

# “Security Operations in the Protected Area or loc with Wireless Secured Communication and Tracking Device”

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**Abstract-***This paper presents a ground robot challenge that examines the application and competence of technologies that include positioning, object grasping, force control, target identification, and system stability. Teams are challenged to develop a lightweight mobile manipulator that can autonomously pick, transport and stack building blocks, and will compete on the bases of completion time and assembly height, while meeting the specified weight and size constraints on the robot. This paper presents the design and implementation of vision-based surveillance robot system that integrates an off-the-shelf Android smart phone. Micro aerial vehicles (MAVs) are small lightweight unmanned aerial vehicles used by dismounted soldiers for aerial reconnaissance and acquiring information for local situation awareness.*

## I. INTRODUCTION

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 casualties and later statements by Pakistan's Prime Minister and Chief of Army Staff showed involvement of Pakistani paramilitary forces, led by General Ashraf Rashid.

The Indian Army, later on supported by the Indian Air Force, recaptured a majority of the positions on the Indian side of the LOC infiltrated by the Pakistani troops and militants. With international diplomatic opposition, the Pakistani forces withdrew from the remaining Indian positions along the LOC.

The war is one of the most recent examples of high altitude warfare in mountainous terrain, which posed significant logistical problems for the combating sides. INDIAN government had to face huge loss because of the war. Human loss, machine loss, aircrafts, tankers. Indian economy decreased by 38%, cost of all commodities increased, taxes increased all together country had to face tremendous loss. The proposed system is based on IOT. The system uses an IR and camera based security system

for protected areas and borders, Which senses intruders, trespassers and transfer video to other end.

Internet of things (IOT) is the network of physical devices, vehicles, home appliances and other items Embedded with electronics, software, sensors, actuators, and network activity which enables these objects to connect and exchange data.

## II. LITERATURE SURVEY

### 2.1 “Design and Development of multifunctional Robot for Military purpose Applications”

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.

### 2.2 “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 control system consists of Touch screen 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.

### 2.3 “Wireless Multifunctional Robot for Military Applications”

The system presents a modern approach for surveillance at remote and border areas using multifunctional robot based on current 3G technology used in Defence and military applications. The robotic vehicle has ability to substitute

the soldier at border areas to provide surveillance. The robotic vehicle works both as autonomous and manually controlled vehicle using internet as communication medium. This multisensory robot used to detect human, bombs, harmful gases and fire at remote and war field areas.

### III. SYSTEM ANALYSIS

System analysis is a problem solving technique that decomposes a system into its component pieces for the studying how well those components parts works and interact to accomplish their purpose. The development of a computer-based information system includes a system analysis phase which produces or enhances the data model which itself is a precursor to creating or enhancing a database.

#### EXISTING SYSTEM

As we have seen many different devices are used for mine detections, weapon detection, gas detection human detection and gas detection etc. In present existing system there are different servers are required for each robot. And we need more employees to control each system. 360° rotating camera is not used. For recording continues video there is no camera facility is not present. There is no GPS connection present in existing system. Security management is one of the most important challenges in LOC area in Army. Cost consumption is high.

#### DISADVANTAGES

- Vast Area constraints.
- Huge human resource is required.
- Area and Climatic challenges are taken into consideration.
- Mines, live human, shooting, gas detection, wireless camera and GPS connections are not implemented in single device.
- Different servers are used for each device
- Cost consumption is high.

#### PROPOSED SYSTEM

The proposed systems 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. The device also shoots the intruder when enemy cross the border, the bullet is equipped with a GPS facility if the intruder escapes then the system can track enemy with the help of ARM 11 devices or smartphone. The gun rotate 360° direction. The device will also activate the Camera, which will start capture the live video and transmit the same to the receiver end that is the smart phone. Using camera it detect object then it send alert to the control room where user can perform all operation.

