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Autonomous Intelligent POD for Military Purpose

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Abstract: *At present, the surveillance of International border areas is a challenging task. The border guarding forces are patrolling the border seriously, but it is no longer viable to watch the border at each and every moment. A critical requirement of this state of affairs is a robot that robotically detects trespasser in the border and reports close by board security control unit. Many of the army departments now make use of robots to elevate out risky jobs that can't be executed by means of the soldiers. In this present work, a Raspbian working system-based undercover agent robot platform with far off monitoring and manage algorithm through the Internet of Things (IoT) has been developed which will save human lives, reduces manual error and protect us from enemies. The spy robotic device comprises the Raspberry Pi (small single-board computer), pi camera and sensors. The information regarding the detection of living objects with the aid of the PIR sensor is dispatched to the users thru the net server and pi digicam capture the moving object which is posted inner the webpage simultaneously. The consumer in the manipulate room in a position to access the robot with wheel drive control buttons on the webpage. The movement of a robotic is also controlled robotically via obstacle detecting sensors to avoiding collisions. This surveillance system using a spy robot can be custom-made for more than a few fields like industries, banks and shopping malls.*

Keywords: *Border security, Raspbian OS, IoT, Spy Robot, Raspberry Pi, PIR sensor, Obstacle Detecting Sensor.*

I. INTRODUCTION

In today's world the robotics field is growing exponentially and some of the popular robotic products are used mostly by the industries, defense, academic and research communities. The design and implementation price of a robot is very much less than hiring a human caregiver. The robots can be reprogrammed faster and more efficient. The robot has ample intelligence to cowl the largest area to grant a secured space. The intelligent robots can perform favored tasks in unstructured environments with or without human instructions. The real time object detection is required because security and safety are quintessential in the remote monitoring and manage systems such as smart home environments, customer surveillance system, etc. The real-time human physique detection is essential for quite a number fields like home protection systems, surveillance systems, verbal exchange structures and more. Basically, the surveillance systems are building up with a couple of cameras which are placed in one-of-a-kind angles of view to track human objects. Particularly the tracking task is needed on cameras for dynamic objects which increases the number of cameras used in the system. An intelligent surveillance system with multiple cameras is difficult and costly. In proposed system a single camera is set up on a robot and the robot can move all directions to take images in different angles. This system is very flexible to monitor any living object with the assist of the PIR sensor and it is more suitable for surveillance systems. A robot can be managed in two strategies via hardwired control or wi-fi control. The wireless control affords additional benefits including increased flexibility and decreased installation cost. In contemporary the internet technology is used for movement control and all other purposes like image or video capture by using the robot and shared via internet.

II. LITERATURE SURVEY

In 2008, Md. Masum Billah, Mohiuddin Ahmed, and Soheli Farhana states that many walking robots are compared and the advantages of a hexapod system overshadows a wheeled robot in many ways.[1] These hexapod robots is mainly used for their efficient navigation method in different types of terrains using opposite gate of locomotion, which make it not only faster but also energy efficient to navigate and negotiate in difficult terrains. Hexapod is used for the purpose of disaster recovery. In any disaster, the elementary tasks at hand are: (i) to reach the affected field (ii) to find and get information about victims, and (iii) to rescue as many of them as possible. It is possible for the robot to reach any kinds of hazardous fields. Since a Hexapod robot has the ability to move in all kinds of terrains and has more advantages over wheeled robots, it is preferred more than the latter[2].

This shows that legged robots can operate in both even and rough terrain. The hexapod provides additional benefits such as sensors and on board equipment. The main application of robots in this mission has been concerned with the replacing of humans by robots or mechanized systems to make the work more time efficient, accurate, uniform and less costly and prevent loss of human lives. In the hazardous field, it will rotate in any direction; heavy legs with powerful servo motors are chosen over other types as they can withstand heavy loads. It can move faster when it is in even terrain, and in uneven terrain, it will navigate very leisurely.[4] They used two types of gaits to handle this terrain detection

- 1) Tripod Gait for Even Terrain,
- 2) Wave Gait for Uneven Terrain.

In 2013, Graeme Best, Peyman Moghadam, Navinda Kottege, Lindsay Kleeman have discussed about the effectiveness of a legged robot's gait. It is immensely dependent on the ground cover of the terrain it traversing. The robot is able to detect and classify the type of ground cover in it is traversing. To achieve this, they presented a novel approach for ground cover classification which utilizes position measurements of the leg servos to estimate the errors between commanded and actual positions of each joint.

