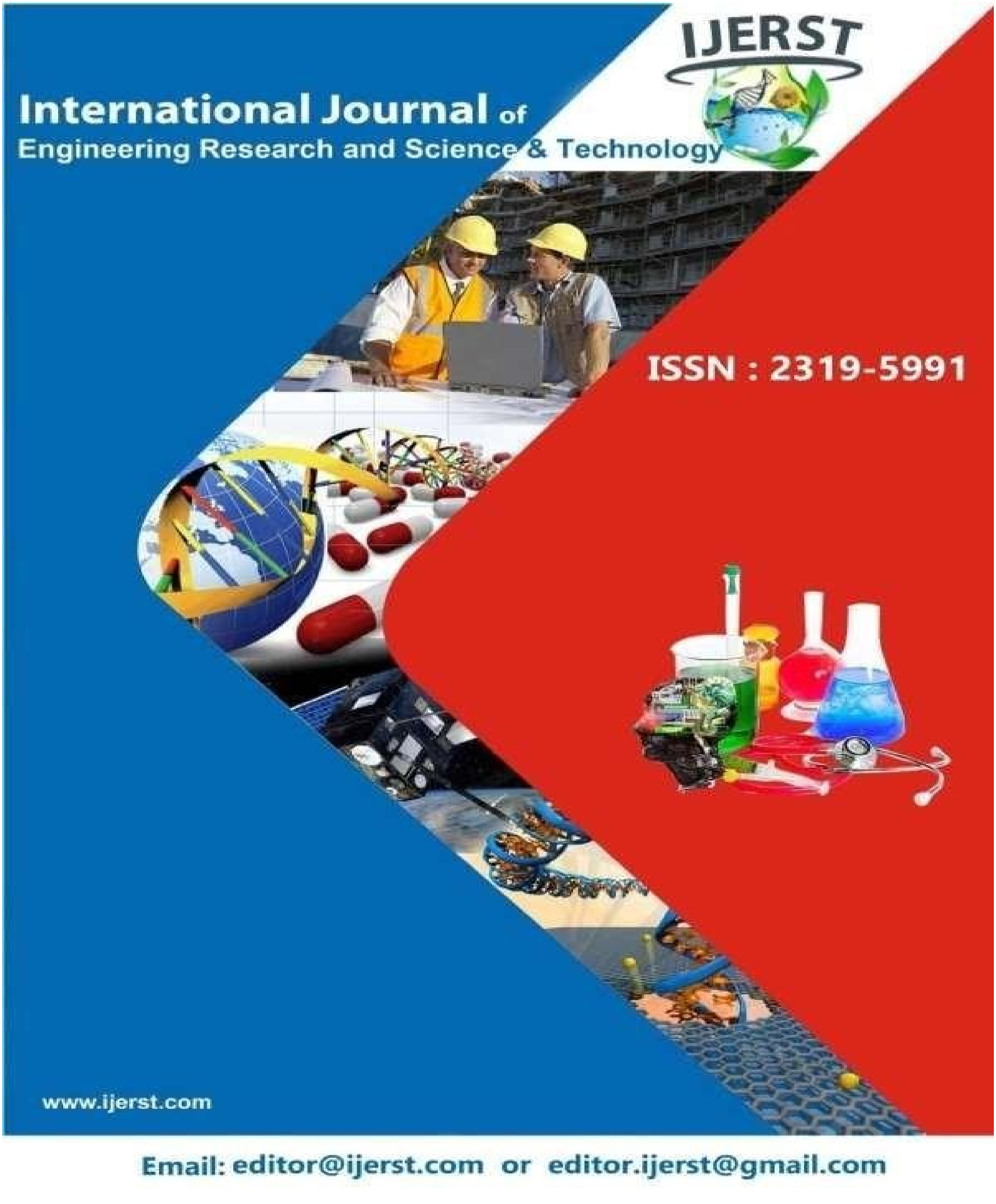

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DESIGN AND IMPLEMENTATION OF AUTOMATED SURVEILLANCE ROBOT FOR HIGH ALTITUDE REGIONS