The robot would also consists of a Gas sensor, and would immediately intimate the respected guards about the

attacks. The system would also consist of a mine sensor, with which it can detect any hidden activated bombs and with the help of GPS facility it would send the exact location of the hidden bomb. In this the robot has been designed and developed which has capability that can move using parallel leg mechanism.

#### ADVANTAGES

- Sensors used to detecting Mines, Weapons, motion and Gas.
- Wireless GPS connection between the device and server.
- Locations are tracked using GPS connection.
- 360 Wireless camera connection with high storage capacity.
- Shooting facility live human detected.
- Motion detected - message or call alert to given Number.
- Surgical attacks are detected.
- Voice and message alarm in case of emergency.
- Low human resources are required.

#### APPLICATION

- Mainly implemented in the border area of our Indian Army
- Mainly implemented for wireless security of Line of Control areas.

### IV. REQUIREMENT SPECIFICATIONS

Requirements analysis gives a broad definition of the system according to the need to understand the various concerned activities precisely. According to the requirement collected from the clients and through the meeting, analysis is done and a specification is prepared. All computer software needs certain hardware components or other software resources. These prerequisites are known as system requirements and are often used as a guideline as opposed to an absolute rule. Most software defines two sets of system requirements: minimum and recommended. With increasing demand for higher processing power and resources in newer versions of software, system requirements tend to increases over time. Industry analysts suggest that this trend plays a bigger part in driving upgrades to existing computer that technological advancement.

#### HARDWARE REQUIREMENTS

##### 1. PIR SENSOR

The unit output is high whenever human's motion is detected. PIR stands for Passive Infrared. In simple terms, it is a motion detector. This sensors measure infrared radiation emanating from objects in the field of view. It only has one output pin and another two pins is connected to 5V and GND separately. Apparent motion is detected when an infrared emitting source with one temperature,

such as human body, passes in front of source with another temperature, such as wall. The unit output is high whenever there is motion detected. If the motion is continuous, the output remains high. After motion stops, the output remains high for a few seconds (depend on the variable resistor adjusted). It will remain high for longer if H from the jumper is selected.



Fig:1 Passive Infrared Sensor

As shown in the above fig.1 A Passive Infrared sensor (PIR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. PIR sensors are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall. All objects emit what is known as black body radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term passive in this instance means that the PIR device does not emit an infrared beam but merely passively accepts incoming infrared radiation.

The human body radiates infrared waves with wavelengths of 8 to 12 micrometers. Any movement by a person leads to a change in the amount of infrared energy which a sensor can detect within its range. The PIR sensor reacts to this change in infrared energy and provides a low-frequency, small amplitude signal. This signal can be amplified and decoded using microcontroller.

## 2. SST89E516RD2 Micro controller

The SST89E516RD2 is a member of the Flash Flex family of 8-bit microcontroller products designed and manufactured with patented and proprietary Super Flash CMOS semiconductor process technology. The split-gate cell design and thick-oxide tunneling injector offer significant cost and reliability benefits for SST customers. It uses the 8051 instruction set and is pin- for-pin compatible with standard 8051 microcontroller devices. As shown in the below figures are the different version of microcontroller i.e. SST89E516RD2 and SST89E516RD.



Fig:2 SST89E516RD2 and SST89E516RD

## Micro Controller

### FEATURES

- SST89E516RD2 - Silicon Storage Technology where 89E is version Research Development 2.
- 8-bit 8051-Compatible Microcontroller (MCU) with Embedded Super Flash Memory
- Fully Software Compatible - Development Toolset Compatible - Pin-For-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 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
- ^ SST89E516RD2 Operation- 0 to 40 MHz at 5V
- ^ SST89V516RD2 Operation- 0 to 33 MHz at 3V
- ^ 1 Kbyte Internal RAM

### 3. LCD

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals as shown in below fig. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

### 3. SPECIFICATIONS:

- Resolution

- Spatial performance
- Temporal performance
- Color performance
- Brightness and contrast ratio