In addition to this, they also employ a multi-class Support Vector Machine with a required dimensional feature space consisting of features in gait-phase and frequency domains. They have implemented this algorithm in the Robot Operating System (ROS)[3]. Humans naturally adjust their walking style according to the terrain they are walking on similarly This same logic is tried in these robots. In order to achieve this kind of behaviour, it must have the ability to autonomously differentiate between terrain types. For example, amphibious legged robot changes their behaviour by differentiating between sand and shallow water to determine when to switch from a walking to swimming gait. In this they have performed two types of terrain classification:

- a) Exteroceptive sensing,
- b) Interactive sensing.

Exteroceptive sensing based terrain classification algorithms use a variety of sensors like vision and range. Interactive sensing techniques, measure aspects of the interaction between the robot and the terrain as the robot moves through the environment. All of the terrain classification approached in the previously mentioned studies require additional external sensors to the robot. But in this case, they propose a new approach that utilizes position sensors that come built into a hexapod robot's leg actuators and it does not require modifying the hardware of the robot. These robots are equipped with an Arduino microprocessor board accompanying a software that includes an open-loop gait engine. The data is then collected in real time by a laptop connected via a serial connection. In 2013, M. Z. A. Rashid, M. S. M. Aras, A. A. Radzak, A. M. Kassim and A. Jamali explained the hexapod robot with manoeuvrable wheel is designed and developed.

The purpose of this robot is to ease the movement either on the flat surface or on the inclined surface. This is quite different from the previous version; they have added an additional feature which helps in climbing. In flat surface, the robot will move using the manoeuvrable wheel, while in incline surface the robot will climb using its legs. This will be decided by the robot based on the sensor devices and algorithm developed by the controller attached to the robot. The study of this project is to develop a new hexapod robot which is quite different from the existing product in the market today.[5]

In 2016, V.S. Mahadevan, J. Dhivya, T. Monisha, J. Geetha, R. Divya encompasses a study on the development of a walking gait for fault tolerant locomotion in an unstructured environment. Quadra pod is a four-leg walking robot. It should be a micro robot, designed with manual control. The parts contain Arduino Nano (ATMEGA 328), servomotor, ultrasonic sensor, PIR sensor and wireless module. They have used this robot to detect humans in a disaster environment and also for detecting obstacles. Human detection and tracking are the main problems in computer field.

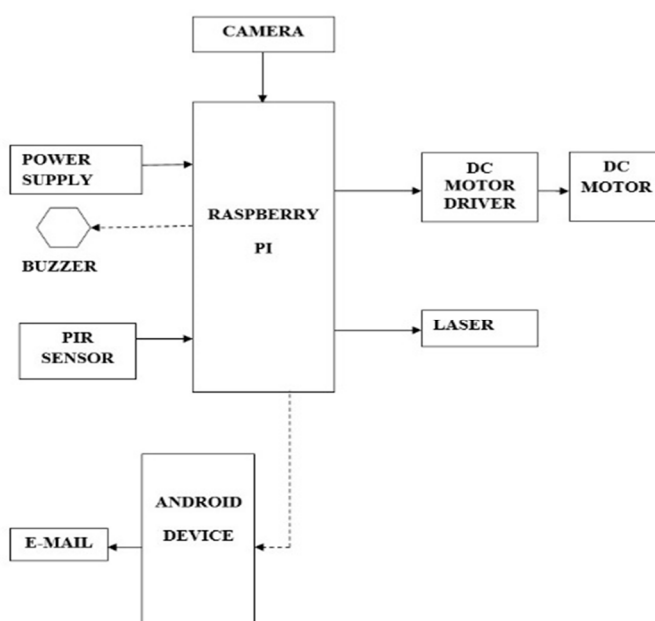
It includes many advanced technologies in different fields such as pattern recognition, automatic control, artificial intelligence and computer technology. They have also added life detection and obstacle detection features in this robot. In 2016, R. Karan Kumar, Raju N were worried about their safety. Since there is an increase in the crime rates, because of this there was a huge increase in surveillance system. The system is widely used for monitoring and capturing of videos lively.[6] It can be fixed in homes, offices and other remote areas, where the movement of people is less. Using raspberry pi, the system acts like a robot in LAN.

