integrating various sensors, Cameras, Grippers and actuators into web application using MQTT and HTTP protocol. The system uses ARDUINO controller.

Multifunctional Robot for Border security Applications:

The system presents a modern approach for surveillance at remote and border areas using multifunctional robot based on current 3G technology used in defense and military applications. The robotic vehicle has ability to substitute the solider at border areas to provide surveillance. The robotic vehicle works both as autonomous and manually controlled vehicle using internet as communication medium.

Design and implementation of e- surveillance robot:

The proposed security solution hinges on the novel integration of camera on Raspberry Pi. Raspberry Pi operates and controls video camera for surveillance and records video for future playback. The SST89E516RD2 is a member of the Flash Flex family of 8bit microcontroller products designed and manufactured with patented and proprietary Super Flash CMOS semiconductor process technology. This microcontroller is better than Raspberry Pi.

2.3 DEFINATION

There is no unique definition available for Internet of Things that is acceptable by the world community of users. In fact, there are many different groups including academicians, researchers, practitioners, innovators, developers and corporate people that have defined the term, although its initial use has been attributed to Kevin Ashton, an expert on digital innovation. What all of the definitions have in common is the idea that the first version of the Internet was about data created by people, while the next version is about data created by things. The best definition for the Internet of Things would be: "An open and comprehensive network of intelligent objects that have the capacity to auto-organize, share information, data and resources, reacting and acting in face of situations and changes in the environment" Internet of Things is maturing and continues to be the latest, most hyped concept in the IT world. Over the last decade the term Internet of Things (IoT) has attracted attention by projecting the vision of a global infrastructure of networked physical objects, enabling anytime, anyplace connectivity for anything and not only for any one. The Internet of Things can also be considered as a global network which allows the communication between human-to-human, human-to-things and things-to-things, which is anything in the world by providing unique identity to each and every object. IoT describes a world where just about anything can be connected and communicates in an intelligent fashion that ever before. Most of us think about "being connected" in terms of electronic devices such as servers, computers, tablets, telephones and smart phones. In what's called the Internet of Things, sensors and actuators embedded in physical objects—from roadways to pacemakers—are linked through wired and wireless networks, often using the same Internet IP that connects the Internet. These networks churn out huge volumes of data that flow to computers for analysis. When objects can both sense the environment and communicate, they become tools for understanding complexity and responding to it swiftly.

What's revolutionary in all this is that these physical information systems are now beginning to be deployed, and some of them even work largely without human intervention.

The "Internet of Things" refers to the coding and networking of everyday objects and things to render them individually machine-readable and traceable on the Internet. Much existing content in the Internet of Things has been created through coded RFID tags and IP addresses linked into an EPC (Electronic Product Code) network.

2.3.1. GENESIS

The Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology (Accessed dated on 20/04/2013 from URL: http://www.ieccr.net/comsoc/ijcis/). The first Internet appliance was a Coke machine at Carnegie Melon University in the early 1980s. Programmers working several floors above the vending machine wrote a server program that chased how long it had been since a storage column in the machine had been unfilled. The programmers could connect to the machine over the Internet, check the status of the machine and determine whether or not there would be a cold drink awaiting them, should they decide to make the trip down to the machine. Though the buzzword "Internet of Things" evolution was set out a way back in 1980's with coffee vending machine, the original term is coined by Kevin Auston, the Executive Director of Auto-ID Labs in MIT in 1999. The concept of IoT first became very popular through the Auto-ID centre in 2003 and in related market analysts publications. Right from the beginning the Internet of Things evolution started, there were many things or objects connected to the internet for the different applications through diverse technologies depending on the type of object for the comfort ability of Human.

2.3.2. TIME SERIES

Accessed from the URL dated on 24/3/2013: http://postscapes.com/internet-ofthings-history.

1999: The term Internet of Things is coined by Kevin Ashton, Executive Director of the Auto-ID Center in Massachute Institute of Technology (MIT)

1999: Neil Gershenfeld first time spoken about IoT principles in his book titled "When Things Start to Think"

1999: MIT Auto-ID Lab, originally founded by Kevin Ashton, David Brock and Sanjay Sarma in this year. They helped to develop the Electronic Product Code 2000: LG announced its first Internet of refrigerator plans

2002: The Ambient Orb created by David Rose and others in a spin-off from the MIT Media Lab is released into wild with NY Times Magazine naming it as one of the Ideas of Year

(2003-2004): RFID is deployed on a massive scale by the US Department of Defense in their Savi program and Wal-Mart in the commercial world 2005: The UN's International Telecommunications Union (ITU) published its first report on the Internet of Things topic 2008: Recognition by the EU and the First European IoT conference is held 2008: A group of companies launched the IPSO Alliance to promote the use of IP in networks of "Smart Objects" and to enable the Internet of Things

2008: The FCC voted 5-0 to approve opening the use of the 'white space' spectrum (2008-2009): The IoT was born according to Cisco's Business Solutions Group

2008: US National Intelligence Council listed the IoT as one of the 6 "Disruptive Civil Technologies" with potential impacts on US interests out to 2025

2010: Chinese Premier Wen Jiabao calls the IoT a key industry for China and has plans to make major investments in Internet of Things

2011: IPv6 public launch-The new protocol allows for 340, 282, 366, 920, 938, 463, 463, 374, 607, 431,768, 211, 456 (2128) addresses

2.3.3. ALIASES

- Different people calling Internet of Things with different names but the objective of IoT is same in the broad sense. The aliases of Internet of Things includes Web of Things, Internet of Objects, Embedded Intelligence, Connected Devices and Technology Omnipotent, Omniscient and Omnipresent. In addition to these, it has also calling as counting
- Cyber Physical Systems "Integrations of computation and physical processes", in which bringing the real and virtual worlds together
- Pervasive Computing is a computer environment in which virtually every object has processing power with wireless or wired connections to a global network
- Ubiquitous Computing or Calm technology, where technology becomes virtually invisible in our lives
- Machine-to-Machine Interaction means no human intervention whilst devices are communicating end-to-end
- HumanComputer Interaction involves the study, planning, and design of interaction between people and computers

- S. Madakam et al. 167 Ambient Intelligence is a developing technology that will increasingly make our everyday environ- ment sensitive and responsive.

2.3.4. REQURIMENTS

For successful implementation of Internet of Things (IoT), the prerequisites are

- Dynamic resource demand
- Real time needs
- Exponential growth of demand
- Availability of applications
- Data protection and user privacy
- Efficient power consumptions of applications (g) Execution of the applications near to end users
- (h) Access to an open and inter operable cloud system.
- According to another author, there are three components, which required for seamless Internet of Things (IoT) computing
- Hardware—composed of sensors, actuators, IP cameras, CCTV and embedded communication hardware
- Middleware—on demand storage and computing tools for data analytics with cloud and Big Data Analytics
- Presentation—easy to understand visualization and interpretation tools that can be designed for the different applications.

2.3.5. GARTER'S HYPE CYCLE

Garter's Information Technology Hype Cycle is a way to represent emergence, adoption, maturity and impact on applications of specific technologies. In the adjacent graph, X- axis denotes expectations and Y- axis denotes time factors. Internet of Things has been identified as one of the emerging technologies in Internet of Things as noted in Gartner's IT Hype Cycle. It has been forecasted that IoT will takes around 5-10 years for market adoption as of the 2012. See the picture for data.

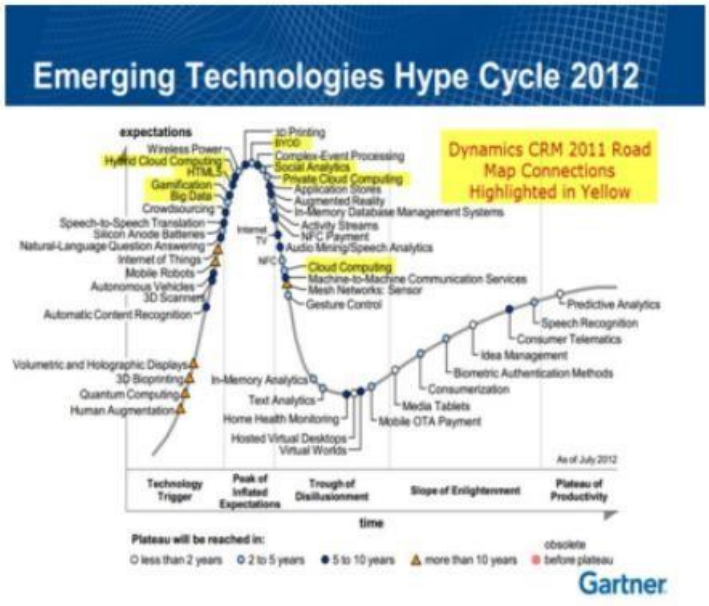

Fig. 2.3.5

2.4. ARCHITECTURE

One of the main problems with the IoT is that it is so vast and such a broad concept that there is no proposed, uniform architecture. In order for the idea of IoT to work, it must consist of an assortment of sensor, network, communications and computing technologies, amongst others. Here, some of IoT architectures or models are given by several researchers, authors and practitioners.

2.4.1. EUROPEAN FP7 RESEARCH PROJECT

- This is to be used as a blueprint for IoT concrete architecture design;
- Model: Architectural Reference Model (ARM);
- Developed By: Project partners of the European FP7 Research Project IoT-A;
- Derived From: Business considerations, application-based requirements and current technologies.

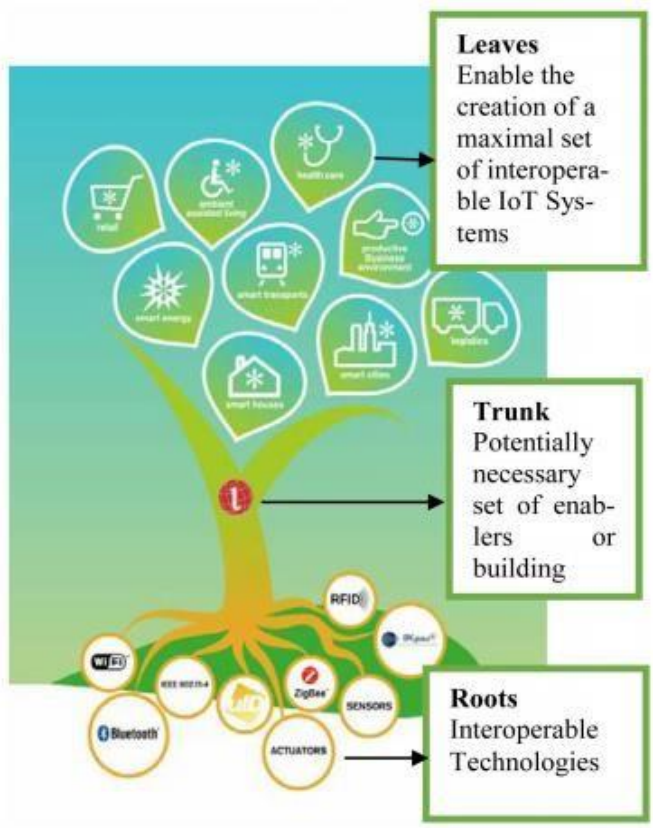

Fig. 2.4.1

2.4.2. ITU ARCHITECTURE

According to the recommendations of the International Telecommunication Union (ITU), the network, Architecture of Internet of Things consists of

- The Sensing Layer
- The Access Layer
- The Network Layer
- The Middleware Layer
- The Application Layers

These are like the Open Systems Interconnection (OSI) reference model in network and data communication.

2.4.3. IOT FORUM ARCHITECTURE

The IoT Forum says that the Internet of Things Architecture is basically categorized into 3 types including Applications, Processors and Transpiration.

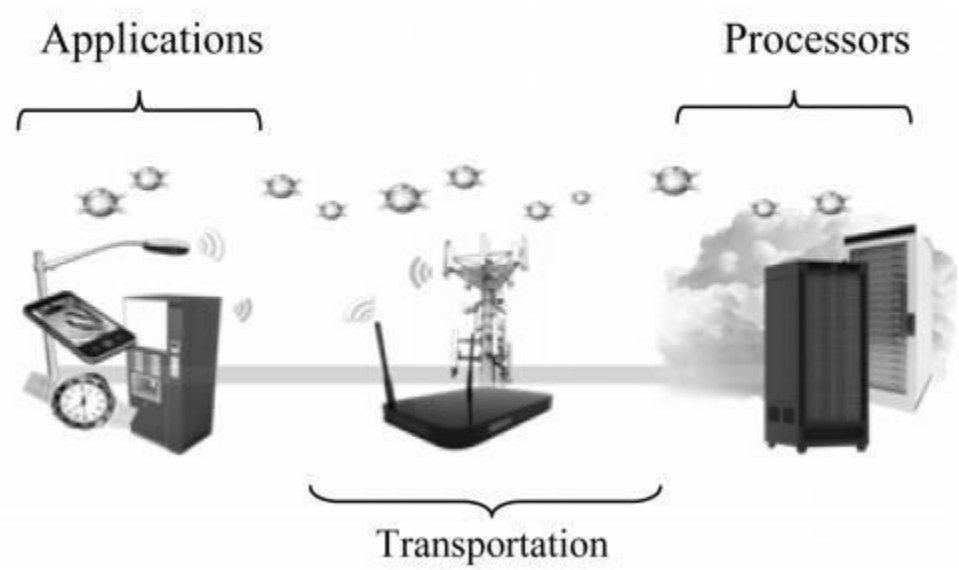

Fig. 2.4.3

2.5 TECHNOLOGY

The Internet of Things was initially inspired by members of the RFID community, who referred to the possibility of discovering information about a tagged object by browsing an internet address or database entry that corresponds to a particular RFID or Near Field Communication technologies. In the research paper "Research and application on the smart home based on component technologies and Internet of Things", the included key technologies of IoT are RFID, the sensor technology, Nano technology and intelligence embedded technology. Among them, RFID is the foundation and networking core of the construction of Internet of Things. The Internet of Things (IoT) enabled users to bring physical objects into the sphere of cyber world. This was made possible by different tagging technologies like NFC, RFID and 2D barcode which allowed physical objects to be identified and referred over the internet. IoT, which is integrated with Sensor Technology and Radio Frequency Technology, is the ubiquitous network based on the omnipresent hardware resources of Internet, is the Internet contents objects together. It is also a new wave of IT industry since the application of computing fields, communication network and global roaming technology had been applied. It involves in addition to sophisticated technologies of computer and communication network outside, still including many new

supporting technologies of Internet of Things, such as collecting Information Technology, Remote Communication Technology, Remote Information Transmission Technology, Sea Measures Information Intelligence Analyzes and Controlling Technology etc.