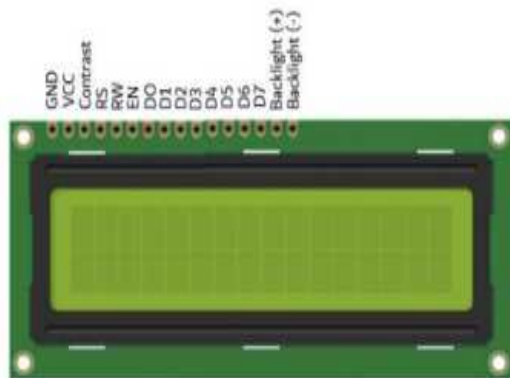


Fig:3 Display of LCD Screen

#### 4. GSM

GSM (Global System for Mobile Communications, originally Groupie Special Mobile) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation digital cellular networks used by mobile devices such as tablets, first deployed in Finland in December 1991. As of 2014, it has become the global standard for mobile communications - with over 90% market share, operating in over 193 countries and territories

GSM is a digital mobile telephony system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

2G networks developed as a replacement for first generation (1G) analog cellular networks, and the GSM standard originally described as a digital, circuit-switched network optimized for full duplex voice telephony. This expanded over time to include data communications, first by circuit-switched transport, then by packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution, or EGPRS). Subsequently, the 3GPP developed third-generation (3G) UMTS standards, followed by fourth-generation (4G) LTE Advanced standards, which do not form part of the ETSI GSM standard.



Fig:4 Global System for Mobile

#### 5.LED

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p-n junction diode that emits light when activated. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm<sup>2</sup>) and integrated optical components may be used to shape the radiation pattern.

#### ADVANTAGES

- Energy efficiency
- Extended life
- Cold temperature operation
- Durability
- Rapid cycling
- Controllability
- No IR or UV Emissions

#### 6. GPS

The Global Positioning System (GPS) fig. shown in below are originally Navistar GPS is a satellite-based radio navigation system owned by the United States government and operated by the United States Air Force. It is a global navigation satellite system that provides geo location and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. Obstacles such as mountains and buildings block the relatively weak GPS signals.

The GPS does not require the user to transmit any data, and it operates independently of any telephonic or internet reception, though these technologies can enhance the usefulness of the GPS positioning information. The GPS provides critical positioning capabilities to military, civil, and commercial users around the world.



Fig:5 Global Positioning System

#### Application in Military

- Navigation: Soldiers use GPS to find objectives, even in the dark or in unfamiliar territory, and to coordinate troop and supply movement.
- Target tracking: Various military weapons systems use GPS to track potential ground and air targets before flagging them as hostile, these weapon systems pass target coordinates to precision-guided munitions to allow them to engage targets accurately. Military aircraft, particularly in air-to-ground roles, use GPS to find targets.
- Missile and projectile guidance: GPS allows accurate targeting of various military weapons including ICBMs, cruise missiles, precision-guided munitions and artillery shells.
- Search and rescue.

Reconnaissance: Patrol movement can be managed more closely.

GPS satellites carry a set of nuclear detonation detectors consisting of an optical sensor called a bang meter

GPS type navigation was first used in war in the 1991 Persian Gulf War, before GPS was fully developed in 1995, to assist Coalition Forces to navigate and perform maneuvers in the war. The war also demonstrated the vulnerability of GPS to being jammed, when Iraqi forces installed jamming devices on likely targets that emitted radio noise, disrupting reception of the weak GPS signal.

#### Application

Many civilian applications use one or more of GPS's three basic components: absolute location, relative movement, and time transfer.

- Agriculture
- Automated vehicle
- Cellular telephony
- Clock synchronization
- Disaster relief/emergency services

- Radio occultation for weather and atmospheric science applications.
- GPS aircraft tracking
- GPS data mining
- Recreation
- Robotics
- Sport

#### 7. STEPPER MOTOR

A stepper motor or step motor or stepping motor is a brushless DC electric motor that 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 position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed. Stepper motor is a special type of electric motor that moves in increments, or steps, rather than turning smoothly as a conventional motor does. The size of the increment is measured in degrees and can vary depending on the application.