It requires a WIFI network. It uses python language for coding. Recently IP is used widely by the people. Before the usage of IP, analogue IP was used because of their low budget and cost effective. Raspberry pi is a high resource software, so it is made easy for the live streaming and for the controlling of robot. Night vision is also available in raspberry pi. It not only had vision detection but could also detect "smoke detection" in case of potential crimes and potential fire. Night vision is applicable by the removal of IR filter from the web camera. Object can be detected by the background subtraction algorithm. [7]The system identifies the object and sends a message or triggers alarm to the informer that an unauthorized person has been entered. P. Arena, L. Fortuna, M. Frasca, L.

Patane, M. Pavone used a six-legged robot named "Gregor1" which describes the implementation of a bio inspired robot. It controls both the structure and locomotion by the biological observation of a cockroach for their specialized leg function and self-stabilizing posture. We use the theory called "central pattern generator" for the control of locomotion. The fundamental aim is to artificially replicate the extraordinary agility of a cockroach. The implementation on the rear legs of a cockroach plays a crucial role in overcoming obstacle and payload capability. In this project the role of artificial CPG cellular neural network is done.

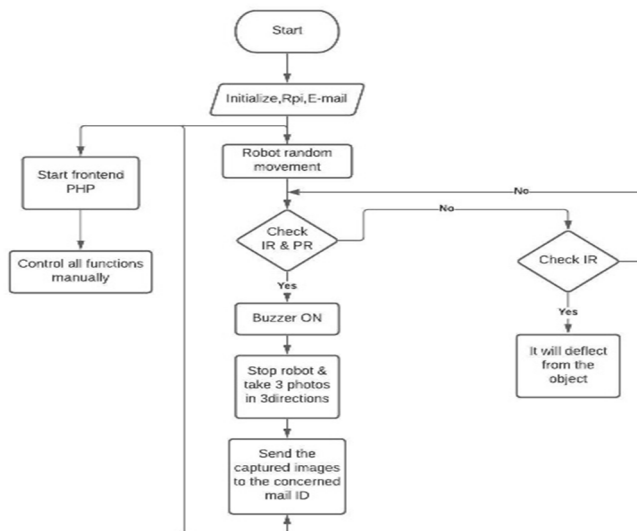
The Robot Gregor 1 can walk and travel at the speed of 0.1 body length per second and negotiates the obstacles for nearly more than 170% of height from its mass centre. In the field of explorative robotics, the concept called "Mission capable legged robot" acquires a major increase in the interest. In this we concern about rare leg mechanism of the cockroach that plays a crucial role in overcoming obstacle.[8] For the sprawled posture, Gregor 1 exhibits the stable posture with high margin stability. In order to coordinate the robot actuators, the basic unit of adopted CPG with nonlinear oscillators have been coupled for a network. In this experiment, the speed, manoeuvrability, obstacle climbing capability and ever genetic performance of the robot is discussed.

III. SYSTEM DESIGN AND IMPLEMENTATION



The above block diagram consists of a camera module, raspberry pi, a power supply, a DC Motor driver and a DC motor, a PIR Sensor and an android device.

Basically, two gear motors are sufficient to produce the movement of the pod and the motor driver module is used to supply enough current to drive the motors which protects the Raspberry-pi module from the damage.[9] The major advantage of using the minimum number of gear motor is minimizing the power consumption. Robot has an infrared sensor which is used to sense the obstacles coming on the robot's path. It keeps moving in random directions and when an obstacle comes in its path, it will automatically deflect away from it. Besides, the PIR sensor detects the presence of a human being from the thermal radiation produces by them, which in turn triggers the visual sensor (pi camera) then captures the images of the intruder and sends it to the person in-charge. The pod can also be operated by using control buttons available on the front end php (i.e., client web page). Now-a-days the Raspberry-pi has been widely used to make projects in various fields like medical, defense, agriculture and industries. Autonomous Intelligent Pod is designed with Raspberry-pi 3 module which has an inbuilt wireless controller and pi camera support. It continuously monitors the surrounding areas for the presence of unauthorized people and to detect the presence of enemies at the border. The user will be observing this image data on the front end php at the control room.[10] User unit communicates with the pod with the help of Internet. This IoT application is developed by python, HTML and JavaScript. The proposed system has limitation which is more suitable for almost flat surface on which the robot can operate. This design would not be suitable for rough terrain environments like rocky or hilly terrain due to their wheeled mechanisms.[11]



Initially the pod is started, The Raspberry Pi and Email is initialized. The pod starts to move in random motion and the front-end PHP is also available to use.