2.5.1 RADIO FREQUENCY IDENTIFICATION (RFID)

Radio Frequency Identification (RFID) is a system that transmits the identity of an object or person wirelessly using radio waves in the form of a serial number [20]. First use of RFID device was happened in 2nd world war in Brittan and it is used for Identify of Friend or Foe in 1948. Later RFID technology is founded at Auto-ID centre in MIT in the year 1999. RFID technology plays an important role in IoT for solving identification issues S. Madakam et al. 170 of objects around us in a cost effective manner. The technology is classified into three categories based on the method of power supply provision in Tags: Active RFID, Passive RFID and Semi Passive RFID. The main components of RFID are tag, reader, antenna, access controller, software and server. It is more reliable, efficient, secured, inexpensive and accurate. RFID has an extensive range of wireless applications such as distribution, tracing, patient monitoring, military apps etc.

2.5.2 INTERNET PROTOCOL (IP)

Internet Protocol (IP) is the primary network protocol used on the Internet, developed in 1970s. IP is the principal communications protocol in the Internet protocol suite for relaying datagrams across network boundaries. The two versions of Internet Protocol (IP) are in use: IPv4 and IPv6. Each version defines an IP address differently. Because of its prevalence, the generic term IP address typically still refers to the addresses defined by IPv4. There are five classes of available IP ranges in IPv4: Class A, Class B, Class C, Class D and Class E, while only A, B, and C are commonly used. The actual protocol provides for 4.3 billion IPv4 addresses while the IPv6 will significantly augment the availability to 85,000 trillion addresses. IPv6 is the 21st century Internet Protocol. This supports around for 2128 addresses.

2.5.3 ELECTRONIC PRODUCT CODE (EPC)

Electronic Product Code (EPC) is a 64 bit or 98 bit code electronically recorded on an RFID tag and intended to design an improvement in the EPC barcode system. EPC code

can store information about the type of EPC, unique serial number of product, its specifications, manufacturer information etc. EPC was developed by AutoID centre in MIT in 1999. EPCglobal Organisation [Wikipedia, "EPCglobal", 2010] which is responsible for standardization of Electronic Product Code (EPC) technology, created EPCglobal Network [Wikipedia, "EPCglobal Network", 2010] for sharing RFID information. It has four components namely Object Naming Service (ONS), EPC Discovery Service (EPCDS), EPC Information Services (EPCIS) and EPC Security Services (EPCSS).

2.5.4 BARCODE

Barcode is just a different way of encoding numbers and letters by using combination of bars and spaces of varying width. Behind Bars [23] serves its original intent to be descriptive but is not critical. In The Bar Code Book, Palmer (1995) acknowledges that there are alternative methods of data entry techniques. Quick Response (QR) Codes the trademark for a type of matrix barcode first designed for the automotive industry in Japan. Bar codes are optical machine-readable labels attached to items that record information related to the item. Recently, the QR Code system has become popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard. There are 3 types of barcodes of Alpha Numeric, Numeric and 2 Dimensional. Barcodes are designed to be machine readable. Usually they are read by laser scanners, they can also be read using a cameras.

2.5.5 WIRELESS FIDELITY (Wi-Fi)

Wireless Fidelity (Wi-Fi) is a networking technology that allows computers and other devices to communicate over a wireless signal. Vic Hayes has been named as father of Wireless Fidelity. The precursor to Wi-Fi was invented in 1991 by NCR Corporation in Nieuwege in the Netherland. The first wireless products were brought on the market under the name WaveLAN with speeds of 1 Mbps to 2 Mbps. Today, there are nearly pervasive Wi-Fi that delivers the high speed Wireless Local Area Network (WLAN) connectivity to millions of offices, homes, and public locations such as hotels, cafes, and airports. The integration of Wi-Fi into notebooks, handhelds and Consumer Electronics (CE) devices has accelerated the adoption of Wi-Fi to the point where it is nearly a default in these devices. Technology contains any type of WLAN product support any of the IEEE 802.11

together with dual-band, 802.11a, 802.11b, 802.11g and 802.11n. Nowadays entire cities are becoming Wi-Fi corridors through wireless APs. 4.6. Bluetooth Bluetooth wireless technology is an inexpensive, short-range radio technology that eliminates the need for pro-S. Madakam et al. 171 prietary cabling between devices such as notebook PCs, handheld PCs, PDAs, cameras, and printers and effective range of 10 - 100 meters. And generally communicate at less than 1 Mbps and Bluetooth uses specification of IEEE 802.15.1 standard. At first in 1994 Ericson Mobile Communication company started project named "Bluetooth". It is used for creation of Personal Area Networks (PAN). A set of Bluetooth devices sharing a common channel for communication is called Piconet. This Piconet is capable of 2 - 8 devices at a time for data sharing, and that data may be text, picture, video and sound. The Bluetooth Special Interest Group comprises more than 1000 companies with Intel, Cisco, HP, Aruba, Intel, Ericson, IBM, Motorola and Toshiba.

2.5.6 ZIGBEE

ZigBee is one of the protocols developed for enhancing the features of wireless sensor networks. ZigBee technology is created by the ZigBee Alliance which is founded in the year 2001. Characteristics of ZigBee are low cost, low data rate, relatively short transmission range, scalability, reliability, flexible protocol design. It is a low power wireless network protocol based on the IEEE 802.15.4 standard. ZigBee has range of around 100 meters and a bandwidth of 250 kbps and the topologies that it works are star, cluster tree and mesh. It is widely used in home automation, digital agriculture, industrial controls, medical monitoring &power systems.

2.5.7 NEAR FIELD COMMUNICATION (NFC)

Near Field Communication (NFC) is a set of short-range wireless technology at 13.56 MHz, typically requiring a distance of 4 cm. NFC technology makes life easier and more convenient for consumers around the world by making it simpler to make transactions, exchange digital content, and connect electronic devices with a touch. Allows intuitive initialization of wireless networks and NFC is complementary to Bluetooth and 802.11 with their long distance capabilities at a distance circa up to 10 cm. It also works in dirty environment, does not require line of sight, easy and simple connection method. It is

first developed by Philips and Sony companies. Data exchange rate now days approximately 424 kbps. Power consumption during data reading in NFC is under 15ma.

2.5.8 ACTUATOR

An actuator is something that converts energy into motion, which means actuators drive motions into mechanical systems. It takes hydraulic fluid, electric current or some other source of power. Actuators can create a linear motion, rotary motion or oscillatory motion. Cover short distances, typically up to 30 feet and generally communicate at less than 1 Mbps. Actuators typically are used in manufacturing or industrial applications. There are three types of actuators are

- Electrical: ac and dc motors, stepper motors, solenoids
- Hydraulic: use hydraulic fluid to actuate motion
- Pneumatic: use compressed air to actuate motion.

All these three types of actuators are very much in use today. Among these, electric actuators are the most commonly used type. Hydraulic and pneumatic systems allow for increased force and torque from smaller motor.

2.5.9 WIRELESS SENSON NETWORK (WSN)

A WSN is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations (Wikipedia). Formed by hundreds or thousands of motes that communicate with each other and pass data along from one to another. A wireless sensor network is an important element in IoT paradigm. Sensor nodes may not have global ID because of the large amount of overhead and large number of sensors. WSN based on IoT has received remarkable attention in many areas, such as military, homeland security, healthcare, precision agriculture monitoring, manufacturing, habitat monitoring, forest fire and flood detection and so on. Sensors mounted to a patient’s body are monitoring the responses to the medication, so that doctors can measure the effects of the medicines.

2.5.10 ARTIFICIAL INTELLIGENCE (AI)

Artificial Intelligence refers to electronic environments that are sensitive and responsive to the presence of people. In an ambient intelligence world, devices work in concert to support people in carrying out their every- S. Madakam et al. 172 day life activities in easy, natural way using Information and Intelligence that is hidden in the network connected devices. It is characterized by the following systems of characteristics

- Embedded: Many Net- worked devices are integrated in to the environment
- Context Aware: These devices can recognize you and your situational context
- Personalized: They can be tailored to your needs
- Adaptive: They can change in response to you
- Anticipatory: They can anticipate your desires without conscious mediation.

2.6 ARM 11

ARM11 is a group of older 32-bitRISCARMprocessor cores licensed by ARMHoldings. The ARM11 core family consists of ARM1136J (F)-S, ARM1156T2 (F)-S, ARM1176JZ (F)-S, and ARM11MPCore. Since ARM11 cores were released from **2002 to 2005**, they are no longer recommended for new IC designs, insteadARM Cortex-AandARMCortex-Rcores are preferred.

The ARM11 microarchitecture(announced 29 April 2002) introduced the **ARMv6** architectural additions which had been announced in October 2001. These includeSIMDmedia instructions,multiprocessorsupport and a new cache architecture. The implementation included a significantly improved instruction processing pipeline, compared to previousARM9orARM10families, and is used insmartphonesfromApple,Nokia, and others.
The initial ARM11 core (ARM1136) was released to licensees in October 2002.

The ARM11 family are currently the only ARMv6-architecture cores. There are, however, ARMv6-M cores (Cortex-M0 and Cortex-M1), addressingmicrocontrollerapplications;[2]ARM11 cores target more demanding applications.

Chapter 3

HARDWARE

This chapter confers on the hardware components that we have used to complete this project. The components include microcontrollers, sensors, relay and motors. The description about the same is given below.

3.1 BLOCK DIAGRAM

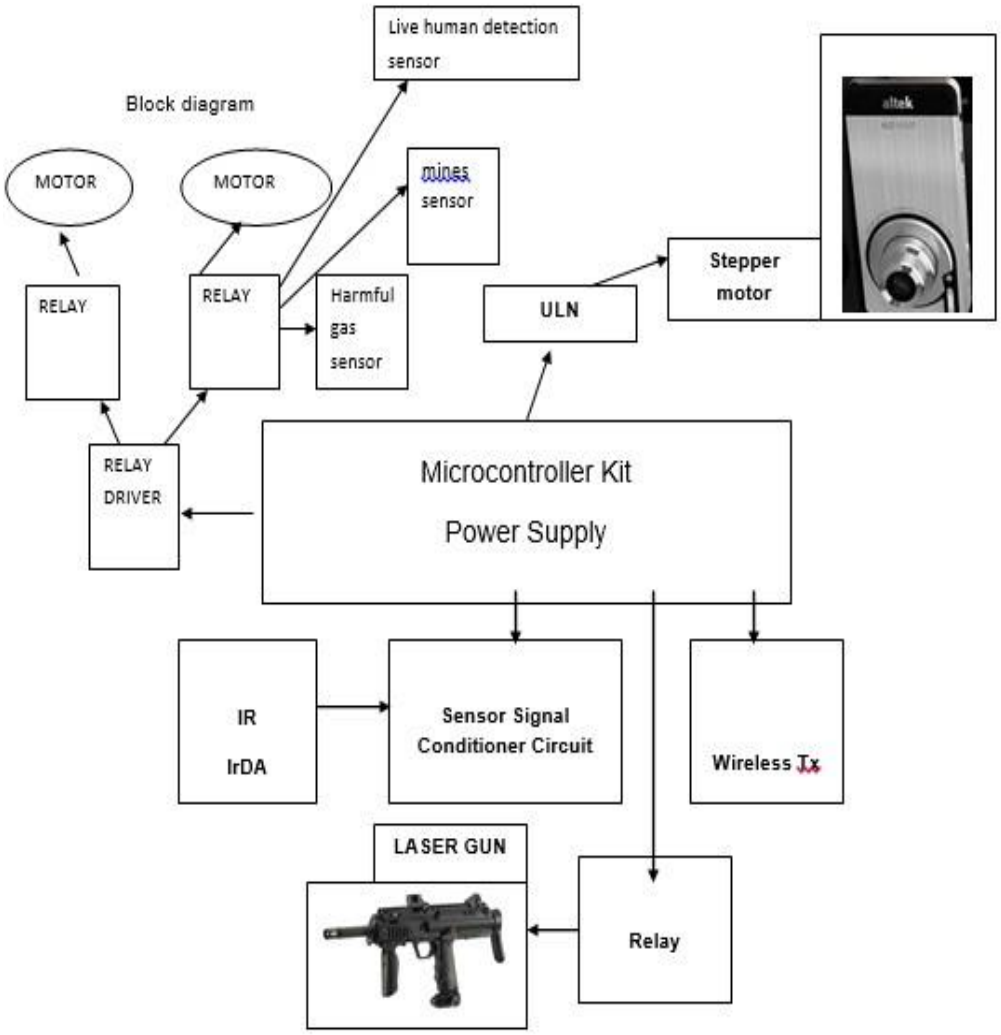

Fig. 3.1

3.2 MICROCONTROLLER

The SST89E516RDx and SST89V516RDx are members of the Flash Flex family of 8-bit microcontroller products designed and manufactured with SST's patented and proprietary Super Flash CMOS semiconductor process technology. The split gate cell design and thickoxidetunneling injector offer significant cost and reliability benefits for SST's customers. The devices use the 8051 instruction set and are pin-for-pin compatible with standard 8051 microcontroller devices.

