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GSM and Electro-pneumatic based Security System for Prison Inmate Escape Prevention

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ABSTRACT: Places such as jails, prison cells, require security systems so tight, so alert to prevent top captives and criminals from escaping. Multiple layers of defence mechanisms which will enrich the existing available security options are therefore required. High end security systems will ensure curbing of treacherous, unethical factors. Our motivation regarding this project came from the various prison escape cases witnessed at the world level which could have had been prevented due to either efficient technology or careful, vigilant observation and maintenance of existing systems. Advanced Security Systems in Prisons is basically a two level defence system which functions to detect treacherous activities and give an intimidation to security officials in cases of inmate escape. The first line of defence is used to detect any sort of trespassing or motion in the horizontal and vertical plane with the help of PIR sensors and Ultrasonic speed sensors respectively. The second line of defence consists of an Electro-pneumatic system which gets activated after the first level. It facilitates in the release of a gas, a suitable gas capable of making the trespasser unconscious.

KEYWORDS: Security System, Arduino, GSM, PIR sensor, Ultrasonic speed sensor, Electro-pneumatic system

I. INTRODUCTION

A security alarm is a system designed to detect intrusion – unauthorized entry – into a building or area. Security alarms are used in residential, commercial, industrial, and military properties for protection against burglarly or property damage, as well as personal protection against intruders. Car alarms likewise protect vehicles and their contents. Prisons also use security systems for control of inmates. Our motivation for making this model came from the intention of helping the security officials trace unethical activities in cells. As glitches in the working mechanism of the current system or negligence can pose a grave, potential threat to the society if high profile criminals manage to escape. There have been cases noted of such kind time and again in the world history. Some of them are as follows:

- Eight inmates charged with violent crimes escaped from the Curry County Adult Detention Center in Clovis, New Mexico on August 24, 2008. The men escaped by climbing prison pipes in a narrow space inside a wall, inmate still at large. Salas was taken into custody by the US Marshals Service on Thursday, October 4, 2012 in Chihuahua City, Mexico, and was extradited back to New Mexico.
- In 2005, Tihar jail, 13 undertrials escaped while they were being taken to courts located on the jail premises. As they were waiting for a bus to be shifted to the high-security jail, the men opened the latch of a gate and ran towards a wall where they had fixed a ladder beforehand. The men managed to climb out of the jail but were caught later.

Therefore we have devised a system which includes two lines of Defence which can help notify security officials in such cases of discrepancies.



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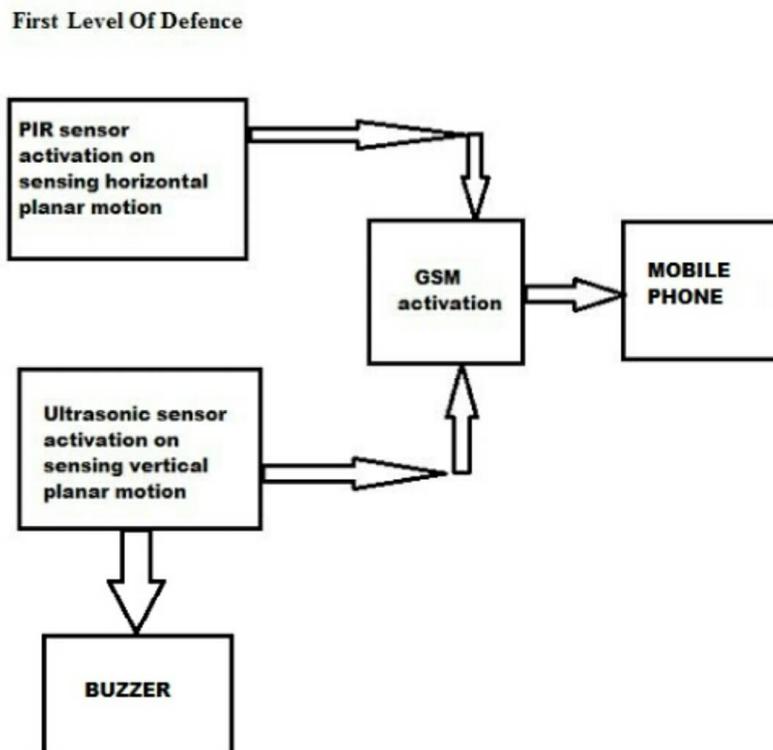
II. LITERATURE SURVEY

Current study on the existing security arrangements in the world are as follows:

- A remote surveillance monitoring system was designed to protect the prison's personnel from hazards in remote places.
- A vision sensor to identify emergency vehicles over a road side with the Camera Closed Circuit Television (CCTV) was implemented recently. The CCTV captured the vehicle image by which the traffic light was controlled.
- A novel model based on electronic monitoring was developed to improve the prison security. This was also useful in monitoring people under house arrest. The CCTV cameras are being employed in prisons efficiently to prevent mishaps such as self-harm/suicide. Its usage in detecting escapes, collecting evidence and to make better safety in prison is analyzed.