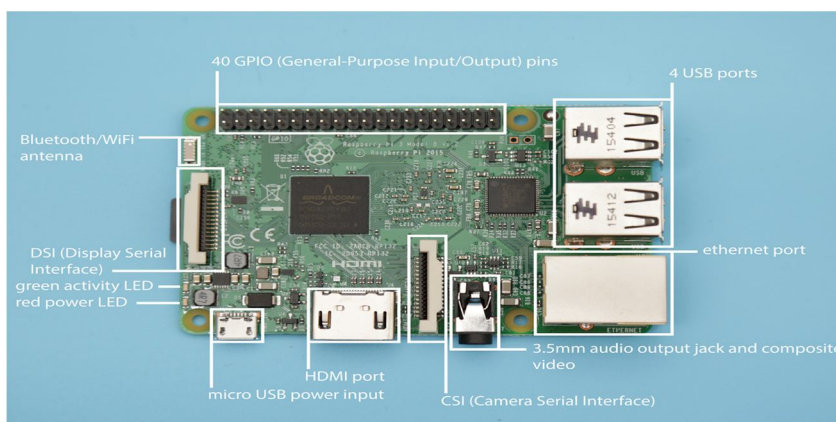
Now when there is an obstacle or an intruder both the IR Sensor and PIR sensor senses

If it is an obstacle, only the IR sensor is HIGH and it will deflect from the object.

If it is a human being, both the IR Sensor and PIR Sensor is HIGH. It then gives a buzzer alert, [12]The pod stops and takes photos in 3 directions and sends the captured images to the designated person’s mail id who has access to the front end PHP in an android device. He then takes full control of the pod through the PHP and takes decision as to check if the intruder is from our side or the enemy’s side and take a shot at him if required through the PHP itself.

IV. HARDWARE REQUIREMENTS AND DESCRIPTIONS

A. Raspberry Pi



The Raspberry Pi is a small, inexpensive, and programmable computer created by the Raspberry Pi Foundation. Like a personal computer, a Raspberry Pi can have a screen for output and a mouse and keyboard for user input. It runs an operating system like Mac's OS and Microsoft's Windows 10. You can download applications to it like a word processor or play games on it. Raspberry Pi can be used to power robots, they can be strung together to create digital networks, and they have even been sent to near space. So, there is no mistaking that there is a lot that one can do with a Raspberry Pi board.

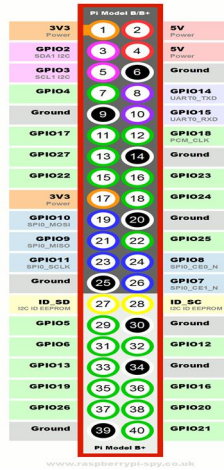
B. Power Source

The Raspberry Pi is a device which consumes 700mA or 3W of power. It is powered by a Micro USB charger or the GPIO header. Any good smart phone charger will do the work of powering the Raspberry Pi.

C. SD Card

Just like any other computer the Raspberry Pi needs an OS (Operating System) to manage tasks, open applications, and control attached accessories. The OS and all other software are stored on the micro SD card that plugs into the Raspberry Pi.

D. GPIO-General Purpose Input Output



General-purpose input/output (GPIO) is a generic pin on an integrated circuit whose behavior, including whether it is an input or output pin, can be controlled by the user at run time.[13]

- 1) *GPIO capabilities may include*
 - a) GPIO pins can be configured to be input or output
 - b) GPIO pins can be enabled /disabled
 - c) Input values are readable (typically high=1, low=0)

E. Camera



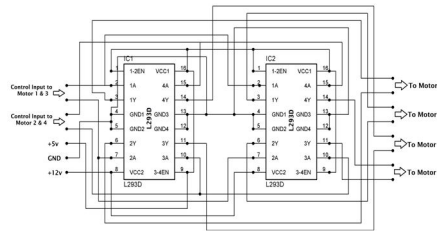
We are using a 5 MP camera module connected to the Raspberry Pi using a CSI connector for live streaming and capturing images of the intruder.

F. DC Motor



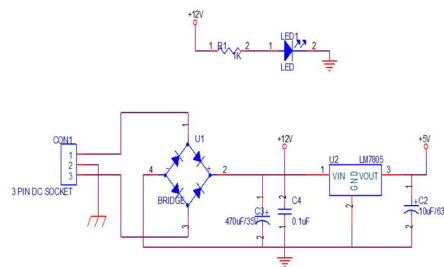
The above image is a 12V, 100RPM DC geared motor. It contains Brass gears and steel pinions to ensure longer life and better wear and tear properties.

G. 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. In the above image, the two L293D's are used to drive four motors.[14] 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.

H. Power Supply



An AC to DC adaptor has been used to get DC input for the mother board. In mother board, a 5V regulator circuit is present, 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.