Typical increments are 0.9 or 1.8 degrees, with 400 or 200 increments thus representing a full circle. The speed of the motor is determined by the time delay between each incremental movement.

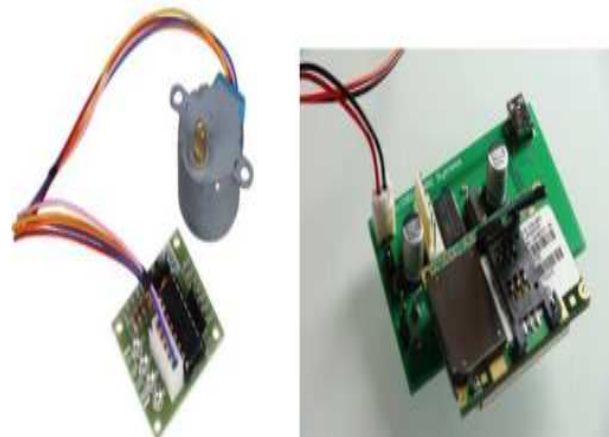


Fig.6 5V Stepper motor and L298 Stepper Motor driver

An electric motor is all about magnets and magnetism: the working principle of motor. A motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets: Opposites attract and likes repel. So if you have two bar magnets with their ends marked "north" and "south," then the north end of one magnet will attract the south end of the other. On the other hand, the north end of one magnet will repel the north end of the other (and similarly, south will repel south). Inside an electric motor, these attracting and repelling forces create rotational motion.

#### 8. POWER SUPPLY

An AC to DC adaptor has been used to get DC input for the mother board. In mother board, we have developed a



5V regulator circuit, which is needed for microcontroller as supply voltage. IR transmitters are also connected to 5V supply, so that they always transmit high signal. LM7805 is used for 5V regulated supply. The

below fig. 4.18 shows the circuit diagram of power supply.

#### FEATURES

- Output current in excess of 0.5A
- No external components
- Internal thermal overload protection
- Internal short circuit current-limiting
- Output transistor safe-area compensation
- Available in TO-220, TO-39, and TO-252 D-PAK packages
- Output voltages of 5 V, 12V, and 15V

#### 9. DC MOTORS

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 are shown in below fig.4.19 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.

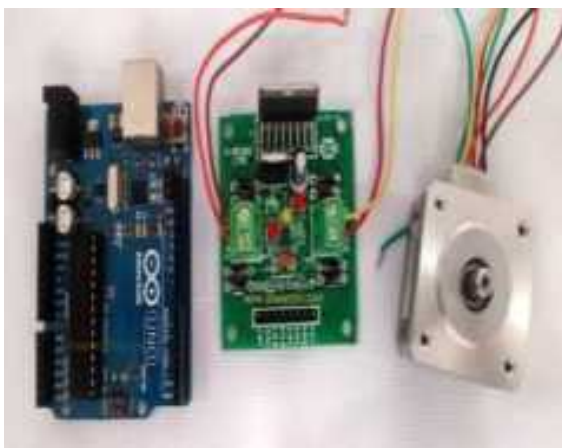


Fig.7 DC MOTOR

#### FEATURES OF DC MOTOR:

- > Bidirectional Shaft rotation
- > Accepts PWM pulses for Speed Control
- > Works with wide range of Voltages
- > Gear ratio of 50:1 provides a good torque for easy effortless elevator motion.

> Rugged Design for more reliability.

#### SOFTWARE REQUIREMENTS

##### 1. ANDRIOD

Android is a complete set of software for mobile devices such as tablet computers, smart phones, electronic book readers, notebooks, set-top boxes etc. It contains a Linux based operating systems, middleware and key mobiles applications. It can be thought of as a mobile operating system. It is not limited to mobile only. It is currently used in mobiles, tablets televisions etc. middleware is computer software that provides services to software applications beyond those availability from the operating system.it can be described as “software glue”. Middleware makes it easier for software developers to perform communication and input/output, so they can focus on the specific purpose of their applications.