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ABSTRACT

Presently the surveillance of International border areas is very daunting task. The se-curity forces are patrolling the border in hostile conditions. They are getting help from surveillance cameras already mounted but they cover very limited areas. The cameras already mounted at a fixed position, is not of much use as we cannot change the camera view in real time. Also it is not possible to mount the cameras in the forest areas as the trees obstruct the view of the camera. This paper explains how to design and imple-ment wireless robot which will enable us to control the robot with the help of internet and it will be able to detect the living bodies with the help of PIR sensor. It will help in rescue operation and user can access the video transmitted from the remote area such as the sensitive areas or areas which are beyond our reach. The total system con-tains mobile robot, controlled with the Internet, which has camera mounted on it and also it has a Ultrasonic sensor for detection of living bodies. User will be able to control the robot through internet, thus, providing user with wireless control of robot. Also information regarding the detection of living bodies will also be given to user on the webpage from the Ultrasonic sensor and simultaneously user is able access the video transmission from the robot. The camera mounted on the robot is able to move hori-zontally around its vertical axis and vertically along its vertical axis. Camera move-ment is controlled through webpage at the user interface, thus, providing user with enhanced view of the surroundings. A wireless camera on the robot is also used to feed live video during day and night. With the aid of an Arduino microcontroller, the robot is commanded manually as well as automatically. Additionally, this robot makes use of a few sensors to gather information and convey the information to the controlling authority, generally an Arduino microcontroller, which regulates the activities of the robot. The operator or owner of the robot can also detect the presence of metal explo-sives utilizing metal detecting elements in addition to the live video streaming to carry out environmental surveillance which can also be used for defense related applications.

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Keywords: microcontroller, camera, object detecting system, IOT, l293D, robo, mo-tors, etc.

I. INTRODUCTION

1.1 INTRODUCTION

Microcontroller are widely used in Embedded Systems products. An Embedded product uses the microprocessor (or microcontroller) to do one task & one task only. A printer is an example of Embedded system since the processor inside it perform one task only namely getting the data and printing it. Although microcontroller is preferred choice for many Embedded systems, there are times that a microcontroller is inadequate for the task. For this reason, in recent years many manufactures of general-purpose microprocessors such as INTEL, Motorola, AMD & Cyrix have targeted their microprocessors for the high end of Embedded market. One of the most critical needs of the embedded system is to decrease power consumptions and space. This can be achieved by integrating more functions into the CPU chips. All the embedded processors have low power consumptions in additions to some forms of I/O, ROM all on a single chip. In higher performance Embedded system, the trend is to integrate more & more function on the CPU chip & let the designer decide which feature he/she wants to use.

1.2 EMBEDDED SYSTEM

Physically, embedded systems range from portable devices such as digital watches and MP3 players to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them but are not truly embedded systems, because they allow different applications to be loaded and peripherals to be connected. Embedded systems span all aspects of modern life and there are many examples of their use. Telecommunications systems employ numerous embedded systems from telephone switches for the network to mobile phones at the end-user. Computer networking uses dedicated routers and network bridges to route data.

EXAMPLES OF EMBEDDED SYSTEM:

Automated teller. machines (ATMS). Integrated system in aircraft and missile. Cellular telephones and telephonic switches. Computer network equipment, including

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routers timeservers and firewalls. Computer printers, Copiers. Disk drives (floppy disk drive and hard disk drive). Engine controllers and antilock brake controllers for automobiles. Home automation products like thermostat, air conditioners sprinkles and security monitoring system. House hold appliances including microwave ovens, washing machines, TV sets DVD layers/recorders. Medical equipment. Measurement equipment such as digital storage oscilloscopes, logic analysers and spectrum analysers. Multimedia appliances: internet radio receivers, TV set top boxes.Small hand-held computer with P1M5 and other applications. Programmable logic controllers (PLC's) for industrial automation and monitoring. Stationary video game controllers.

1.3 CHARACTERISTICS:

Embedded systems are designed to do some specific tasks, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reasons such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs. Embedded systems are not always standalone devices. Many embedded systems consist of small, computerized parts within a larger device that serves a more general purpose. For example, the Gibson Robot Guitar features an embedded system for tuning the strings, but the overall purpose of the Robot Guitar is, of course, to play music. Similarly, an embedded system in an automobile provides a specific function as a subsystem of the car itself.

The software written for embedded systems is often called firmware, and is usually stored in read- only memory or Flash memory chips rather than a disk drive. It often runs with limited computer hardware resources: small or no keyboard, screen, and little memory.

1.4 MICROPROCESSOR (MP):

A microprocessor is a general-purpose digital computer central processing unit (CPU). Although popularly known as a "computer on a chip" is in no sense a complete digital computer. The block diagram of a microprocessor CPU is shown, which contains an arithmetic and logical unit (ALU), a program counter (PC), a stack pointer (SP), some working registers, a clock timing circuit, and interrupt circuits.