3.2.1 FEATURES:

- 8-bit 8051-Compatible Microcontroller (MCU) with Embedded SuperFlash
    - Memory. – Fully Software Compatible – Development Toolset Compatible – PinFor-Pin Package Compatible
- SST89E516RD2 Operation – 0 to 40 MHz at 5V
- SST89V516RD2 Operation – 0 to 33 MHz at 3V
- 1 Kbyte Internal RAM
- Dual Block Super Flash EEPROM – 64 Kbyte primary block + 8 Kbyte secondary block (128-Byte sector size for both blocks) – Individual Block Security Lock with Soft Lock – Concurrent Operation during In-Application Programming (IAP) – Memory Overlay for Interrupt Support during IAP
- Support External Address Range up to 64 Kbyte of Program and Data Memory
- Three High-Current Drive Ports (16 mA each) • Three 16-bit Timers/Counters
- Full-Duplex, Enhanced UART – Framing Error Detection – Automatic Address Recognition
- Ten Interrupt Sources at 4 Priority Levels – Four External Interrupt Inputs
- Programmable Watchdog Timer (WDT)
- Programmable Counter Array (PCA)
- Four 8-bit I/O Ports (32 I/O Pins) and One 4-bit Port
- Second DPTR register
- Low EMI Mode (Inhibit ALE)
- SPI Serial Interface • Standard 12 Clocks per cycle, the device has an option to double the speed to 6 clocks per cycle.
- TTL- and CMOS-Compatible Logic Levels
- Brown-out Detection
- Low Power Modes – Power-down Mode with External Interrupt Wake-up – Idle Mode
- Temperature Ranges: – Commercial (0°C to +70°C) – Industrial (-40°C to +85°C)
- Packages Available – 40-contact WQFN (Port 4 feature not available) – 44-lead PLCC – 40-pin PDIP (Port 4 feature not available) – 44-lead TQFP All non-Pb (lead-free) devices are RoHS compliant.

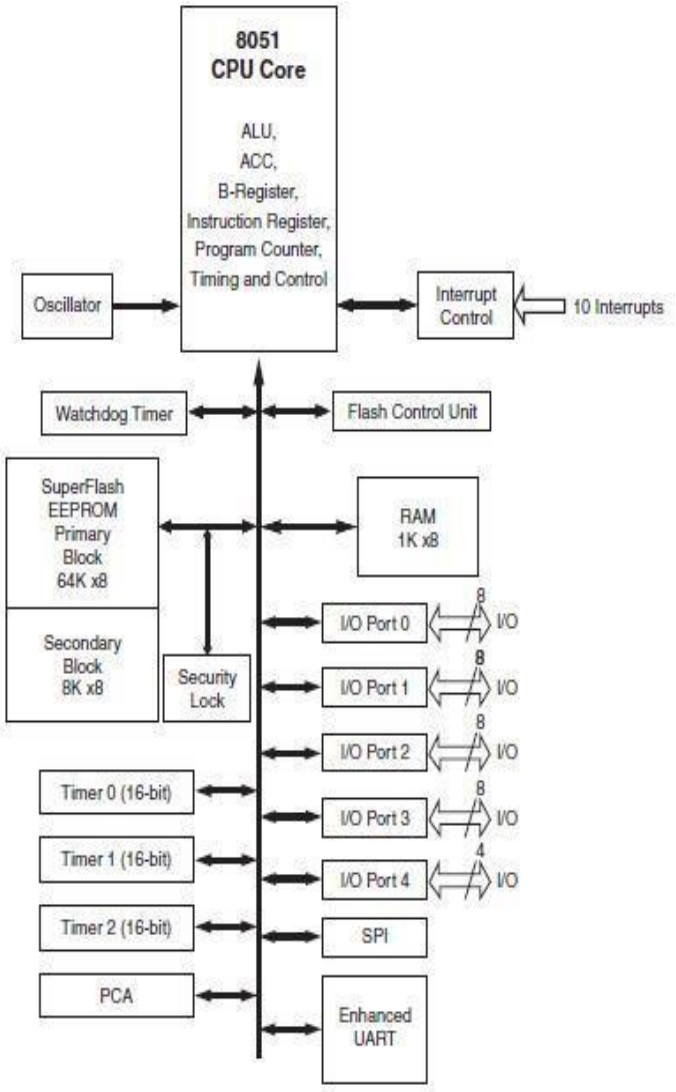
8051
CPU Core
ALU,
ACC,
B-Register,
Instruction Register,
Program Counter,
Timing and Control
Oscillator
Interrupt Control
10 Interrupts
Watchdog Timer
Flash Control Unit
SuperFlash EEPROM Primary Block 64K x8
Secondary Block 8K x8
Security Lock
RAM 1K x8
I/O Port 0
I/O Port 1
I/O Port 2
I/O Port 3
I/O Port 4
8
4
I/O
Timer 0 (16-bit)
Timer 1 (16-bit)
Timer 2 (16-bit)
PCA
SPI
Enhanced UART

Fig. 3.2.1(a)

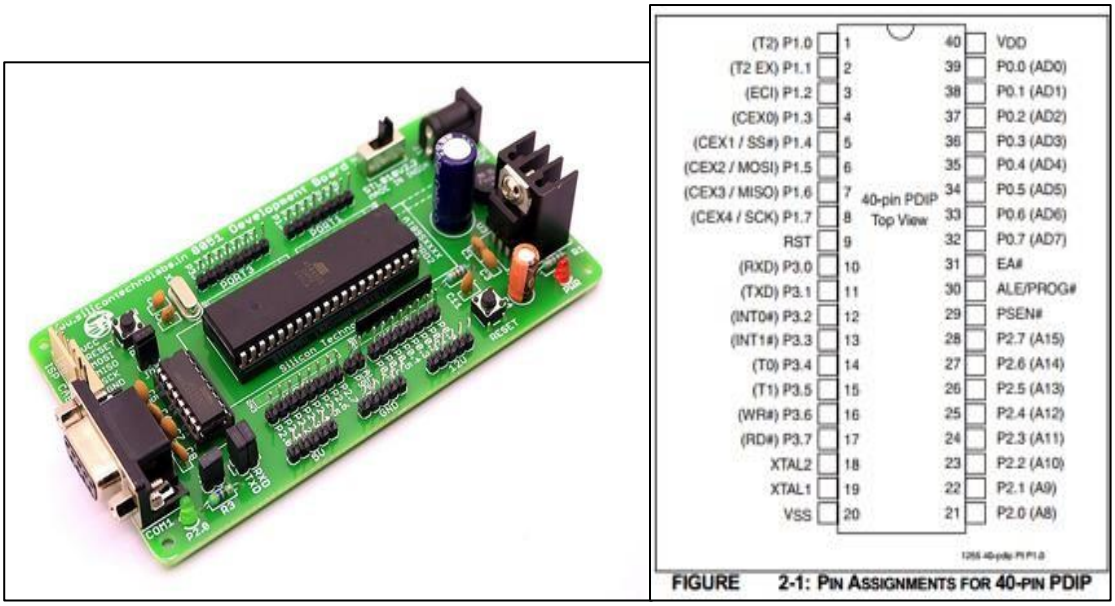

Fig. 3.2.1(b)

3.2.2 PRODUCT DESCRIPTION:

The SST89E516RDx and SST89V516RDx are members of the FlashFlex family of 8-bit microcontroller products designed and manufactured with SST's patented and proprietary SuperFlash CMOS semiconductor process technology. The split-gate cell design and thick oxidetunnelling injector offer significant cost and reliability benefits for SST's customers. The devices use the 8051 instruction set and are pin-for-pin compatible with standard 8051 microcontroller devices. The devices come with 72 KByte of on-chip flash EEPROM program memory which is partitioned into 2 independent program memory blocks. The primary Block 0 occupies 64 KByte of internal program memory space and the secondary Block 1 occupies 8 KByte of internal program memory space. The 8-KByte secondary block can be mapped to the lowest location of the 64 KByte address space; it can also be hidden from the program counter and used as an independent EEPROM-like data memory. During power-on reset, the devices can be configured as either a slave to an external host for source code storage or a master to an external host for an in-application programming (IAP) operation. The devices are designed to be programmed insystem and in-application on the printed circuit board for maximum flexibility. The devices are pre-programmed with an example of the bootstrap loader in the memory, demonstrating the initial user program code loading or subsequent user code updating via the IAP operation. The sample bootstrap loader is available for the user's reference and convenience only; SST does not guarantee its functionality or usefulness. Chip-Erase or Block-Erase operations will erase the preprogramed sample code.

3.3 GAS SENSOR

The **MQ-2 Gas sensor** can detect or measure gasses like LPG, Alcohol, Propane, Hydrogen, CO and even methane. The module version of this sensor comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers.

3.3.1 FEATURES:

- Operating Voltage is +5V
- Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane
- Analog output voltage: 0V to 5V
- Digital Output Voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds
- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

Fig. 3.3.1

3.4 PIR SENSOR

A **passive infrared sensor** (**PIR sensor**) is an electronic sensorthat measuresinfrared(IR) light radiating from objects in its field of view. They are most often used in PIR-basedmotiondetectors.

A PIR-basedmotiondetectoris used to sense movement of people, animals, or other Objects. They are commonly used in burglar alarmsand automatically-Activatedlightingsystems. They are commonly called simply "PIR", or sometimes "PID", for "passive infrared detector".

3.4.1 OPERATION

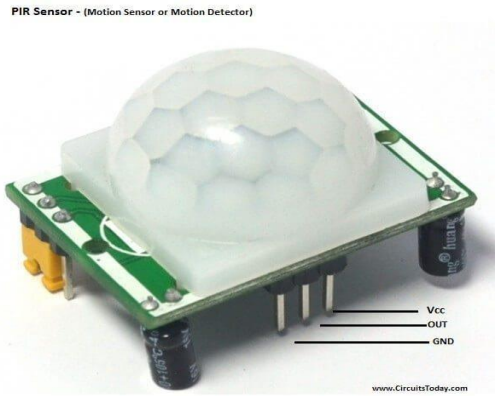

Fig:3.4.1

An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of the sensor. When an object, such as ahuman, passes in front of the background, such as awall, the temperature at that point in the sensor's field of view will rise fromroomtemperaturetobodytemperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. Objects of similar temperature but different surface characteristics may also have a different infrared emission pattern, and thus moving them with respect to the background may trigger the detector as well.

PIRs come in many configurations for a wide variety of applications. The most common models have numerousFresnellensesor mirror segments, an effective range of about ten meters (thirty feet), and a field of view less than 180 degrees. Models with wider

fields of view, including 360 degrees, are available—typically designed to mount on a ceiling. Some larger PIRs are made with single segment mirrors and can sense changes in infrared energy over thirty meters (one hundred feet) away from the PIR. There are also PIRs designed with reversible orientation mirrors which allow either broad coverage (110° wide) or very narrow "curtain" coverage, or with individually selectable segments to "shape" the coverage.

3.5 IR SENSOR

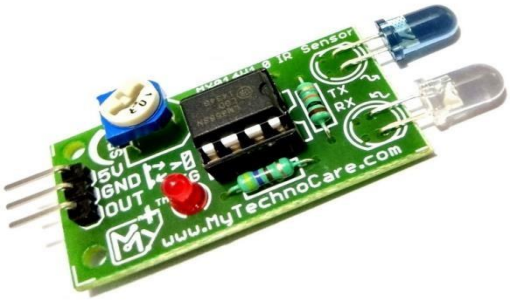

Fig:3.5

Infrared radiation is an electromagnetic wave with wavelength of 700nm to 1 mm. It is emitted by objects with temperature above 0 kelvin. Furthermore intensity and wavelength of infrared radiation depends on the temperature of the object.

The infrared sensors are the sensors that detect/measure infrared radiation or change in the radiation from outer source or inbuilt source. Also sensors that uses the property of infrared radiations to detect the changes in surrounding are termed as infrared sensors.

3.5.1 REFLECTANCE SENSOR

These types of sensors use reflective property of IR. The emitter emits an IR beam which is reflected by the object. The reflected IR is the detected by the receiver. The object causes change in the property of the reflected IR or the amount of IR received by the receiver varies. The degree of change is dependent on the reflectance of the object. Thus detecting the change in amount of received IR helps in figuring out the properties of object such as surface geography and reflectance.

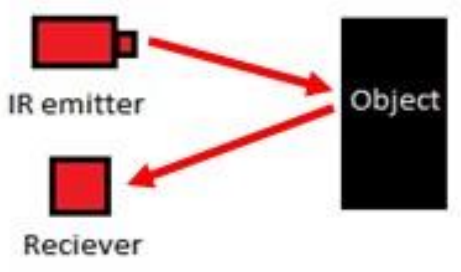

Fig:3.5.1

3.6 METAL DETECTOR

A **metal detector** is an electronicinstrumentwhich detects the presence ofmetalnearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator. Usually the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes. Another common type are stationary "walk through" metal detectors used forsecurity screeningat access points inprisons,courthouses, andairportsto detect concealed metal weapons on a person's body.

The simplest form of a metal detector consists of an oscillatorproducing analternating currentthat passes through a coil producing an alternatingmagnetic field. If a piece of electrically conductive metal is close to the coil,eddy currentswill be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as amagnetometer), the change in the magnetic field due to the metallic object can be detected.

The first industrial metal detectors were developed in the 1960s and were used extensively for mineral prospecting and other industrial applications. Uses include detecting landmines, the detection of weapons such as knives and guns (especially in airportsecurity), geophysicalprospecting,archaeologyand treasure hunting. Metal detectors are also used to detect foreign bodies in food, and in theconstruction industryto detectsteelreinforcing barsin concrete and pipes and wires buried in walls and floors.

Fig:3.6

3.7 RELAYS

A relay is defined as an electrically operated switch; their main use is controlling circuits by a low-power signal or when several circuits must be controlled by one signal. The first relay was used in long distance telegraph circuits as amplifiers, basically they repeated the signal they received from one circuit, and transmitted it into a different one, they were also used in early computers to perform logical operations.

The Arduino relay module is designed for a wide range for micro controllers such as the Arduino board, AVR, PIC, ARM, with digital outputs. This module incorporates 2 relays. The following forms the relay system:

- **Input:**Vcc, connected to the 5V current on the Arduino Board, GND, connected to the ground and 2 digital inputs. (In1 & In2
- **Output**: The 2 channel relay module could be considered like a series switches: 2 normally Open (NO), 2 normally closed (NC) and 2 common Pins (COM).