##### 2. JDK

A Java Development Kit (JDK) is a program developed environment for writing Java applets and applications. It consists of a runtime environment that “sits on top” of the operating systems layers as well as the tools and programming that developers need to compile, debug and run applets and applications written in the Java languages.

##### 3. ECLIPSE

Eclipse is a platform that has been designed from the ground up for building integrated web and applications developed tooling. By design, the platform does not provides a great deal of end user functionality by itself. The value of the platform is what it encourages rapid development of integrated features based on a plug-in model.

Eclipse provides a common user interface model for working with tools. It is designed to run on multiple operation systems while providing robust integration with each underlying OS. Plug in can program to the Eclipse portable APIs and run unchanged on any of the supported operating systems.

##### 4. SQLite

Like any other applications you may have the need to store data in some kind of a database. For iPhone applications, we can use SQLite for free. SQLite is a software library that implements a self- contained, server less, zero-configuration, transactions SQL database engine.

SQLite is an embedded relational database engine. Its developers call it a self-contained, server less, zero-configuration, transactions SQL database engine. It is very popular and there are hundreds of millions copies worldwide in use today.

#### V. SYSTEM DESIGN

The word system is possibly the most overused and abused term in the technical lexicon. System can be defined as the “a set of fact, principles, rules etc., classified and arranged in an orderly form so as to show a logical plan linking the various parts” here the system design defines the computer based information system. The primary objective is to identify user requirements and to build a system that satisfies these requirements.

Design is much more creative process than analysis. Design is the first step in the development of any system or product. Design can be defined as “the process of applying various techniques and principles for the purpose of defining a device, a process or a system in sufficient detail to permit its physical realization”.

It involves four major steps they are

- Understanding how the system is working now;
- Finding out what the system does now;
- Understanding what the new system will do; and
- Understanding how the new system will work.

So as to avoid these difficulties, a new system was designed to keep these requirements in mind. Therefore the manual process operation has been changed into GUI based environment, such that the user can retrieve the records in a user-friendly manner and it is very easy to navigate to the corresponding information.

VI. SYSTEM ARCHITECTURE

The proposed system has an IR Sensor which senses any intruders/trespassers and will activate the alarm as well as switch on the guns in that particular place. The robot also shoots the intruder when he cross the border, the bullet is equipped with a GPS facility if the intruder escapes then the system can track him with the help of ARM 11 devices or smartphone. The robot will also activate the Camera, which will start capture the live video and transmit the same to the receiver end that is the smart phone.

The robot would also consists of a Gas sensor, and would immediately intimate the respected guards about the attacks. The system would also consist of a mine sensor, with which it can detect any hidden activated bombs and with the help of GPS facility it would send the exact location of the hidden bomb.

The below block diagram gives an idea of how the robot works. It shows how the system circuit works and how the current flow goes through it. The wireless communication used is Bluetooth which helps in transferring the data and messages. . In the proposed system, the system circuit can be implemented with the help of a block diagram which includes the sensors, modules of Bluetooth, camera, buzzer unit and the power supply.