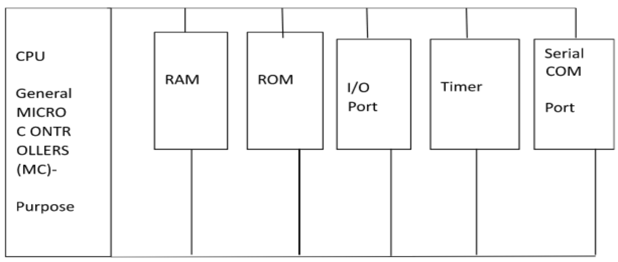

Fig 1.1 Block diagram of microprocessor

1.5 MICROCONTROLLER (MC):

Figure shows the block diagram of a typical microcontroller. The design incorporates all of

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the features found in micro-processor CPU: ALU, PC, SP, and registers. It also added the other features needed to make a complete computer: ROM, RAM, parallel I/O, serial I/O, counters, and clock circuit.

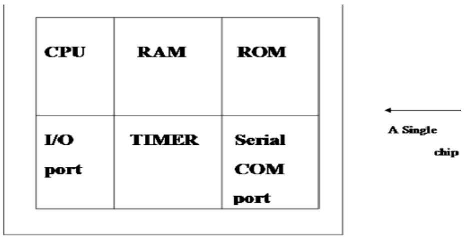

Fig 1.2 Microcontroller

1.6 COMPARISION BETWEEN MICROPROCESSOR AND MICROCONTROLLER

The microprocessor must have many additional parts to be operational as a computer whereas microcontroller requires no additional external digital parts. The prime use of microprocessor is to read data, perform extensive calculations on that data and store them in the mass storage device or display it. The prime functions of microcontroller is to read data, perform limited calculations on it, control its environment based on these data. Thus the microprocessor is said to be general-purpose digital computers whereas the microcontroller are intend to be special purpose digital controller. Microprocessor need many opcodes for moving data from the external memory to the CPU, microcontroller may require just one or two, also microprocessor may have one or two types of bit handling instructions whereas microcontrollers have many.

II. LITERATURE SURVEY

2.1 INTRODUCTION

Internet of Things (IOT) can be defined as a network of interconnected physical objects that are accessible through the internet. Basically, IOT is an ecosystem in which all the physical devices are connected to the internet through network devices and exchange data. Today, IOT is a major technology by which we can produce various useful internet applications. IOT is a topnotch technique which reduces human effort and provides easy accessibility to physical devices. IOT allows physical devices to be controlled remotely across existing network infrastructure. “Things” in the IoT sense, is the mixture of hardware, software, data, and services. These devices gather useful data with the help of various existing technologies and share that data between other devices. Examples include Surveillance robot car which uses Wi-Fi, GPRS or Bluetooth for exchanging data between various devices.

Robotics is a multidisciplinary field of science and engineering which includes mechanical, electronic, information and computer science engineering. It deals with the design, development, execution, and manipulation of robots, as well as computer systems for their control, information processing, and sensory

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feedback.

Indian Armed force is the world's 4th active defense force as per the man- power and weapons we have. But technology wise we are too behind. All the technical equipment and weapons we have are either adopted or borrowed from other nation. Indian forces have much equipment for aerial as well as naval surveillance and many of them are self-made. In border areas, if there is any kind of suspicious activity then our soldiers have to search that place manually which has a huge risk of life during encounters with the attackers. This kind of situation also occurs during hostage situations. But we can make improvement by using a land-based surveillance system. With the terror always being India's first enemy, robots are the only option that can be used to save human life. India is still enduring and suffering from regular threats and terror attacks from neighboring nations. The recent terror attacks in Kashmir and Mumbai terror attack have consummated that the future of warfare will be handled by the robot and automatic machines as far as possible to protect human life. Currently, the Indian Army has DRDO Daksh Military robot used for locating, handling and destroying hazardous objects safely in the battlefield. With the rapid proliferation of technology in the automation field by incorporating Military Robots as Soldiers in the war field to diminish injury and demise in war fields. The project aims in designing a Surveillance Robot Car which can be controlled from anywhere around the world by using the IOT technology. Wi-Fi module will be installed on the robot car to control it from the ground station and also receive the live video surveillance via the android application.