I. PIR Sensor



PIR stands for Passive Infrared. In simple terms, it is a motion detector.

Apparently when a 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.[15] The unit output is high whenever there is motion detected. If the motion is continuous, the output remains high.

J. Laser

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "light amplification by stimulated emission of radiation". Laser is used as a substitute for a gun in our prototype.

K. Buzzer



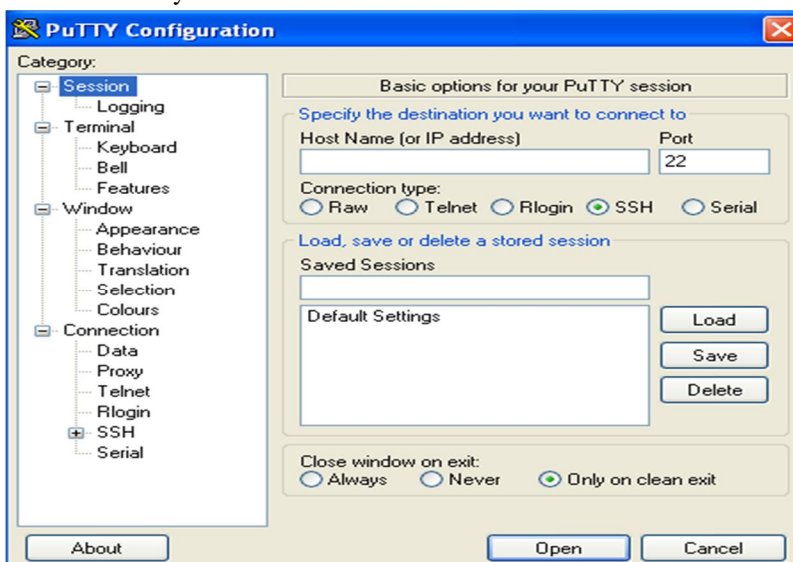
A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric

L. Android Device

Android is an array of software intended for mobile devices that features an operating system, core applications and middleware. An Android device may be a Smartphone, tablet, PC, e-book reader or any type of mobile device that requires an OS. We are using an android device to display the Front-End PHP through which the pod can be controlled.[18]

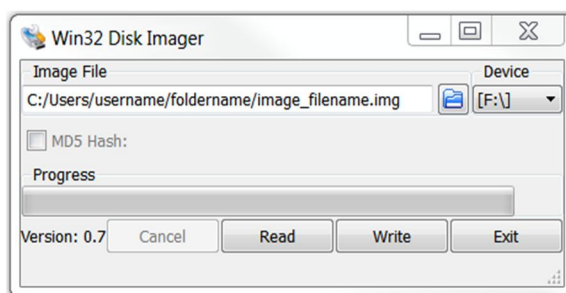
Software requirements and descriptions

1) **PUTTY**: It is used for code development. It is a powerful, feature-rich development tool for Raspberry pi. It is used for developing applications for embedded systems.



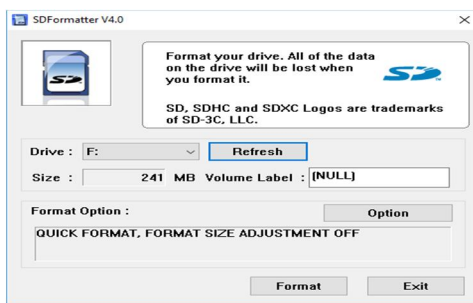
PuTTY is a client program for the SSH, Telnet and Rlogin network protocols. These protocols are all used to run a remote session on a computer, over a network. PuTTY implements the client end of that session: the end at which the session is displayed, rather than the end at which it runs.[16]

2) **WIN32 Disk Imager**



Win32DiskImager is an open sourced Windows program for saving or restoring images from removable drives like USB drives, SD Memory cards, etc. It can be used to write a bootable or update images (i.e. SD card image) to a SD Flash device or USB flash device. Hence, it is extremely useful for embedded development.[17]

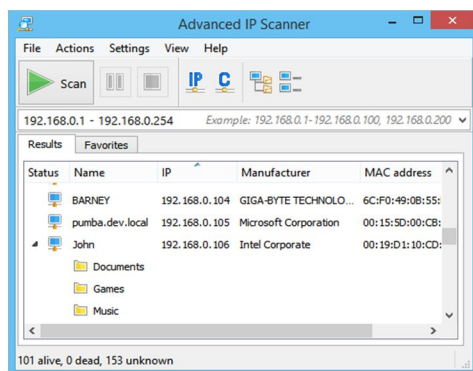
3) SD Card Format



The Raspberry Pi Model B+ uses a standard **micro SD** card to store the operating system (e.g. **Raspbian**). However, before installing the OS, you will need to format the SD card to use the **FAT32** file system.