3.7.1 FEATURES:

Number of Relays	2
Control Signal	TTL Level
Rated Load	7A/240VAC 10A/125VAC 10A/28VDC

Contact Action Time	10ms/5ms
Interface Board	5V 2-Channel Relay interface board, and each one need 15-20mA Driver Current.
Equipment	· Equipped with high-current relay, AC250V 10A; DC30V 10A · Indication LED's for Relay output status.
Supported Microcontrollers	Standard interface that can be controlled directly by microcontroller (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic)

3.8 ULN 2803

ULN2803 is a High voltage, high current Transistor Array IC used especially with Microcontrollers where we need to drive high power loads. Thic IC consists of a eight NPN Darlington connected transistors with common Clamp diodes for switching the loads connected to the output. This IC is widely used to drive high loads such Lamps, relays, motors etc. It is usually rated at 50v/500mA. This article brings out the working of ULN2803 IC and how to use it in a circuit.

Most of the Chips operates with low level signals such as TTL, CMOS, PMOS, NMOS which operates at the range of (0-5)v and are incapable to drive high power inductive loads. However this chip takes low level input signals (TTL) and use that to switch/turn off the higher voltage loads that is connected to the output side.

The ULN2803 IC consists of eight NPN Darlington pair which provides the proper current amplification required by the loads. We all know that the transistors are used to amplify the current but here Darlington transistor pairs are used inside the IC to make the required amplification.

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amplify the current but here Darlington transistor pairs are used inside the IC to make the required amplification.

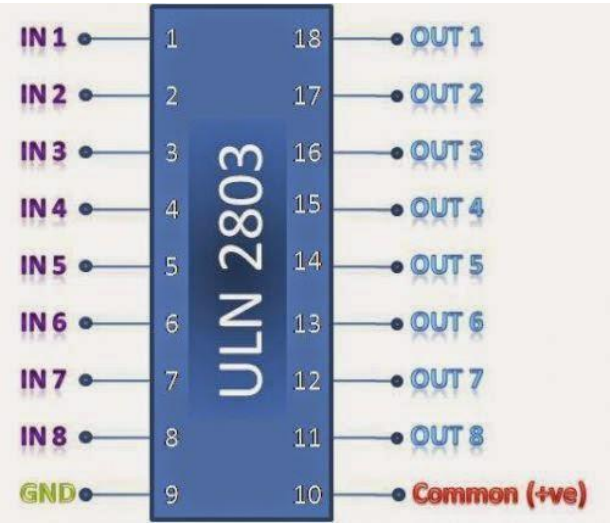


Fig:3.8

3.9 GSM MODEM

GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.

There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.

3.9.1 GSM ARCHITECTURE:

A GSM network consists of the following components:

A Mobile Station: It is the mobile phone which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.

Base Station Subsystem: It acts as an interface between the mobile station and the network subsystem. It consists of the Base Transceiver Station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the Base Station Controller which controls the Base Transceiver station and acts as a interface between the mobile station and mobile switching centre.

Network Subsystem: It provides the basic network connection to the mobile stations. The basic part of the Network Subsystem is the Mobile Service Switching Centre which provides access to different networks like ISDN, PSTN etc. It also consists of the Home Location Register and the Visitor Location Register which provides the call routing and roaming capabilities of GSM. It also contains the Equipment Identity Register which maintains an account of all the mobile equipment's wherein each mobile is identified by its own IMEI number. IMEI stands for International Mobile Equipment Identity.

Fig:3.9.1

3.9.2 FEATURES:

- Improved spectrum efficiency
- International roaming

- Compatibility with integrated services digital network(ISDN) Support for new services.
- SIM phonebook management
- Fixed dialing number (FDN)
- Uses encryption to make phone calls more secure
- Real time clock with alarm management
- High-quality speech
- Short message service (SMS)

3.9.3 GSM MODEM

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.

A GSM modem can also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. GSM modem is usually preferable to a GSM mobile phone. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging.

3.9.4 WORKING:

From the below circuit, a GSM modem duly interfaced to the MC through the level shifter IC Max232. The SIM card mounted GSM modem upon receiving digit command by SMS from any cell phone send that data to the MC through serial communication. While the program is executed, the GSM modem receives command ‘STOP’ to develop an output at the MC, the contact point of which are used to disable the ignition switch. The command so sent by the user is based on an intimation received by him through the GSM modem ‘ALERT’ a programmed message only if the input is driven low. The complete operation is displayed over 16×2 LCD display.

Intelligent GSM Device for Automation and Security

In these days, the GSM mobile terminal has become one of the items that are constantly with us. Just like our wallet/purse, keys or watch, the GSM mobile terminal provides us a communication channel that enables us to communicate with the world. The requirement for a person to be reachable or to call anyone at any time is very appealing.

In this project, as the name says project is based on GSM network technology for transmission of SMS from sender to receiver. SMS sending and receiving is used for ubiquitous access of appliances and allowing breach control at home. The system proposes two sub-systems. Appliance control subsystem enables the user to control home appliances remotely and the security alert subsystem gives the automatic security monitoring. The system is capable enough to instruct user via SMS from a specific cell number to change the condition of the home appliance according to the user's needs and requirements. The second aspect is that of security alert which is achieved in a way that on the detection of intrusion, the system allows automatic generation of SMS thus alerting the user against security risk.

3.10 BLUETOOTH:

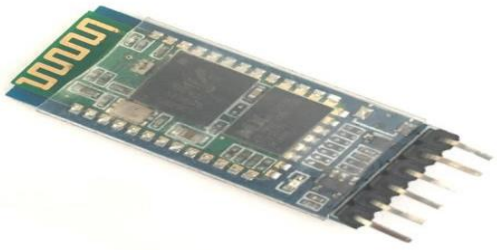


Fig:3.10

HC - 05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04 - External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

The Bluetooth module HC-05 is a MASTER/SLAVE module.By default the factory setting is SLAVE.The Role of the module (Master or Slave) can be configured only by AT

COMMANDS.The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections.Master module can initiate a connection to other devices.The user can use it simply for a serial port replacement to establish connection between MCU and GPS, PC to your embedded project, etc.Just go through the datasheet for more details

3.10.1 HARDWARE FEATURES

- Typical - 80dBm sensitivity.
- Up to +4dBm RF transmit power.
- 3.3 to 5 V I/O.
- PIO (Programmable Input/Output) control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

3.10.2 SOFTWARE FEATURES

- Slave default Baud rate: 9600, Data bits:8, Stop bit:1,Parity:No parity.
- Auto - connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto - pairing PINCODE:”1234” as default.

3.10.3 PIN DESCRIPTION:

The HC-05 Bluetooth Module has 6pins. They are as follows:

Enable:

When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate. When enable is left open or connected to 3.3V, the module is enabled i.e. the module remains on and communication also takes place.

Txd AND Rxd

These two pins acts as an UART interface for communication

STATE:

It acts as a status indicator. When the module is not connected to / paired with any other Bluetooth device, signal goes Low. At this low state, the led flashes continuously which denotes that the module is not paired with other device. When this module is connected to/paired with any other Bluetooth device, the signal goes high. At this high state, the led blinks with a constant delay say for example 2s delay which indicates that the module is paired.

BUTTON SWITCH:

This is used to switch the module into AT command mode.To enable AT command mode,press the button switch for a second.With the help of AT commands,the user can change the parameters of this module but only when the module is not paired with any other BT device.If the module is connected to any other bluetooth device, it starts to communicate with that device and fails to work in AT command mode.

3.11 LCD 16x2

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pin outs have already been visualized above now let us get a bit technical.

Figure 16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. A Single character with all its Pixels is shown in the below picture.

Now, we know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780 is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen. You can learn how to interface an LCD using the above mentioned links. If you are an advanced programmer and would like to create your own library for interfacing your Microcontroller

with this LCD module then you have to understand the HD44780 IC is working and commands which can be found its datasheet.

Fig:3.11

3.11.1 FEATURES

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

3.12 STEPPER MOTOR

A stepper motor or step motor or stepping motor is a brushless DC electricmotorthat divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any positionsensorforfeedback(anopen-loop controller), as long as the motor is carefully sized to the application in respect totorqueand speed.

Switched reluctance motorsare very large stepping motors with a reduced pole count, and generally are closed-loopcommutated

Brushed DC motorsrotate continuously when DC voltageis applied to their terminals. The stepper motor is known by its property to convert a train of input pulses (typically square wave pulses) into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle.

Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. The electromagnets are energized by an externaldrivercircuitor amicro controller. To make the motor shaft turn, first, one electromagnet is given power, which magnetically attracts the gear's teeth. When the gear's teeth are aligned to the first electromagnet, they are slightly offset from the next electromagnet. This means that when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one. From there the process is repeated. Each of those rotations is called a "step", with aninteger numberof steps making a full rotation. In that way, the motor can be turned by a precise angle.

Fig:3.12

The circular arrangement of electromagnets is divided into groups, each group called a phase, and there is an equal number of electromagnets per group. The number of groups is chosen by the designer of the stepper motor. The electromagnets of each group are interleaved with the electromagnets of other groups to form a uniform pattern of arrangement. For example, if the stepper motor has two groups identified as A or B, and ten electromagnets in total, then the grouping pattern would be ABABABABAB.

Electromagnets within the same group are all energized together. Because of this, stepper motors with more phases typically have more wires (or leads) to control the motor.

Stepper motors' nameplates typically give only the winding current and occasionally the voltage and winding resistance. The ratedvoltagewill produce the rated winding current at DC: but this is mostly a meaningless rating, as all modern drivers are current limiting and the drive voltages greatly exceed the motor rated voltage.

Data sheets from the manufacturer often indicate Inductance. Back-EMF is equally relevant, but seldom listed (it is straightforward to measure with an oscilloscope). These figures can be helpful for more in-depth electronics design, when deviating from standard

supply voltages, adapting third party driver electronics, or gaining insight when choosing between motor models with otherwise similar size, voltage, and torque specifications.

A stepper's low speed torque will vary directly with current. How quickly the torque falls off at faster speeds depends on the winding inductance and the drive circuitry it is attached to, especially the driving voltage.

Steppers should be sized according to publishedtorque curve, which is specified by the manufacturer at particular drive voltages or using their own drive circuitry. Dips in the torque curve suggest possible resonances, whose impact on the application should be understood by designers.

Step motors adapted to harsh environments are often referred to as IP65 rated.[7]

The US National Electrical Manufacturers Association (NEMA) standardises various aspects of stepper motors. They are typically referred with NEMA DD, where DD is the diameter of the faceplate in inches × 10 (e.g., NEMA 17 has diameter of 1.7 inches). There are further specifies to describe stepper motors, and such details may be found in theICS16-2001standard (section 4.3.1.1). There are also useful summaries and further information on theRiprap

3.13 DC MOTOR

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. Theuniversal motorcan operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of

power electronics has made replacement of DC motors with AC motorspossible in many applications.

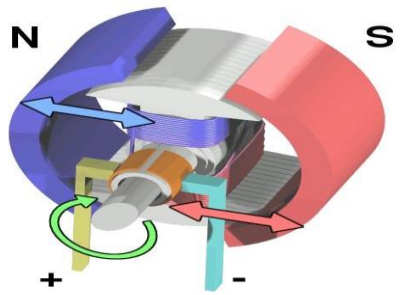


Fig:3.13

Chapter 4

SOFTWARE

4.1ANDROID SDK.

Android SDK and Eclipse IDE Installing Android and Eclipse You need to install the Android SDK; you should also install the Eclipse IDE. Instructions are found at http://developer.android.com/sdk/installing.html Android SDK+Eclipse is installed in computer lab 7017. Set the path to the Android SDK The first time you run Eclipse you should check that the path to the Android SDK is set. From the menu, select Window/Preferences and click on Android. Browse to the Android SDK location. Hello World Select File/New/Android Project from the menu. Fill in the Project Name, chose a Build Target (at present time, 2.1 is recommended). Then add the Application Name, Package Name (at least one sub package is required), the Activity Name and the Minimum SDK version (make sure this version matches the Build Target). An example is provided below.

Create an Android Virtual Device, AVD To (test) run your application, you need an Android Virtual Device, that is an emulator emulating a smart phone on your computer. Select from the menu, Window/Android SDK and AVD Manager. Select Virtual Devices and click on New, then fill in a Name for your AVD, pick a Target (must match the Build Target) and size of the SDcard (memory card). If you want to add properties, such as an accelerometer, to your virtual device, select Hardware/New.

Run your application Right-click on the icon for your project in the left window, then select Run As…/Android Application. If there are no errors, your Virtual Device is launched. This will take some time, be patient. You should then see a device as below. If you click on the ”back button” on the virtual device, you will see the main menu of the phone. To restart your application, click on the menu button, or on Launcher Icon on the device screen, and select your application. A small change in the layout The components in an Android User Interface are usually defined in an XML-file. The line set ContentView(R.layout.main) in the Hello Activity class refers to a layout defined in the in the file res/layout/main.xml (select the main.xml tab at the bottom to see the xml code). The line android: text="@string/hello" tell us the message is defined in another xml file, res/values/strings.xml. Open this file and change the value of the string labeled hello. Run the new version of your application In Eclipse, select Run As…/Android Application to

upload the new version of your application to your virtual device. There's no need to restart the virtual device between different runs; if you do so you once again have to wait for a long time.

Export/Import Eclipse projects Export Select from the menu: File/Export…/Archive file… In the wizard, select the desired project. Browse to the destination folder and enter a name for the archive. Click OK. Import This instruction assumes the project is exported as an archive file. Select from the menu: File/Import…/General/Existing projects into Workspace… In the wizard, select the radio button "Select archive file", and browse to the desired archive file (zip or tar). Click OK.

Appendix A; problem when entering text in the AVD If you, when entering text in the AVD, get Chinese (?) characters instead of Latin characters, longclick on the text component. A context menu appears, select Input Method, and then the proper input method. Appendix B; installing an application on a device To install your application on an actual Android smartphone, you must first create an application package (an APK file). This instruction assumes the device has the Astro File Manager installed; download it from http://www.androidfreeware.net/download-astro-file-manager.html . Create an APK file Right-click on the project header and select Android Tools > Export signed application package. In the wizard, select Project and create a new keystore. Add the details on the key and create it. Provide a name for your APK file, with the suffix .apk. Download and install Connect the device to your computer through a USB cable, then install (mount) it (you can see how to do this on the device). After this you can find the device on your computer as a separate drive (in Windows, open My Computer). Copy the APK-file to this unit. Uninstall the device and remove the USB cable. Start the Astro File Manager and browse to your application. Select install. Newer versions of the Android OS require a permission to download applications from other sources than the Android Market. The setting is found on your device via Settings/Applications/Unknown sources1.