III. PROPOSED MODEL

FLOWCHART AND SCHEME OF THE SYSTEM



First line of defence

In the first level of defence there are two sub levels. We are using two types of sensors : PIR sensor and Ultrasonic speed sensor. The PIR sensor is used to detect any trespassing or motion in the horizontal plane. The Ultrasonic speed sensor takes care of any motion in the vertical plane. The Ultrasonic speed motion sensor is capable of producing different alarm tones for varying heights in the vertical plane. The system is programmed in such a way that for each



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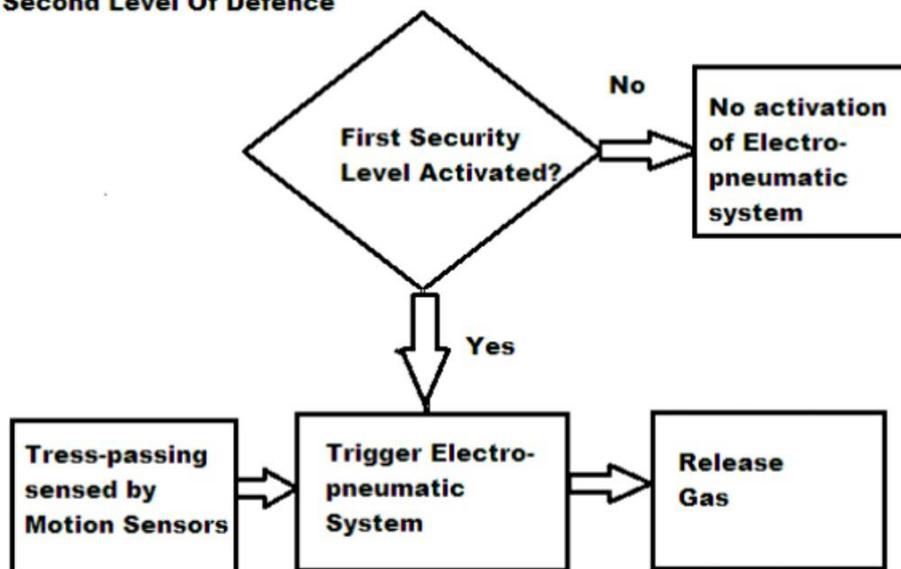
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range a different audio tone is set. In this system, the ultrasonic speed sensor is capable of detecting presence of an object in three level ranges. The ranges are defined from 0-30, 30-70, 70-110 cm. The presence of object sensed in the vertical plane would trigger the ultrasonic sensor and depending on in which range the object is present the particular alarm tone is generated. Thus, there will be three different alarm tones respective of the distance ranges. These motion sensors which will detect motion and which will indeed trigger GSM. This will be further used to trigger the buzzer. In Jail security systems motion sensors will be set up in restricted areas in the jail surroundings around the prison cells. Any unethical or treacherous activity will thus be detected if an inmate tries to escape. As soon as the inmate comes in the range of the motion sensors, GSM will trigger the buzzer and an emergency warning will be thus set. The number of PIR and Ultrasonic sensors used depend totally upon the architecture, construction and surroundings of the jail. Their positions depend upon parameters such as height and area of the prison passages susceptible to inmate escapes. For effective functioning the number of sensors used must be increased accordingly. PIR and Ultrasonic speed sensors detecting motions in larger ranges can be used. In our prototype we have limited the number of sensors used. For larger, real time security systems in jails the number of sensors to be used can be determined accordingly.

Second Level Of Defence



Second Line Of defence

Electro-pneumatic system.

In this, plastic angled solenoid valve is used. Safety system which includes a Direct-acting solenoid valve is used. If the first security level is activated, immediately the other security systems are alerted. The other case includes tress-passing. If any of such unethical, treacherous, suspicious activities are sensed by the motion sensors then electric signals are sent for the release of the gas in the electro-pneumatic system. As soon as the circuitry gets completed in the electro-pneumatic system, electric field is generated in the solenoid thus accounting to generation of pressure. The pressure generated leads to the release of the stored gas. The gases which can be used to make the tress-passer unconscious for a certain period of time can be Nitrous Oxide, Chloroform, etc. For the sake of demonstration and convenience we have used air pressure in our given setup.



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COMPONENTS USED

ARDUINO UNO

Arduino Uno based on the ATmega328P is used in the given setup. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. The PIR and Ultrasonic sensors are connected to the input pins. It is used for setting up a connection between the sensors and the GSM module.