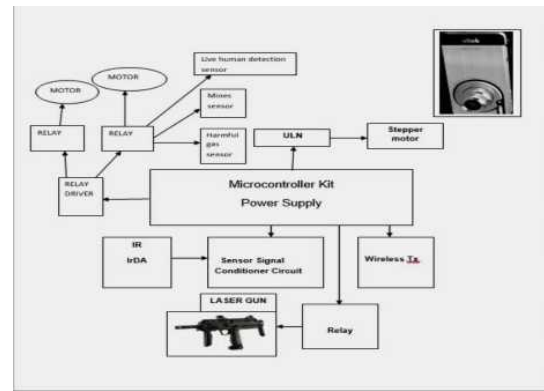


Fig:8 Block Diagram of the Device

VII. FLOW CHART

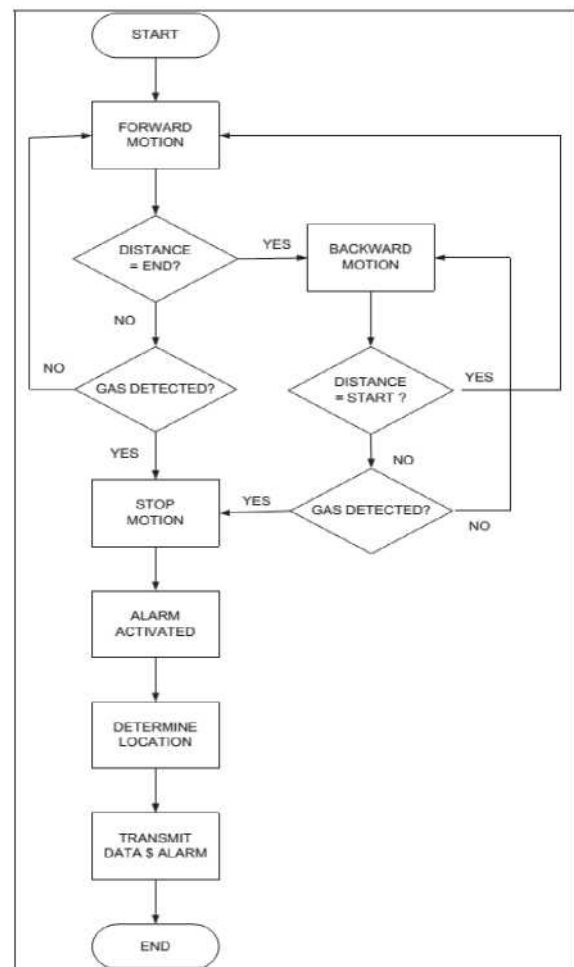


Fig.9 Flow Chart of LOC

SYSTEM CIRCUIT DIAGRAM

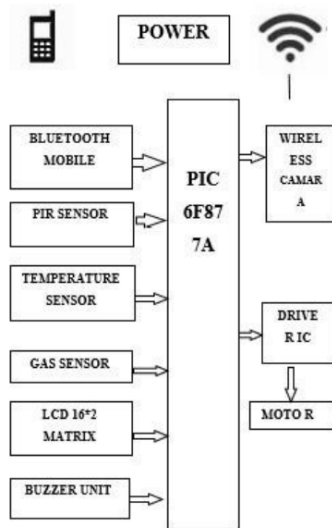


Fig:10 System Circuit Diagram

The mine detecting robot works in single mode, which means that, the robot can be controlled in manual mode only. This is the distinguishing factor while compared to the other kind of robots, as the most of the bots work in manual mode. The manual mode robot is programmed within the embedded chip. This version of robot is mainly defined by the factor named Artificial Intelligence. The second distinguishing factor from the other robots is that, the proposed robot is capable of sensing humans, who are trapped inside the coal mines. This is done with the help of sensor (PIR) which help in detecting obstacles.

Buzzer unit act as an indicator, that is, it helps in identifying whether any obstacle is present in its way or not. If an obstacle is present, it gives an alert message to its operator. The PIR (Passive Infra-Red) sensor is used mainly for detecting the obstacles. The motor helps in moving the robot which implemented with the help of driver IC. The aim of the robot is monitoring and detecting the variations in human, gas and obstacles in coal mine environments. Not only detecting, tracing on to a screen can be easily done by wireless camera attached on the robot. The visualization of all details is done by using the wireless LCD connected to the robot, so that all details of the environment can trace easily.

## VIII. SENSORS

### 1. Bluetooth Module

Bluetooth is used for sending videos, and pictures. Although Wi-Fi is a good transmission media they are not used in this robot because the rays are very explosive in nature. So we are using Bluetooth module.

### 2. Gas Sensor

MQ-3-SEN-O8880 is the sensor used for detecting the hazardous gas details of the environment. MQ-4 gas sensor

has high sensitivity to Methane, also to Propane and Butane. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. The sensor could be used to detect different combustible gas, especially Methane; it is with low cost and suitable for different application.