Various sensors are installed on the robot car to sense or detect the atmosphere and its surrounding environment and act accordingly. Face Detection technique is implemented to detect and recognize the suspected people in the surveillance region and to store the image in the database for future use. The component used for this robot car are Arduino Due, 32-bit ARM Processor development environment released by the Arduino community, the motor driver module L298N can control either two DC motors or one bipolar stepper motor, the direction and motor speed can be controlled by L298N H-bridge module. WiFi module provides an internet connection between a user or ground station and the robot car to transmit live videos of active zone and to receive the commands given to it from the user or ground station.

III. PROBLEM STATEMENT

The existing system consists of Raspberry pi and Arduino which was used to build the SMART- I server. The robot consisted of motor drivers, servo motors, sensors, and an infrared

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sensor that was connected to the Arduino using a separate battery for line tracing. Raspberry pi was used as a server which was connected to the Arduino via serial communication port or the USB port. It was an IOT based surveillance robot with client server based robot architecture. The existing system includes its own server for which the IOT is used and it provides not only smart phone app client but web- based client also. Both the smart phone based and the web- based client can control and monitor the robot using Internet. The robot had its own server through which it communicated with PC or Smartphone using Wi-Fi. It consists of a webcam that uses Apache server port 8080, to capture and transfer the image to the server which further stores that image in the database that are viewed by the client in the real time. Node.js server was built and, Open CV and C++ was used for the image processing. Here the image stored in the database and the recently taken image was compared by using image processing techniques, if any anomaly or abnormal state occurs then the user or client was notified about the anomaly via notification sent from the car to the user's smart phone or to the web- based app. If the event occurred and context value was not under the threshold value set by the user, it could be sent to the user as a notification.

3.1 Disadvantages of Existing System:

Limited effectiveness: Surveillance robots may not be able to detect certain types of fires, or they may be ineffective if their sensors are not calibrated correctly.

False alarms: Surveillance robots may generate false alarms, or they may take too long to respond to commands.

Maintenance and calibration: Surveillance robots require regular maintenance and calibration, which can be expensive and time-consuming.

Cost: Surveillance robots can be expensive to purchase and maintain.

Glitches: Surveillance robots may experience glitches, such as ignoring or misunderstanding commands.

Privacy concerns: Surveillance robots may invade.

Technical disruptions: Surveillance robots may break down or malfunction

IV. PROPOSED SYSTEM

First, the system architecture explains the plan of an IOT controlled surveillance robot car which is manually controlled by an android application and monitoring system. The later section describes the framework of the

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proposed robot car and the requirement analysis. The design of an IOT controlled surveillance robot is proposed below.System Architecture The below figure shows the architecture of the proposed system. In this, the base of the architecture is IOT through which the user connects to the car and can control it. Android phone must be connected to the internet, which will be used to communicate with the robot for performing the tasks, from the base station. The robot car will send the images and the live feed via Wi-Fi to the server and will store the

surveillance video as well as image in the database for further use.

4.1 BLOCK DIAGRAM OF PROPOSED SYSTEM

The automated surveillance robot for high-altitude regions operates by integrating multiple sensors and components for remote monitoring, obstacle detection, and security applications. The power supply unit ensures a stable energy source for all electronic components, including the Raspberry Pi Pico, which serves as the main controller, processing sensor data and managing motor movements via the L293D motor driver. The ultrasonic sensor detects obstacles in the robot's path by measuring distance and relaying data to the microcontroller, which makes real-time decisions to avoid collisions. For security applications, the metal sensor scans the surroundings for metallic objects such as landmines, weapons, or unauthorized metallic intrusions, triggering an alert when metal is detected.

Simultaneously, the fire sensor continuously monitors environmental temperature and infrared radiation to detect fire hazards, generating an emergency alert in case of abnormal heat levels or flame detection.

The ESP32-CAM module captures real-time video footage and transmits it wirelessly to a remote monitoring station via Wi-Fi, allowing operators to receive live feeds from the surveillance zone.

The LCD display provides real-time updates on critical sensor data, including obstacle proximity,fire warnings, metal detection status, and battery levels. The DC motors, controlled by the L293D motor driver, enable the robot to navigate rough terrains, ensuring smooth movement in highaltitude

regions.