GSM MODULE

SIMCom presents an ultra compact and reliable wireless module-SIM900. GSM MODULE SIMCOM 900A is used in the given setup. This is a complete Quad-band GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core, allowing to benefit from small dimensions and cost-effective solutions. As soon as motion is detected a message of 'THREAT DETECTED' is received at the end of the security officials. We have used a mobile handset for receiving the messages for the purpose of simplification and demonstration. As soon as the first line of defence gets activated a buzzer sets up an alarm tone detecting situation or emergency or potential threat.

PIR SENSOR

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. In this model we have used PIR 325 sensor which has a detection range of about 900cm. We have used 4 sensors of such kind for better coverage area.

ULTRASONIC SENSOR

The Ultrasonic sensor SL-HC-SR04 is used in the given setup. We have used 2 sensors of such kind. The ranges are defined from 0-30, 30-70, 70-110 cm vertically for both the sensors. For every particular range the alarm tone set up is different. The maximum range for each sensor is 400cm circumferentially.

RELAY MODULE

A Relay is an electrically operated switch. It uses an electromagnet to mechanically operate the switch and provide electrical isolation between two circuits.

SOLENOID VALVE

A plastic angled solenoid valve is used. Size- 1/2". It has an input voltage of 12V. The electro-pneumatic system is connected to a pressurised gas storage. After the activation of the first level of defence the second level is alerted. The circuitry gets completed in the electro-pneumatic system and pressure is generated by the solenoid valve. The pressure generated leads to the release of gas. The pressure generated can be known by the pressure gauge. The stored gas can be any gas such as nitrous oxide capable enough of making the trespasser unconscious. For the ease of simplification, we have used air for the setup.

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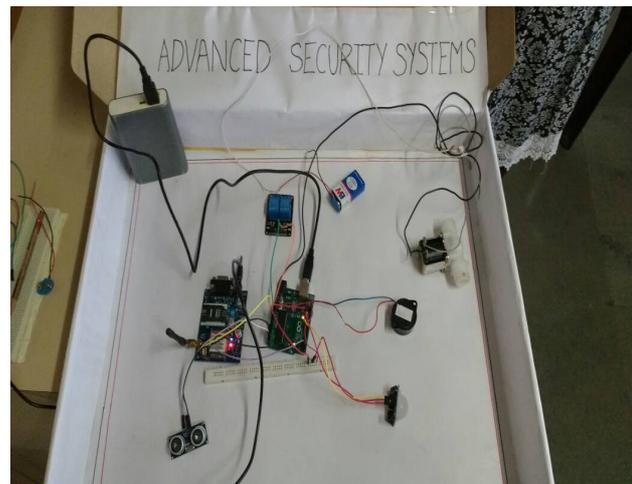
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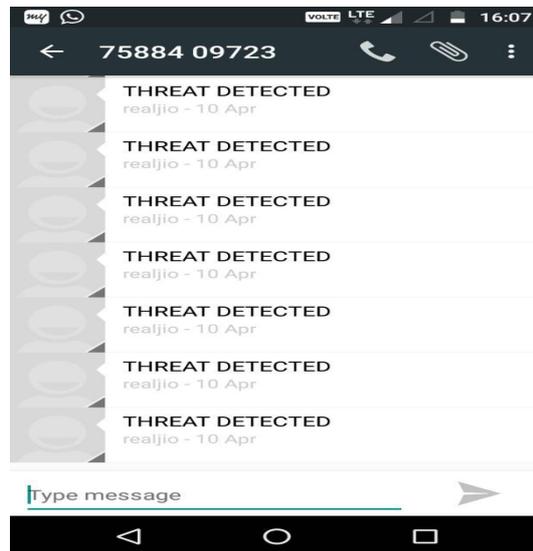
IV.RESULTS

OUTPUT SETUP

The following is the demonstration of the setup for the security system:



Whenever a threat is detected, that is ,any trespassing occurs a message is received at the end where security officials are located and further action is taken.In the above given setup we have used a mobile handset.The threats occurred are detected by the GSM.



V. APPLICATIONS

They have their major applications in prison security systems. But, they could be even utilised in other areas like wildlife sanctuaries, zoos, museums etc.

For even enhanced security multiple levels could be added further to ensure strict vigilance against trespassing. High profile criminals could be kept under such vigilant systems.The further stages for instance could include electric wire fencing across the walls covering the outer circumference of the jail.



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VI. CONCLUSION

As the system is of two level security system, it makes it more efficient. It ensures immediate response against any treacherous activity. Escaping one level of the system triggers the GSM Module and the message is sent to the responsible person. It also leads to the activation of second where the latter releases the gas and prevents the inmate from escaping the prison. The proposed prison security system is fully automated and with this the manpower required can be reduced. This kind of security system can also be used in defence areas and in military applications. It helps the personnel to monitor the prison from remote places.

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