4.2 JAVA

Java is a general-purpose computer-programming language that is concurrent, classbased, object-oriented, and specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere" (WORA), meaning that compiled Java code can run on all platforms that

support Java without the need for recompilation. Java applications are typically compiled to bytecode that can run on any Java virtual machine (JVM) regardless of computer architecture. As of 2016, Java is one of the most popular programming languages in use, particularly for client-server web applications, with a reported 9 million developers. Java was originally developed by James Gosling at Sun Microsystems (which has since been acquired by Oracle Corporation) and released in 1995 as a core component of Sun Microsystems' Java platform. The language derives much of its syntax from C and C++, but it has fewer low-level facilities than either of them.

The original and reference implementation Java compilers, virtual machines, and class libraries were originally released by Sun under proprietary licenses. As of May 2007, in compliance with the specifications of the Java Community Process, Sun relicensed most of its Java technologies under the GNU General Public License. Others have also developed alternative implementations of these Sun technologies, such as the GNU Compiler for Java (bytecode compiler), GNU Classpath (standard libraries), and IcedTea-Web (browser plugin for applets).

The latest version is Java 10, released on March 20, 2018, which follows Java 9 after only six months in line with the new release schedule. Java 8 is still supported but there will be no more security updates for Java 9. Versions earlier than Java 8 are supported by companies on a commercial basis; e.g. by Oracle back to Java 6 as of October 2017 (while they still "highly recommend that you uninstall" pre-Java 8 from at least Windows computers).

4.2.1 PRINCIPLES

There were five primary goals in the creation of the Java language:

- It must be "simple, object-oriented, and familiar".
- It must be "robust and secure".
- It must be "architecture-neutral and portable".
- It must execute with "high performance".
- It must be "interpreted, threaded, and dynamic".

4.2.2 SYNTAX

The syntax of Java is largely influenced by C++. Unlike C++, which combines the syntax for structured, generic, and object-oriented programming, Java was built almost exclusively as an object-oriented language. All code is written inside classes, and every data item is an object, with the exception of the primitive data types, (i.e. integers, floating-point numbers, boolean values, and characters), which are not objects for performance reasons. Java reuses some popular aspects of C++ (such as the printf method).

Unlike C++, Java does not support operator overloading[58] or multiple inheritance for classes, though multiple inheritance is supported for interfaces.[59]

Java uses comments similar to those of C++. There are three different styles of comments: a single line style marked with two slashes (//), a multiple line style opened with /* and closed with */, and the Javadoc commenting style opened with /** and closed with */. The Javadoc style of commenting allows the user to run the Javadoc executable to create documentation for the program and can be read by some integrated development environments (IDEs) such as Eclipse to allow developers to access documentation within the IDE.

4.3 EMBEDDED C

Embedded C is a set of language extensions for theC programming languageby theC Standards Committeeto address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such asfixedpoint arithmetic, multiple distinctmemory banks, and basicI/Ooperations.

In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as, fixed-point arithmetic, named address spaces, and basic I/O hardware addressing.

Embedded C uses most of the syntax and semantics of standard C, e.g., main() function, variable definition, datatype declaration, conditional statements (if, switch case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, etc.

A Technical Report was published in 2004and a second revision in 2006.

4.3.1 EMBEDDED SYSTEMS PROGRAMMING

Embedded systems programming is different from developing applications on a desktop computers. Key characteristics of an embedded system, when compared to PCs, are as follows:

- Embedded devices have resource constraints(limited ROM, limited RAM, limited stack space, less processing power)
- Components used in embedded system and PCs are different; embedded systems typically uses smaller, less power consuming components.
- Embedded systems are more tied to the hardware.

Two salient features of Embedded Programming are code speed and code size. Code speed is governed by the processing power, timing constraints, whereas code size is governed by available program memory and use of programming language. Goal of embedded system programming is to get maximum features in minimum space and minimum time.

Embedded systems are programmed using different type of languages:

- Machine Code
- Low level language, i.e., assembly
- High level language like C, C++, Java, Ada, etc.
- Application level language like Visual Basic, scripts, Access, etc.

Assembly language maps mnemonic words with the binary machine codes that the processor uses to code the instructions. Assembly language seems to be an obvious choice for programming embedded devices. However, use of assembly language is restricted to developing efficient codes in terms of size and speed. Also, assembly codes lead to higher software development costs and code portability is not there. Developing small codes are not much of a problem, but large programs/projects become increasingly difficult to manage in assembly language. Finding good assembly programmers has also become difficult nowadays. Hence high level languages are preferred for embedded systems programming.

4.3.2 ADVANTAGES OF C IN EMBEDDED SYSTEM

- It is small and reasonably simpler to learn, understand, program and debug.
- C Compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers.
- Unlike assembly, C has advantage of processor-independence and is not specific to any particular microprocessor/ microcontroller or any system. This makes it convenient for a user to develop programs that can run on most of the systems.
- As C combines functionality of assembly language and features of high level languages,
- C is treated as a 'middle-level computer language' or 'high level assembly language'
- It is fairly efficient
- It supports access to I/O and provides ease of management of large embedded projects.

Many of these advantages are offered by other languages also, but what sets C apart from others like Pascal, FORTRAN, etc. is the fact that it is a middle level language; it provides direct hardware control without sacrificing benefits of high level languages.

Compared to other high level languages, C offers more flexibility because C is relatively small, structured language; it supports low-level bit-wise data manipulation.

Compared to assembly language, C Code written is more reliable and scalable, more portable between different platforms (with some changes). Moreover, programs developed in C are much easier to understand, maintain and debug. Also, as they can be developed more quickly, codes written in C offers better productivity. C is based on the philosophy 'programmers know what they are doing'; only the intentions are to be stated explicitly. It is easier to write good code in C & convert it to an efficient assembly code (using high quality compilers) rather than writing an efficient code in assembly itself. Benefits of assembly language programming over C are negligible when we compare the ease with which C programs are developed by programmers.

Objected oriented language, C++ is not apt for developing efficient programs in resource constrained environments like embedded devices. Virtual functions & exception handling of C++ are some specific features that are not efficient in terms of space and speed in embedded systems. Sometimes C++ is used only with very few features, very much as C.

Ada, also an object-oriented language, is different than C++. Originally designed by the U.S. DOD, it didn't gain popularity despite being accepted as an international standard twice (Ada83 and Ada95). However, Ada language has many features that would simplify embedded software development.

Java is another language used for embedded systems programming. It primarily finds usage in high-end mobile phones as it offers portability across systems and is also useful for browsing applications. Java programs require Java Virtual Machine (JVM), which consume lot of resources. Hence it is not used for smaller embedded devices.

Dynamic C and B# are some proprietary languages which are also being used in embedded applications.

Efficient embeddedC programsmust be kept small and efficient; they must be optimized for code speed and code size. Good understanding of processor architecture embedded C programming and debugging tools facilitate this.

4.3.3 DIFFERENCE BETWEEN C AND EMBEDDED C

Though **C and embedded C** appear different and are used in different contexts, they have more similarities than the differences. Most of the constructs are same; the difference lies in their applications.

C is used for desktop computers, while **embedded C** is for microcontroller based applications. Accordingly, C has the luxury to use resources of a desktop PC like memory, OS, etc. While programming on desktop systems, we need not bother about memory. However, embedded C has to use with the limited resources (RAM, ROM, I/Os) on an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash.

Compilers for C (ANSI C) typically generate OS dependant executable. **Embedded C** requires compilers to create files to be downloaded to the microcontrollers/microprocessors where it needs to run. Embedded compilers give access to all resources which is not provided in compilers for desktop computer applications.

Embedded systems often have the real-time constraints, which is usually not there with desktop computer applications.

Embedded systems often do not have a console, which is available in case of desktop applications.

So, what basically is different while programming with **embedded C** is the mindset; for embedded applications, we need to optimally use the resources, make the program code efficient, and satisfy real time constraints, if any. All this is done using the basic constructs, syntaxes, and function libraries of 'C'.

4.4 KEIL-C COMPILER

C51 C Compiler

The Keil C51 C Compiler for the 8051 microcontroller is the most popular 8051 C compiler in the world. It provides more features than any other 8051 C compiler available today.

The C51 Compiler allows you to write 8051 microcontroller applications in C that, once compiled, have the efficiency and speed of assembly language. Language extensions in the C51 Compiler give you full access to all resources of the 8051.

The C51 Compiler translates C source files into relocatable object modules which contain full symbolic information for debugging with the µVision Debugger or an in-circuit emulator. In addition to the object file, the compiler generates a listing file which may optionally include symbol table and cross reference information.

4.4.1 FEATURES

- Nine basic data types, including 32-bit IEEE floating-point,
- Flexible variable allocation with bit, data, bdata, idata, xdata, and pdatamemory types,
- Interrupt functions may be written in C,
- Full use of the 8051 register banks,
- Complete symbol and type information for source-level debugging,
- Use of AJMP and ACALL instructions,
- Bit-addressable data objects,
- Built-in interface for theRTX51 Real-Time Kernel,
- Support for dual data pointers on Atmel, AMD, Cypress, Dallas Semiconductor, Infineon, Philips, and Triscend microcontrollers,
- Support for the Philips 8*x*C750, 8*x*C751, and 8*x*C752 limited instruction sets,Support for the Infineon 80C517 arithmetic unit.

4.5 FLASH MAGIC BURNER SOFTWARE

NXP Semiconductors produce a range of **Microcontrollers** that feature both on chip Flash memory and the ability to be reprogrammed using In-System Programming technology.

Flash Magic is Windows software from the Embedded Systems Academy that allows easy access to all the ISP features provided by the devices.

4.5.1 FEATURES

- Erasing the Flash memory (individual blocks or the whole device)
- Programming the Flash memory
- Modifying the Boot Vector and Status Byte
- Reading Flash memory
- Performing a blank check on a section of Flash memory
- Reading the signature bytes
- Reading and writing the security bits
- Direct load of a new baud rate (high speed communications)
- Sending commands to place device in Boot loader mode

Flash Magic provides a clear and simple user interface to these features. Under Windows, only one application may have access the COM Port at any one time, preventing other applications from using the COM Port.

Flash Magic only obtains access to the selected COM Port when ISP operations are being performed. This means that other applications that need to use the COM Port, such as debugging tools, may be used while Flash Magic is loaded.

4.6 ECLIPSE IDE

Eclipse is an integrated development environment (IDE) used in computer programming, and is the most widely used Java IDE. It contains a base workspace and an extensible plug-in system for customizing the environment. Eclipse is written mostly in Java and its primary use is for developing Java applications, but it may also be used to develop applications in other programming languages via plug-ins, including Ada, ABAP, C, C++, C#, COBOL, D, Fortran, Haskell, JavaScript, Julia, Lasso, Lua, NATURAL, Perl,

PHP, Prolog, Python, R, Ruby (including Ruby on Rails framework), Rust, Scala, Clojure, Groovy, Scheme, and Erlang. It can also be used to develop documents with LaTeX (via a TeXlipse plug-in) and packages for the software Mathematica. Development environments include the Eclipse Java development tools (JDT) for Java and Scala, Eclipse CDT for C/C++, and Eclipse PDT for PHP, among others.

The initial codebase originated from IBM Visual Age. The Eclipse software development kit (SDK), which includes the Java development tools, is meant for Java developers. Users can extend its abilities by installing plug-ins written for the Eclipse Platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules. Since the introduction of the OSGi implementation (Equinox) in version 3 of Eclipse, plug-ins can be plugged-stopped dynamically and are termed (OSGI) bundles.

Eclipse software development kit (SDK) is free and open-source software, released under the terms of the Eclipse Public License, although it is incompatible with the GNU General Public License. It was one of the first IDEs to run under GNU Class path and it runs without problems under Iced Tea.