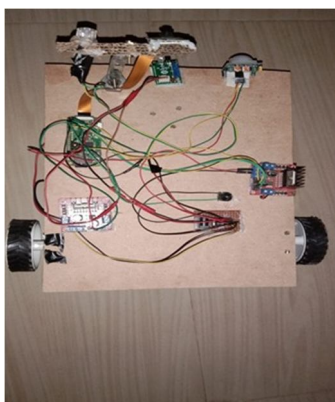
The SD Memory Card Formatter formats SD Memory Card, and SDHC Memory Card (respectively SD/SDHC Cards) complying with the SD File System Specification created by the SD Association (SDA).

4) Advanced IP Scanner

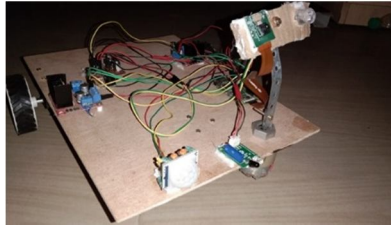


Advanced IP Scanner is a reliable and free network scanner to analyze LAN. The program shows all network devices, gives you access to shared folders, provides remote control of computers (via RDP and Radmin), and can even remotely switch computers off. It is easy to use and runs as a portable edition. Advanced IP Scanner 2.5 is a free, fast and powerful network scanner with a user-friendly interface. In a matter of seconds, Advanced IP Scanner can locate all the computers on your wired or wireless local network and conduct a scan of their ports.

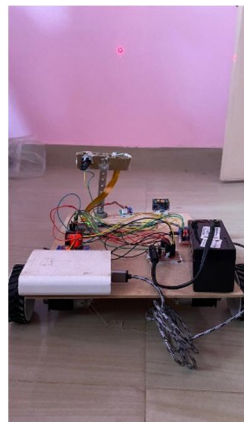
V. PROTOTYPE MODULE AND RESULTS



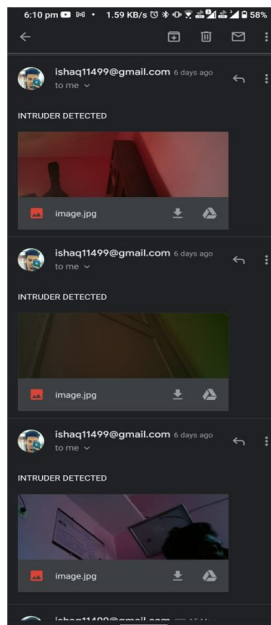
Pod (Top View)



Pod (Top Side)



Prototype using laser



Intruder alert email received from the pod

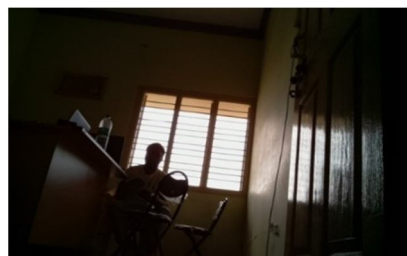


Image captured by the Raspberry Pi Camera Module

VI. CONCLUSION

There are no present security methods to safeguard our borders therefore implementation of android-based robot for border security could be more helpful. It reduces human involvement in the borders. This method reduces the risk in the lives of our soldiers. PIR sensor is used to track motion of intruder and camera for video surveillance. Alert message is being sent to the control room, and the provision for firing is passed on. This system provides more security and reducing the risk of soldiers.

A Security interface is obtained to Android mobile device. This is a short range system and can be extended to long range by choosing proper PIR motion sensor and it is simple in its operation. The range and security features were achieved through the use of the internet in the mobile device. The system was able to send e-mail to specified number of the security personnel and to the android mobile which is on the robot when PIR motion sensor detects intruder.

PIR motion sensor is connected to one of the pin on the input port of raspberry pi and depending on sensor signal status; when it is high, raspberry pi sends the control signal to android device in order to send e-mail. After the reception of the e-mail application in the android mobile gets activated which in turns takes the image of the intruder and upload that image to pre-specified email id. Design and development of better battery backup system can be included for the future work. Improvements like video streaming could also be another aspect for future work. This work could also be extended to Nuclear Power Plant to restrict trespassers from reaching restricted area.

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