### 3. Driver IC

The movement of the wheels are controlled by driver IC that is placed on the PIC microcontroller. The 360 degree movement of this robot can be done using these driver IC's which controls the motors of the robot.

### 4. Wireless Camara

The live streaming of the environment can be possible by using a wireless camera also the images can be spot out. By the name declares the camera was connected to the screen wirelessly.

### 5. Buzzer Unit

Buzzer unit is used for the indication purpose, that is, it gives a sound alert when there is any variation of cases, temperature and if there is any obstacles are there in front of the robot. Through the alert we can easily understand the situation of the field.

## IX. SNAPSHOTS

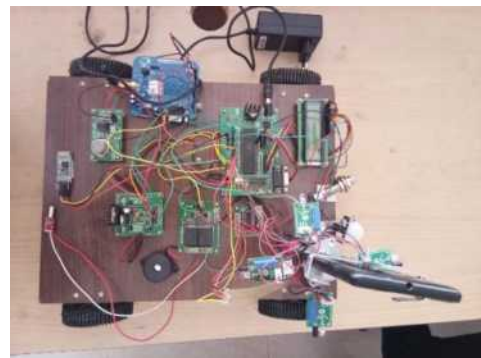


Fig.11 Moving Device

## X. CONCLUSION

In this project the current area of research where lots of scope exists. Currently this particular security technique is required by several countries .one such enhancement we are trying to do.

The type of communication technique enhance operation, where the user can control the m from any part of world by getting live video feedback, compared to earlier robots work like Wi-Fi with constraints have limited, IoT and s video camera makes it cost effectiveness combat robot. This robotic vehicle with different widely be used as surveillance robot for se c emergency rescue operations where human and user will be able to alert prior to intruder

The proposed system gives an exposure to design a multifunctional Defence robot. This robot has a



widespread industrial, defense applications. The laser gun attached to the robot is an excellent substitute for the weapons carried by the soldiers. The laser gun can be triggered with the help of wireless camera. It can be used in a hostage situation to pinpoint the exact location of terrorists with the help of wireless camera, saving many lives during rescue mission. Another application is border security system to sense movement of intruder through pair sensor. The current range of operations is up to 10m and can be made more sophisticated. Laser gun found to be very accurate in pointing to the target.

#### FUTURE SCOPE

We can use this system for military applications installing suitable sensors. Just by changing the robotic unit design we can use it in hospitals for patient monitoring. Using some chemical sensors we can detect harmful gas leakage in the chamber the time delay which occurs in the execution of commands can be reduced and thus we can have more real time access to the robot. With reduced time delay we can have faster operation and quick response to any illegal activities in the monitored area. Also it can be used as a spy robot. The robot is very economical.

In future we can create this device fully automatic using artificial intelligence. In current robot we can sense the metal device near to device only. In future we can create a device to detect for a vast area

#### REFERENCES

- [1] Tarunpreet Kaur, Dilip Kumar, "Wireless Multifunctional Robot for Military Applications" Proceedings of 2015 RA ECS UIET Punjab University Chandigarh 21-22nd, December 2015.
- [2] Kishan Malaviya, Mihir Vyas, Ashish, Vara, "Autonomous Landmine Detecting and Mapping Robot", Silver Oak College of Engg & Tech, Gujarat Technological University, Gujarat. Vol-3 Issue-2, February 2015.
- [3] Sharath Sethu Raghavan, Jasim M, Aqib Saman K, Jisnu Thomas, Faheem E, "Hazardous Gas & Mine Detecting Robot", IES College of Engineering, Calicut University, Thrissur, Kerala, vol1 JUNE 2017.
- [4] Bhawana D. Parate and Jagruti J. Shah, "Design and Development of Multifunctional Robot for Military Purpose Application", International Journal of Engineering Research and Applications IJERA ISSN: 2248-9622 International.