4.7 PROGRAM CODE

EMBEDDED C PROGRAM

```
#include<P89V51RD2.H>                    // header file of RD2 microcontroller
#include<LCD.c>
#include<113_UART.c>
#include<gsm.c>


sbit w_m1=P1^0;
sbit w_m2=P1^1;
sbit w_m11=P1^2;
sbit w_m22=P1^3;
sbit ir1=P3^2; sbit
ir3=P3^4; sbit
ir2=P3^3; sbit
ir4=P3^5;
```

```
sbitRelay=P1^4;
sbitpir=P1^5; sbit
gas=P1^6;
code unsigned char SM_clock[] = {0x06,0x0C,0x09,0x03};                    //      For      Clockwise
Rotation code unsigned char SM_anticlock[] =
{0x06,0x03,0x09,0x0C};
char flag=0;
voidforward_motor();
void reverse_motor();
void left_motor(); void
right_motor();
voidSM_Clk_Rotate( char SM_data, char step_delay, bit Clk0_Anticlk1_flag );
xdata unsigned char SM_Step_Count = 0;
voidanticlock_Stepper(); void
clock_Stepper(); void
Device_Init( void ); void
MSDelay(unsigned int );
//-------------------------------------------------------------------------------------------------------------
// void main (void)
//-------------------------------------------------------------------------------------------------------------  - void
main( void )

{
Relay=0;
forward_motor();
reverse_motor();
left_motor();
right_motor();


Device_Init( );
GSM_Init();
ALCD_Message(  0X80, "  WELCOME  " );
MSDelay(500);
ALCD_Message(  0X01, "" );
while(1)
{
while(Rx_ST_Flag==0)
{
```

```
if(pir==1)
{
ALCD_Message(  0X01, "" );
ALCD_Message(  0X80, " HUMAN DETECTED " );
MSDelay(1000);
GSM_Send_SMS(Mb_Num, "HUMAN DETECTED" );
}
if(gas==1)
{
ALCD_Message(  0X01, "" );
ALCD_Message(  0X80, " GAS DETECTED " );
MSDelay(1000);
GSM_Send_SMS(Mb_Num, "GAS DETECTED" );
 }
if(ir1==1)
 {
ALCD_Message(  0X80, "ENEMY IN FRONT" );
MSDelay(1000);
ALCD_Message(  0X01, "" );
if(flag == 0)
{
flag=0;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 1)
 {
clock_Stepper();
flag=0;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
```

```
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 2)
{
anticlock_Stepper();
flag=0;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 3)
{
anticlock_Stepper();
anticlock_Stepper();
flag=0;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
GSM_Send_SMS(Mb_Num, "ENEMY IN FRONT" );
}
if(ir2==1)
{
ALCD_Message(  0X80, "ENEMY IN RIGHT" );
MSDelay(1000);
ALCD_Message(  0X01, "" );
if(flag == 0)
{
```

```
anticlock_Stepper();
flag=1;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 1)
{
flag=1;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 2)
{
anticlock_Stepper();
anticlock_Stepper();
flag=1;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 3)
{
clock_Stepper();
```

```
flag=1;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
GSM_Send_SMS(Mb_Num, "ENEMY IN RIGHT" );
}
if(ir3==1)
{
ALCD_Message(  0X80, "ENEMY IN LEFT" );
MSDelay(1000);
ALCD_Message(  0X01, "" );
if(flag == 0)
{
clock_Stepper();
flag=2;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 1)
{
clock_Stepper();
clock_Stepper();
flag=2;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
```

```
Relay=1;
 MSDelay(300);
Relay=0;
}
 else if(flag == 2)
{
flag=2;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 3)
{
anticlock_Stepper();
flag=2;
Relay=1;
MSDelay(300);
Relay=0;
 MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}

 GSM_Send_SMS(Mb_Num, "ENEMY IN LEFT" );

 }

if(ir4==1)

{
ALCD_Message(  0X80, "ENEMY IN BEHIND" );
MSDelay(1000);
ALCD_Message(  0X01, "" );
```

```
if(flag == 0)
{
clock_Stepper();
clock_Stepper();
flag=3;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 1)
{
anticlock_Stepper();
flag=3;
Relay=1;
MSDelay(300);
Relay=0;
 MSDelay(300);
Relay=1;
 MSDelay(300);
Relay=0;
}
else if(flag == 2)
{
clock_Stepper();
flag=3;
Relay=1;
MSDelay(300);
Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
else if(flag == 3)
```

```
{
flag=3;
Relay=1;
MSDelay(300);
 Relay=0;
MSDelay(300);
Relay=1;
MSDelay(300);
Relay=0;
}
GSM_Send_SMS(Mb_Num, "ENEMY IN BEHIND" );
}
}; //Rx_ST_Flag=0;
 if(Rx_data_arr[1]=='1')
{
 Rx_ST_Flag = 0;
 forward_motor();
 Rx_count=0;
 Rx_data_arr[0]='9';
}
else if(Rx_data_arr[1]=='4')
{
Rx_ST_Flag = 0;
reverse_motor();
Rx_count=0;
Rx_data_arr[0]='9';
}
else if(Rx_data_arr[1]=='3')
{
Rx_ST_Flag = 0;
left_motor();
Rx_count=0;
 Rx_data_arr[0]='9';
}
else if(Rx_data_arr[1]=='2')
{
Rx_ST_Flag = 0;
```

```
right_motor();
Rx_count=0;
Rx_data_arr[0]='9';
}  // while(1);
}
while(1)            // spin over
{;
}}
voidDevice_Init( void )
{
xdata unsigned char UC_count = 0xFD;                    // For 9600 Buad Rate
EA = 0;
UART0M1_Tx_Init( );                    // UART0 mode 1 Transmit initialization
Timer1M2_Init(UC_count );                              // Timer 1 mode 2 initialization
EA = 1;                                                // Enable Global Interrupts
TR1 = 1;                               // Start Timer 1
ALCD_Init();// 0.1 sec delay

}
voidMSDelay( unsigned intMilli_Sec )
{
data unsigned intx,y;
for(x=0;x<Milli_Sec;x++)
{
for(y=0;y<180;y++)
{
} }}
voidforward_motor()
{
w_m1=1;
w_m2=0;
w_m11=1;
w_m22=0;
MSDelay( 1000);
w_m1=0;
w_m2=0;
w_m11=0;
w_m22=0;
```

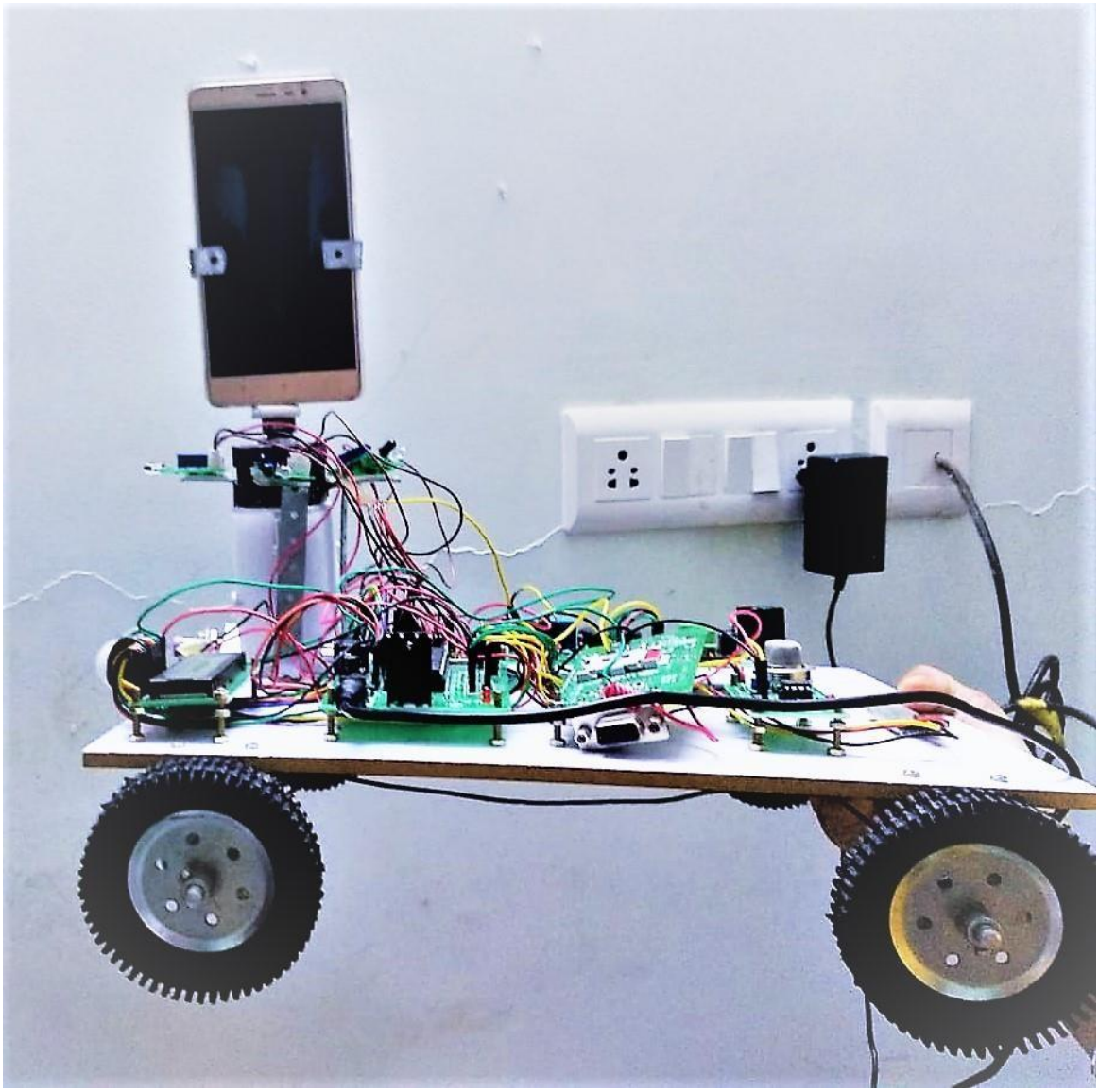
```
}
voidreverse_motor()
{
w_m1=0;
w_m2=1;
w_m11=0;
w_m22=1;
MSDelay( 1000);
 w_m1=0;
w_m2=0;
w_m11=0;
w_m22=0;
}
voidleft_motor()
{
w_m1=1;
w_m2=0;
 w_m11=0;
 w_m22=1;
 MSDelay( 1000);
 w_m1=0;
 w_m2=0;
 w_m11=0;
w_m22=0;
}
voidright_motor()
{
w_m1=0;
w_m2=1;
w_m11=1;
w_m22=0;
MSDelay( 1000);
w_m1=0;
w_m2=0;
w_m11=0;
 w_m22=0;
}
voidclock_Stepper()
```

```
{
unsigned char i;
SM_Step_Count = 0;
for(i=0; i<50; i++ )
{
SM_Clk_Rotate(SM_Step_Count, 5, 0 );                    // Clock wise rotation
SM_Step_Count++;
if(SM_Step_Count> 3 )
SM_Step_Count = 0;
 } }
voidanticlock_Stepper()
{
 unsigned char i;
SM_Step_Count = 0;
for(i=0; i<50; i++ )
{
SM_Clk_Rotate(SM_Step_Count, 5, 1 );            // Anti    clock     wise rotation
SM_Step_Count++;
if(SM_Step_Count> 3 )
SM_Step_Count = 0;
} }
 voidSM_Clk_Rotate( char SM_data, char step_delay, bit Clk0_Anticlk1_flag )
{
 if ( Clk0_Anticlk1_flag == 0 )
P0= SM_clock[SM_data];
else if ( Clk0_Anticlk1_flag == 1 )
P0 = SM_anticlock[SM_data];
 MSDelay(step_delay );
}
```

Chapter 5

RESULTS

This chapter discusses the results and any limitation and/or problems encountered during the period of the project.



5.1 RESULTS

Managed to successfully apply the merciless bsf using iot and wireless concepts. This prototype can be implemented in real life applications in the field of defence service in order to monitor the intruder trespass.

This prototype is user friendly and cost efficient, user friendly as in the device's movements can be controlled over a remote controller using Bluetooth connectivity. And cost efficient as in the prototype is a compact device which is portable, and it will cost exactly as the project requires (optimum price). It is not bulky and it is a moving robot.

5.2 LIMITATIONS

- Since we are using wireless communication for the video transfer, network might sometime be an issue.
- Intruder monitoring is difficult if they trespass through tunnels and not land.

Chapter 6

APPLICATIONS AND ADVANTAGES

6.1 APPLICATION

Fig:6.1 Applications

An unmanned ground vehicle (UGV) is a vehicle that operates while in contact with the ground and without an onboard human presence. UGVs can be used for many applications where it may be inconvenient, dangerous, or impossible to have a human operator present. Generally, the vehicle will have a set of sensors to observe the environment, and will either autonomously make decisions about its behaviour or pass the information to a human operator at a different location who will control the vehicle through teleoperation.

6.1.1 DESIGN

Based on its application, unmanned ground vehicles will generally include the following components: platform, sensors, control systems, guidance interface, communication links, and systems integration features.

- Platform

The platform can be based on an all terrain vehicle design and includes the locomotive apparatus, sensors and power source. Tracks, wheels and legs are the common forms of locomotion. In addition, the platform may include an articulated body and some are made to join with other units

- Sensors

A primary purpose of UGV sensors is navigation, another is environment detection. Sensors can include compasses, odometers, inclinometers, gyroscopes, cameras for triangulation, laser and ultrasound range finders, and infrared technology.

- Control systems

Unmanned ground vehicles are generally considered Remote-Operated and Autonomous, although supervisory control is also used to refer to situations where there is a combination of decision making from internal UGV systems and the remote human operator

- Remote operations

A remote-operated UGV is a vehicle that is controlled by a human operator via interface. All actions are determined by the operator based upon either direct visual observation or remote use of sensors such as digital video cameras. A basic example of the principles of remote operation would be a remote controlled toy car.

- Guidance interface

Depending on the type of control system, the interface between machine and human operator can include joystick, computer programs, or voice command Communication links between UGV and control station can be done via radio control or fibre optics. It may also include communication with other machines and robots involved in the operations.

- Systems integration

Systems architecture integrates the interplay between hardware and software and determines UGV success and autonomy.

6.1.2 RECONNAISSANCE

Reconnaissance is a mission to obtain information by visual observation or other detection methods, about the activities and resources of an enemy or potential enemy, or about the meteorologic, hydrographic, or geographic characteristics of a particular area. In military operations, reconnaissance or scouting is the exploration outside an area occupied by friendly forces to gain information about natural features and other activities in the area.

Examples of reconnaissance include patrolling by troops (skirmishers, long range reconnaissance patrol, u.s. army rangers, cavalry scouts, or military intelligence specialists), ships or submarines, manned/unmanned reconnaissance aircraft, satellites, or by setting up covert observation posts. Espionage normally is not reconnaissance, because reconnaissance is a military's Special Forces operating ahead of its main forces; spies are non-combatants operating behind enemy lines.

6.1.3 SURVEILLANCE

Surveillance is the monitoring of behaviour, activities, or other changing information for the purpose of influencing, managing, directing, or protecting people.[2]this can include observation from a distance by means of electronic equipment (such as closed-circuit television(cctv) cameras)or interception of electronically transmitted information (such as internet traffic or phone calls). it can also include simple no- or relatively low-technology methods such as human intelligence agents and postal interception. Surveillance is used by governments for intelligence gathering, prevention of crime, the protection of a process, person, group or object, or the investigation of crime. it is also used by criminal organisations to plan and commit crimes, such as robbery and kidnapping, by businesses to gather intelligence, and by private investigators.

6.1.4 LOW-INTENSITY CONFLICT (LIC)

It is a military conflict, usually localised, between two or more state or non-state groups which is below the intensity of conventional war. It involves the state's use of military forces applied selectively and with restraint to enforce compliance with its policies or objectives. The term can be used to describe conflicts where at least one or both of the opposing parties operate along such lines.