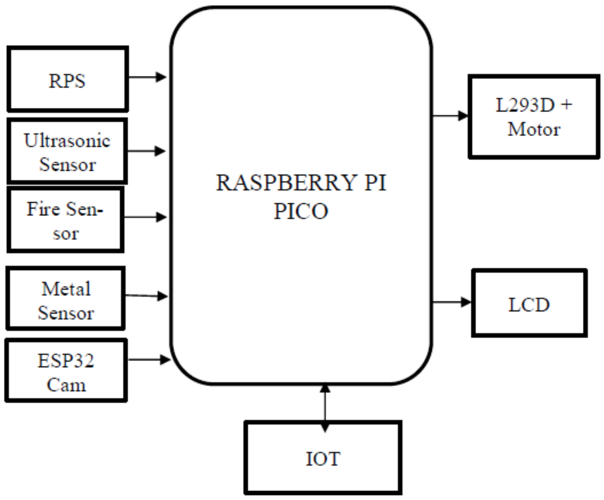

Fig 2.1 Block Diagram

V. BLOCK DIAGRAM OF PROPOSED

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SYSTEM

HARDWARE COMPONENTS

Power Supply, Raspberry Pi PICO, Ultrasonic Sensor, Fire Sensor, Metal Sensor, ESP32 Cam, L293D, Motor, LCD,

SOFTWARE COMPONENTS

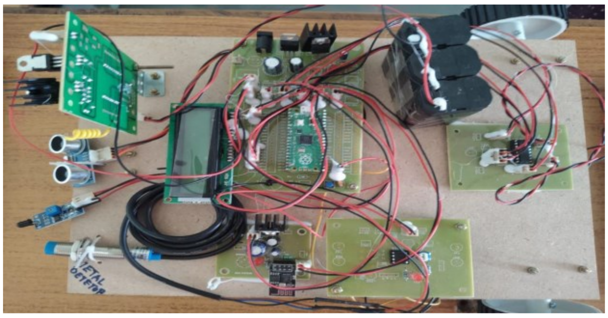
The following software tools used in the proposed system

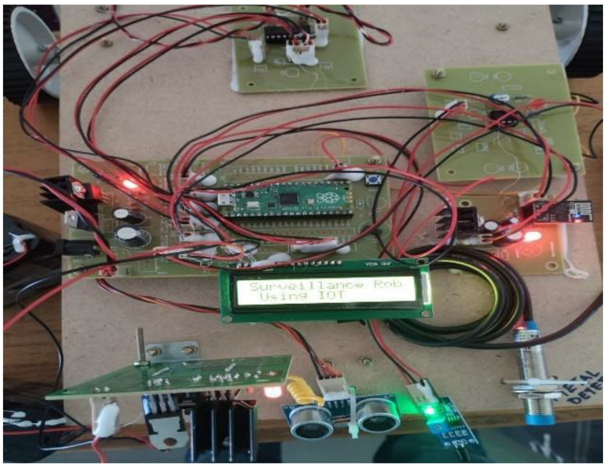
Arduino IDE, Proteus Design Tool

VI. RESULT AND DISCUSSION

6.1 PROTOTYPE (THROUGH KIT)

shows the prototype of the project





EXPERIMENTAL RESULTS

Fig 6.3.Realtime monitoring

VII. CONCLUSION

IoT controlled surveillance robot is designed and built to provide surveillance in dangerous situations like border patrolling and rescue operations and can also be used in hazardous situations like mining, explorations, etc. The Camera mounted on the robot sends the live surveillance to the Android application via the Wi-Fi module installed on the robot. The face detection technique is used in the system to detect the faces and also to store it in the database

VIII. FUTURE SCOPE

There are several developments in this paper which can be executed as a future scope. The future scope is related to the strength and reliability of the robot car, live video surveillance, face recognition, etc. The strength

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of the robot car can be upgraded by placing a sturdier chassis so that it can work on terrains which include mountains, muddy and sandy terrains, which is not feasible with the chassis currently installed on the robot car. There is a lag in live video surveillance which is caused because of network congestion or traffic, this can be improved in the future. The face detection module can also be improved to not only detect but also recognize the faces with the help of multiple images which is already stored
in the database. To increase the security of robot car, while in the hostile situations a fail-safe method can be used which is activated when an assailant tries to access the system by connecting its computer or laptop to the Arduino Due. By using a metal detector on the chassis, we can detect the Land Mine with the help of robot. The experimental graph given above describes the efficiency of the detection of the face using the camera to the distance (in feet) of the victim from the camera. As the distance progresses between the camera and the face, the detection rate will be lower. The detection rate will also be depending on the time (day or night) the images or the videos are recorded.

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