Low-intensity operations consist of the deployment and use of soldiers in situations other than war. For states, these operations are usually conducted against non-state actors and are given terms like counter-insurgency, anti-subversion, and peace keeping violent non-state actors often conduct low-intensity operations against states, often in insurgencies

6.1.5 COMBAT ENGINEERS

Also called field engineer, is a soldier who performs a variety of construction and demolition tasks under combat conditions.

The combat engineer's goals involve facilitating movement and support of friendly forces while impeding those of the enemy. Combat engineers build, repair and maintain buildings, roads and power supplies. They employ explosives for construction and demolition projects, and clear minefields using specialized vehicles such tasks typically include constructing and breaching trenches, tank traps and other fortifications , bunker construction , bridge and road construction or destruction , laying or cleaning land mines , and other physical work in the battle field. Typically, a combat engineer is also trained as an infantry man, and combat engineer units often have secondary role fighting as infantry.

6.1.6 WEAPONS PLATFORM

It is generally any structure or system on which a weapon can be mounted for example: a fighter jet is a weapons platform for missiles, bombs or auto-cannons. other vehicles such as the humvees (a type of four-wheel-drive all-terrain military vehicle) are considered weapons platforms as well, such as for grenade launchers, machine guns and some missile launchers.

6.1.7 HAZARDOUS MISSION SPECIFIC

A smart unmanned ground vehicle (UGV) is designed and developed for some application specific missions to operate predominantly in hazardous environments .In our work, we have developed a small and lightweight vehicle to operate in general cross country terrains in or without daylight. The UGV can send visual feedbacks to the operator

at a remote location. On board infrared sensors can detect the obstacles around the UGV and sends signals to the operator

6.1.8 COMMUNICATION LINKS

Communication between UGV and control station can be done via radio control or fiber optics. It may also include communication with other machines and robots involved in the operation.

6.2 ADVANTAGES

These robots are used to augment the soldier's capability in an open terrain. Self-controlled robot to undertake missions like border patrol, surveillance and in active combat both as a standalone unit (automatic) as well as in co-ordination with human soldiers (manual). Likewise, command controlled mode, we use another specific mode called, self-control mode or automatic mode. In this mode, UGV is manoeuvred automatically and it capable of travelling from one point to another point without human navigation commands. It uses GPS, magnetic compass and adjust strategies based on surroundings using path planning and obstacle detection algorithms.

The demand for military robots has increased tremendously. This has created lot of opportunities for re-searchers to develop efficient robots. The need for self con-trolled robots is due to the terrorism and insurgency problems faced by the people and soldiers. Huge investments are made by nations for the research of new defence systems which are capable of safeguarding citizens from terrorist threats.

Chapter 7

CONCLUSIONS AND SCOPE FOR FUTURE WORK

7.1 CONCLUSION

IoT has been gradually bringing a sea of technological changes in our daily lives, which in turn helps to making our life simpler and more comfortable, though various technologies and applications. There is innumerable usefulness of IoT applications into all the domains including medical, manufacturing, industrial, transportation, education, governance, mining, habitat etc. Though IoT has abundant benefits, there are some flaws in the IoT governance and implementation level. The key observations in the literature are that

- There is no standard definition in worldwide
- Universal standardizations are required in architectural level
- Technologies are varying from vendor-vendor, so needs to be interoperable
- For better global governance, we need to build standard protocols.

Let us hope future better IoT.

7.1.1SCOPE FOR FUTURE WORK

UGVs have many commercial and military applications ranging from agriculture maintenance, in particular crop harvesting and irrigation; to complex missile defence operations, such as advanced Patriot system functions.

Although there are many tactical and efficiency benefits to be gained from military UGVs, there are as many daunting challenge in developing them. After all, there is a huge difference between semi-autonomous and fully-autonomous. Achieving full autonomy is a three step process, the first phase involves technologies for assisting the driver and ensuring driver safety, followed by phases that introduce basic autonomous capabilities that then lay the groundwork for full autonomy. Having this level of autonomy along with a high level of scalability will require highly advanced robotics and system to system communication ability. Achieving this will require upgrades to existing hardware, software, sensors and payloads; modular designs, an open architecture for in/out software and standardization to

allow for faster development and incremental upgrades; miniaturization and light weights; and intelligent behavior that makes them easy for soldiers to work with. Perhaps the most important of these is open architecture. Systems constantly evolve because the environments they operate in is dynamic. Additional features and modifications are inevitable, and in order to prevent system failure the system architecture needs to be open ended to accommodate this change. Although there are many technological barriers that are currently preventing fully autonomous UGVs, the advantages of UGVs will push further research. There needs to a process that is used to further this research.

Touch Screen Controlled Defense Robot:

The robot system can be built with the existing economic conditions that can be used for different sophisticated robotic applications. The system provides continuous visual monitoring through the wireless camera attached to the robot and sends continuous data to the control unit. A multifunctional Robot is been designed according to the specifications made above which uses Zig-Bee Technology. ZigBee cannot be used to cover very long distance, it can only deal with low complexities and is very slow.

Design and Development of Wireless Multifunctional Robot for Military applications:

The project is presenting an IOT Based Wireless multifunctional robot for military application with SST89E516RD2 microcontroller using MQTT protocol and it is done by integrating various sensors, Cameras, Grippers and actuators into web application using MQTT and HTTP protocol. The system uses ARDUINO controller.

Multifunctional Robot for Border security Applications:

The system presents a modern approach for surveillance at remote and border areas using multifunctional robot based on current 3G technology used in defense and military applications. The robotic vehicle has ability to substitute the solider at border areas to provide surveillance. The robotic vehicle works both as autonomous and manually controlled vehicle using internet as communication medium.

Design and implementation of e- surveillance robot:

The proposed security solution hinges on the novel integration of camera on Raspberry Pi. Raspberry Pi operates and controls video camera for surveillance and records video for future playback.

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APPENDIX

The following are the list of topics of the datasheets been attached below, and the information collected from them are from their respective datasheets.

- LCD
- DC motor
- Relay
- Stepper motor
- Gas sensor
- SST89V516RDx microcontroller
- ULN2803

16 x 2 Character LCD

MECHANICAL DATA		
ITEM	STANDARD VALUE	UNIT
Module Dimension	84.0 x 44.0	mm
Viewing Area	66.0 x 16.0	mm
Dot Size	0.55 x 0.65	mm
Character Size	2.95 x 5.55	mm

ABSOLUTE MAXIMUM RATING					
ITEM	SYMBOL	STANDARD VALUE			UNIT
		MIN.	TYP.	MAX.	
Power Supply for Logic	VDD-VSS	- 0.3	–	7.0	V
Input Voltage	VI	- 0.3	–	VDD	V

NOTE: VSS = 0 Volt, VDD = 5.0 Volt

ELECTRICAL SPECIFICATIONS							
ITEM	SYMBOL	CONDITION		STANDARD VALUE			UNIT
				MIN.	TYP.	MAX.	
Input Voltage	VDD	VDD = + 5V		4.7	5.0	5.3	V
		VDD = + 3V		+ 2.7	3.0	5.3	V
Supply Current	IDD	VDD = + 5V		–	1.2	3.0	mA
Recommended LC Driving Voltage for Normal Temp. Version Module Nor Temp/Wide Temp	VDD - V0	- 20 °C		–	–	–	V
		0°C		4.2	4.6	5.0	
		25°C		3.8	4.2	4.6	
		50°C		3.6	4.0	4.4	
		70°C		–	–	–	
LED Forward Voltage	VF	25°C		–	4.2	4.6	V
LED Forward Current	IF	25°C	Array	–	130	260	mA
			Edge	–	20	40	
EL Power Supply Current	IEL	Vel = 110VAC:400Hz		–	–	5.0	mA

PIN NUMBER	SYMBOL	FUNCTION
1	Vss	GND
2	Vdd	+ 3V or +5V
3	Vo	Contrast Adjustment
4	RS	H/L Register Select Signal
5	R/$\overline{W}$	H/L Read/Write Signal
6	E	H →L Enable Signal
7	DB0	H/L Data Bus Line
8	DB1	H/L Data Bus Line
9	DB2	H/L Data Bus Line
10	DB3	H/L Data Bus Line
11	DB4	H/L Data Bus Line
12	DB5	H/L Data Bus Line
13	DB6	H/L Data Bus Line
14	DB7	H/L Data Bus Line
15	A/Vee	4.2V for LED/Negative Voltage Output
16	K	Power Supply for B/L (OV)

DC MOTOR

DRIVER CIRCUITS

Here the driver circuits are used to control the operations of firing unit, laser unit & audio reception unit present on the robotic module. Here three types of driver circuits are used they are ground driver, laser driver and motor driver circuit.

MOTOR DRIVER CIRCUIT

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. We have used this driver circuit too drive the motors of the robot. Each L293D is used to drive two motors.

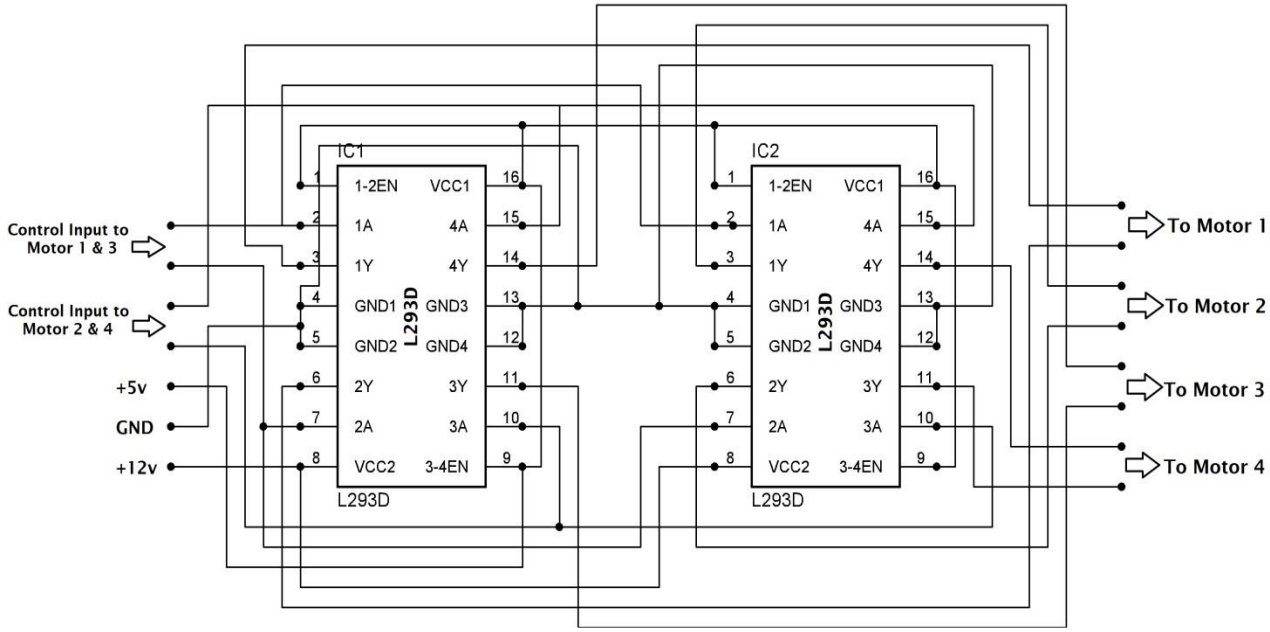

Figure 4.7: Motor Driver Circuit

Two L293D's are used to drive four motors. When both the inputs are low the motor will be in the halt state, when the first input is high and the second input is low the motor will move in the forward direction, when first input is low and second input is high the motor will move in the reverse direction and when both the inputs are low the motor will be in the halt state.

RELAYS

Packaging

Relays are available in a variety of unique package styles. The size and mass of the package are dependent on the electrical characteristics, power dissipation and environmental requirements. Relays are generally the larger size components of a system, where increased attention must be paid to clearances and mounting, especially in high vibration level environments. Many package styles initially developed for unique applications have since gained wide acceptance.

Table 1. Military Relay Specifications

Military Specification	Description
MIL-R-5757	Relays for Electrical, for Electronic and Communication Type Equipment
MIL-R-6106	Electromagnetic Relays
MIL-R-28776	Relays for Electrical for Electronic and Communication type Equipment, Hybrid
MIL-R-39016	Relay, Electromagnetic, Established Reliability
MIL-R-28750	Solid State Relay
MIL-R-83726	Time Delay, Hybrid and Solid State Relays

Packaging

Relays are available in a variety of unique package styles. The size and mass of the package are dependent on the electrical characteristics, power dissipation and environmental requirements. Relays are generally the larger size components of a system, where increased attention must be paid to clearances and mounting, especially in high vibration level environments. Many package styles initially developed for unique applications have since gained wide acceptance.

Failure Modes

Table 2 shows the relative probability of the three principal failure modes for relays. Relays most commonly fail in the "stuck open" position where the mechanical switching element fails to close and the relay fails to carry a current. Relays are less likely to unintentionally close or remain closed after the switching current is released. For this reason, the reliability of relay circuits can be improved by using parallel redundancy.

Table 2. Normalized Failure Mode Distributions for Relays

Failure Mode	Relative Probability
Failure to Trip	55%
Spurious Trip	26%
Short	19%

Temperature

Limit ambient temperature to maximum rated ambient temperature as shown in Table 3.

Table 3. Derating Requirements for Relays

Part Type	Derating Parameter	% of Resistive Load Rated Value in Environment		
		Category 1 Protected	Category 2 Normal	Category 3 Severe
Relay	Continuous Current	70 -- Resistive Load 70 -- Capacitive Load 50 -- Inductive Load 30 -- Motor 20 -- Filament (Lamp)	60 -- Resistive Load 60 -- Capacitive Load 40 -- Inductive Load 20 -- Motor 10 -- Filament (Lamp)	50 -- Resistive Load 50 -- Capacitive Load 30 -- Inductive Load 20 -- Motor 10 -- Filament (Lamp)
	Coil Energize Voltage	110, Maximum	110, Maximum	110, Maximum
	Coil Dropout Voltage	90, Minimum	90, Minimum	90, Minimum
	Ambient Temperature	10°C of Max Rated	20°C of Max Rated	30°C of Max Rated

STEPPER MOTOR

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.

Stepper Motor Advantages and Disadvantages

Advantages:

1. The rotation angle of the motor is proportional to the input pulse.
2. The motor has full torque at standstill (if the windings are energized)
3. Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3 – 5% of a step and this error is non-cumulative from one step to the next.
4. Excellent response to starting/ stopping/reversing.
5. Very reliable since there are no contact brushes in the motor. Therefore, the life of the motor is simply dependent on the life of the bearing.
6. The motors response to digital input pulses provides open-loop control, making the motor simpler and less costly to control.
7. It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft.
8. A wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses.

Disadvantages

1. Resonances can occur if not properly controlled.
2. Not easy to operate at extremely high speeds.

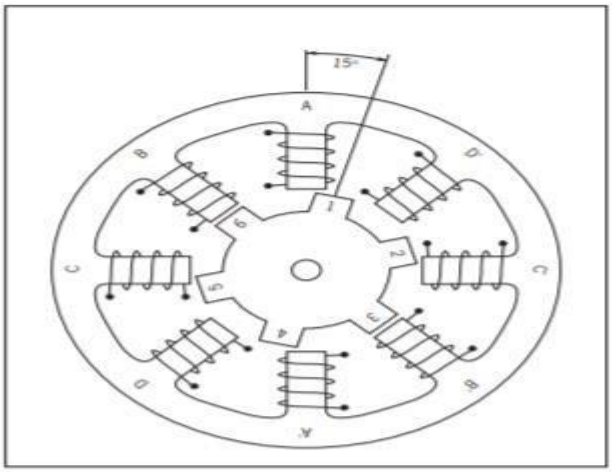

Figure 1. Cross-section of a variable-reluctance (VR) motor.

GAS SENSOR

Model No.			MQ-6
Sensor Type			Semiconductor
Standard Encapsulation			Bakelite (Black Bakelite)
Detection Gas			Isobutane, Butane, LPG
Concentration			300-10000ppm (Butane, Propane, LPG)
Circuit	Loop Voltage	V_c	≤24V DC
	Heater Voltage	V_H	5.0V±0.2V ACorDC
	Load Resistance	R_L	Adjustable
Character	Heater Resistance	R_H	31Ω±3Ω（Room Tem.）
	Heater consumption	P_H	≤900mW
	Sensing Resistance	R_s	2KΩ-20KΩ(in 2000ppm C_3H_8)
	Sensitivity	S	Rs(in air)/Rs(1000ppm C_4H_{10})≥5
	Slope	α	≤0.6($R_{3000ppm}/R_{1000ppm}$ LPG)
Condition	Tem. Humidity		20℃±2℃；65%±5%RH
	Standard test circuit		Vc:5.0V±0.1V； V_H: 5.0V±0.1V
	Preheat time		Over 48 hours

MICROCONTROLLER

2.1 Pin Descriptions

TABLE 2-1: Pin Descriptions (1 of 2)

Symbol	Type[1]	Name and Functions
P0[7:0]	I/O	**Port 0:** Port 0 is an 8-bit open drain bi-directional I/O port. As an output port each pin can sink several LS TTL inputs. Port 0 pins float that have "1"s written to them, and in this state can be used as high-impedance inputs. Port 0 is also the multiplexed low-order address and data bus during accesses to external memory. In this application, it uses strong internal pull-ups when transitioning to V_{OH}. Port 0 also receives the code bytes during the external host mode programming, and outputs the code bytes during the external host mode verification. External pull-ups are required during program verification.
P1[7:0]	I/O with internal pull-ups	**Port 1:** Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 output buffers can drive LS TTL inputs. Port 1 pins are pulled high by the internal pull-ups when "1"s are written to them and can be used as inputs in this state. As inputs, Port 1 pins that are externally pulled low will source current because of the internal pull-ups. P1[5, 6, 7] have high current drive of 16 mA. Port 1 also receives the low-order address bytes during the external host mode programming and verification.
P1[0]	I/O	**T2:** External count input to Timer/Counter 2 or Clock-out from Timer/Counter 2
P1[1]	I	**T2EX:** Timer/Counter 2 capture/reload trigger and direction control
P1[2]	I	**ECI:** PCA Timer/Counter External Input: This signal is the external clock input for the PCA timer/counter.
P1[3]	I/O	**CEX0:** Compare/Capture Module External I/O Each compare/capture module connects to a Port 1 pin for external I/O. When not used by the PCA, this pin can handle standard I/O.
P1[4]	I/O	**SS#:** Master Input or Slave Output for SPI. **OR** **CEX1:** Compare/Capture Module External I/O
P1[5]	I/O	**MOSI:** Master Output line, Slave Input line for SPI **OR** **CEX2:** Compare/Capture Module External I/O
P1[6]	I/O	**MISO:** Master Input line, Slave Output line for SPI **OR** **CEX3:** Compare/Capture Module External I/O
P1[7]	I/O	**SCK:** Master clock output, slave clock input line for SPI **OR** **CEX4:** Compare/Capture Module External I/O
P2[7:0]	I/O with internal pull-up	**Port 2:** Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. Port 2 pins are pulled high by the internal pull-ups when "1"s are written to them and can be used as inputs in this state. As inputs, Port 2 pins that are externally pulled low will source current because of the internal pull-ups. Port 2 sends the high-order address byte during fetches from external Program memory and during accesses to external Data Memory that use 16-bit address (MOVX @DPTR). In this application, it uses strong internal pull-ups when transitioning to V_{OH}. Port 2 also receives some control signals and high-order address bits during the external host mode programming and verification.
P3[7:0]	I/O with internal pull-up	**Port 3:** Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can drive LS TTL inputs. Port 3 pins are pulled high by the internal pull-ups when "1"s are written to them and can be used as inputs in this state. As inputs, Port 3 pins that are externally pulled low will source current because of the internal pull-ups. Port 3 also receives some control signals and a partial of high-order address bits during the external host mode programming and verification.
P3[0]	I	**RXD:** Universal Asynchronous Receiver/Transmitter (UART) - Receive Input
P3[1]	O	**TXD:** UART - Transmit output
P3[2]	I	**INT0#:** External Interrupt 0 Input

TABLE 2-1: Pin Descriptions (Continued) (2 of 2)

Symbol	Type[1]	Name and Functions
P3[3]	I	**INT1#:** External Interrupt 1 input
P3[4]	I	**T0:** External count input to Timer/Counter 0
P3[5]	I	**T1:** External count input to Timer/Counter 1
P3[6]	O	**WR#:** External Data Memory Write strobe
P3[7]	O	**RD#:** External Data Memory Read strobe
PSEN#	I/O	**Program Store Enable:** PSEN# is the Read strobe to External Program Store. When the device is executing from Internal Program Memory, PSEN# is inactive (V_{OH}). When the device is executing code from External Program Memory, PSEN# is activated twice each machine cycle, except when access to External Data Memory while one PSEN# activation is skipped in each machine cycle. A forced high-to-low input transition on the PSEN# pin while the RST input is continually held high for more than ten machine cycles will cause the device to enter External Host mode for programming.
RST	I	**Reset:** While the oscillator is running, a high logic state on this pin for two machine cycles will reset the device. After a reset, if the PSEN# pin is driven by a high-to-low input transition while the RST input pin is held high, the device will enter the External Host mode, otherwise the device will enter the Normal operation mode.
EA#	I	**External Access Enable:** EA# must be driven to V_{IL} in order to enable the device to fetch code from the External Program Memory. EA# must be driven to V_{IH} for internal program execution. However, Security lock level 4 will disable EA#, and program execution is only possible from internal program memory. The EA# pin can tolerate a high voltage[2] of 12V.
ALE/PROG#	I/O	**Address Latch Enable:** ALE is the output signal for latching the low byte of the address during an access to external memory. This pin is also the programming pulse input (PROG#) for flash programming. Normally the ALE[3] is emitted at a constant rate of 1/6 the crystal frequency[4] and can be used for external timing and clocking. One ALE pulse is skipped during each access to external data memory. However, if AO is set to 1, ALE is disabled.
P4[3:0][5]	I/O with internal pull-ups	**Port 4:** Port 4 is an 4-bit bi-directional I/O port with internal pull-ups. The port 4 output buffers can drive LS TTL inputs. Port 4 pins are pulled high by the internal pull-ups when '1's are written to them and can be used as inputs in this state. As inputs, port 4 pins that are externally pulled low will source current because of the internal pull-ups.
P4[0]	I/O	Bit 0 of port 4
P4[1]	I/O	Bit 1 of port 4
P4[2] / INT3#	I/O	Bit 2 of port 4 / INT3# External Interrupt 3 input
P4[3] / INT2#	I/O	Bit 3 of port 4 / INT2# External Interrupt 2 input
XTAL1	I	**Crystal 1:** Input to the inverting oscillator amplifier and input to the internal clock generator circuits.
XTAL2	O	**Crystal 2:** Output from the inverting oscillator amplifier
V_{DD}	I	**Power Supply**
V_{SS}	I	**Ground**

T2-1.0 1273

ULN

DEVICE PART NUMBER DESIGNATION

$V_{CE(MAX)}$	50 V	95 V
$I_{C(MAX)}$	500 mA	500 mA
Logic	**Part Number**	
5V TTL, CMOS	ULN2803A* ULN2803LW*	ULN2823A* ULN2823LW
6-15 V CMOS, PMOS	ULN2804A* ULN2804LW*	ULN2824A* ULN2824LW

Types ULx2803A, ULx2803LW, ULx2804A, and ULx2804LW
ELECTRICAL CHARACTERISTICS at +25°C (unless otherwise noted).

Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			
					Min.	Typ.	Max.	Units
Output Leakage Current	I_{CEX}	1A	All	V_{CE} = 50 V, T_A = 25°C	—	< 1	50	µA
				V_{CE} = 50 V, T_A = 70°C	—	< 1	100	µA
		1B	ULx2804x	V_{CE} = 50 V, T_A = 70°C, V_{IN} = 1.0 V	—	< 5	500	µA
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	2	All	I_C = 100 mA, I_B = 250 µA	—	0.9	1.1	V
				I_C = 200 mA, I_B = 350 µA	—	1.1	1.3	V
				I_C = 350 mA, I_B = 500 µA	—	1.3	1.6	V
Input Current	$I_{IN(ON)}$	3	ULx2803x	V_{IN} = 3.85 V	—	0.93	1.35	mA
			ULx2804x	V_{IN} = 5.0 V	—	0.35	0.5	mA
				V_{IN} = 12 V	—	1.0	1.45	mA
	$I_{IN(OFF)}$	4	All	I_C = 500 µA, T_A = 70°C	50	65	—	µA
Input Voltage	$V_{IN(ON)}$	5	ULx2803x	V_{CE} = 2.0 V, I_C = 200 mA	—	—	2.4	V
				V_{CE} = 2.0 V, I_C = 250 mA	—	—	2.7	V
				V_{CE} = 2.0 V, I_C = 300 mA	—	—	3.0	V
			ULx2804x	V_{CE} = 2.0 V, I_C = 125 mA	—	—	5.0	V
				V_{CE} = 2.0 V, I_C = 200 mA	—	—	6.0	V
				V_{CE} = 2.0 V, I_C = 275 mA	—	—	7.0	V
				V_{CE} = 2.0 V, I_C = 350 mA	—	—	8.0	V
Input Capacitance	C_{IN}	—	All		—	15	25	pF
Turn-On Delay	t_{PLH}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	µs
Turn-Off Delay	t_{PHL}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	µs
Clamp Diode Leakage Current	I_R	6	All	V_R = 50 V, T_A = 25°C	—	—	50	µA
				V_R = 50 V, T_A = 70°C	—	—	100	µA
Clamp Diode Forward Voltage	V_F	7	All	I_F = 350 mA	—	1.7	2.0	V

Characteristic	Symbol	Test Fig.	Applicable Devices	Test Conditions	Limits			
					Min.	Typ.	Max.	Units
Output Leakage Current	I_{CEX}	1A	All	V_{CE} = 95 V, T_A = 25°C	—	< 1	50	µA
				V_{CE} = 95 V, T_A = 70°C	—	< 1	100	µA
		1B	ULx2824x	V_{CE} = 95 V, T_A = 70°C, V_{IN} = 1.0 V	—	< 5	500	µA
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	2	All	I_C = 100 mA, I_B = 250 µA	—	0.9	1.1	V
				I_C = 200 mA, I_B = 350 µA	—	1.1	1.3	V
				I_C = 350 mA, I_B = 500 µA	—	1.3	1.6	V
Input Current	$I_{IN(ON)}$	3	ULx2823x	V_{IN} = 3.85 V	—	0.93	1.35	mA
			ULx2824x	V_{IN} = 5.0 V	—	0.35	0.5	mA
				V_{IN} = 12 V	—	1.0	1.45	mA
	$I_{IN(OFF)}$	4	All	I_C = 500 µA, T_A = 70°C	50	65	—	µA
Input Voltage	$V_{IN(ON)}$	5	ULx2823x	V_{CE} = 2.0 V, I_C = 200 mA	—	—	2.4	V
				V_{CE} = 2.0 V, I_C = 250 mA	—	—	2.7	V
				V_{CE} = 2.0 V, I_C = 300 mA	—	—	3.0	V
			ULx2824x	V_{CE} = 2.0 V, I_C = 125 mA	—	—	5.0	V
				V_{CE} = 2.0 V, I_C = 200 mA	—	—	6.0	V
				V_{CE} = 2.0 V, I_C = 275 mA	—	—	7.0	V
				V_{CE} = 2.0 V, I_C = 350 mA	—	—	8.0	V
Input Capacitance	C_{IN}	—	All		—	15	25	pF
Turn-On Delay	t_{PLH}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	µs
Turn-Off Delay	t_{PHL}	8	All	0.5 E_{IN} to 0.5 E_{OUT}	—	0.25	1.0	µs
Clamp Diode Leakage Current	I_R	6	All	V_R = 95 V, T_A = 25°C	—	—	50	µA
				V_R = 95 V, T_A = 70°C	—	—	100	µA
Clamp Diode Forward Voltage	V_F	7	All	I_F = 350 mA	—	1.7	2.0	V

Complete part number includes prefix to operating temperature range: ULN = -20°C to +85°C, ULQ = -40°C to +85°C