GPS-based handcuffs with geographical prohibitions and a GSM-based prison break warning system

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Abstract: It can be difficult to keep an eye on inmates under house arrest or on prison property, particularly when ongoing surveillance is necessary. Attempts to flee by covert means, like subterranean tunnels or hiding inside items, become much more challenging to identify. A GPS-based shackle system that automates tracking is suggested as a solution to this problem. This method uses GPS and GSM technology to limit a prisoner's movement inside a predetermined geographic area. The system remains dormant as long as the person stays in the designated area. On the other hand, if someone crosses the border, it identifies the breach right away, sounds an alert, and sends authorized people an SMS with the real-time GPS location so they may take prompt action.

To further improve safety, a laser-based security system is incorporated. An LDR (Light Dependent Resistor) sensor and a laser diode make up this setup. Every interruption, such a person crossing the path, stops the laser beam that is continuously falling on the LDR, causing the sensor to detect a change. After processing this modification, a controller sounds an alert by turning on a buzzer. The intrusion can also be reported to authorities by the system. When combined, these technologies offer a dependable and effective way to keep an eye on inmates and stop escape attempts, guaranteeing better security and control.

Keywords: Arduino nano, GPS, GSM, LDR sensor, laser sensor, LCD display, I2c, Arduino Compiler IDE, MC Programming Language: C

I.INTRODUCTION

Keeping inmates from escaping and keeping an eye on those on home arrest are two of the biggest challenges facing prison administrators worldwide. It is challenging to keep an eye on suspects all the time, and it becomes tough and time-consuming to follow someone who crosses the restricted area. The "GPS and GSM Based Handcuff" technology was created as an effective and automatic way to get around these problems. This system combines GPS and GSM modules, a microprocessor, and a wireless communication arrangement. The transmitter attached to the shackle instantly notifies the control room if the suspect travels outside of the prison's or the designated area's communication range.

In order to facilitate rapid and simple tracking, the GPS module simultaneously records the person's precise location and transmits it by SMS to an approved cell number.

To improve jail security, a laser-based security system is added in addition to GPS-based monitoring. This system uses a laser diode and a light-dependent resistor (LDR) sensor. Every disruption, like someone crossing the boundary, stops the laser beam that is constantly falling on the sensor, causing the controller to sound a buzzer alarm and alert the authorities. This guarantees that any unlawful movement is detected right away. The existing prison system is susceptible to numerous escape events because it still mostly relies on human monitoring, particularly in nations like India.

The need on human labor can be greatly decreased by implementing digital solutions like automatic alarm systems and geo-fencing. GPS and GSM offer more dependable and extensive coverage than Wi-Fi and Bluetooth, which have limited range and connectivity problems.

In addition to increasing security, this technique

lowers the expense and labor needed to track down escaped inmates. It guarantees quicker reaction times and keeps things from getting worse. Vehicle tracking systems that offer real-time position, route information, and remote monitoring already employ similar GPS-GSM tracking technologies. This system provides an affordable, dependable, and contemporary method of monitoring inmates and guaranteeing public safety by incorporating such tried-and-true technologies into prison security.

II. LITERATURE REVIEW

• Yoni D. Huaynacho, Abel S. Huaynacho, and Yaneth Chavez (2020) described an RF-based security system that makes use of sensors and controls. In order to demonstrate the efficacy of RF-based monitoring systems in restricted contexts, their study focuses on putting in place a dependable wireless security mechanism that detects intrusions and provides alarms. • In 2020, Peter C.K. Law, Lawrence C.K. Poon, and Andy W.C. Chung presented a smart prison system that uses video analysis to detect human activity. Their research improves the effectiveness of surveillance in correctional facilities by using sophisticated image processing techniques to track prisoner activities and spot suspicious conduct.

• In order to follow moving objects, Pradipta Ghosh, Jason A. Tran, and Bhaskar Krishnamachari (2019) developed the ARREST system, which is based on RSSI (Received Signal Strength Indicator). Their method makes it possible for precise mobile sensing and tracking, which is helpful for keeping an eye on people in dynamic settings. • RF-based analytics employing tag-to-tag networks was covered by M. Stanacevic, Y. Karimi, G. Feng, J. Ryoo, A. Athalye, and P. M. Djuric (2019). Their research offers insights into cutting-edge wireless monitoring methods by demonstrating how RF transmission can be employed for data creation and tracking. • Adri Wahyudi, Fakhri Ramdana, and Rini Handayani (2017) created a tracking, monitoring, and alert system for electronic gadgets. Their prototype highlights affordable options for security and monitoring applications by showcasing real-time tracking and alarm systems.

III.EXISTING SYSTEM

The Zigbee protocol is mostly used for data transfer in the current jail monitoring system. While Zigbee works well for short-range wireless communication, it has serious drawbacks when used in security systems that need to track a user's location in real time. The inability of Zigbee to send precise GPS location information to the receiver side is a significant disadvantage that makes it challenging to follow a prisoner's precise location once they are out of range. This constraint becomes a major worry as modern security systems require greater precision and efficiency.

Despite the introduction of wireless technology into prison management systems, Zigbee deployment is unreliable. Although the system can transmit alerts to jail authorities in an emergency, the effectiveness of the reaction is diminished because of its limited range and incapacity to offer exact position data. Such systems' hardware implementation is likewise complicated and difficult to maintain. The system also has poor precision and a slow response time, which causes delays in action and communication.

3.1. Disadvantages:

• For example, poor precision, high latency, restricted range, and no real-time position monitoring.

• For crucial security applications, the current system is not entirely dependable. Newer technologies like GPS, GSM, and iBeacon sensors are being examined as solutions to these problems because they offer greater accuracy, quicker response times, and real-time tracking capabilities.

IV. PROPOSED WORK

The majority of the time, correctional surveillance and monitoring rely on manual head counts, which are prone to human mistake. The current surveillance system takes a long time and is relatively slow. As a result, it is impossible to properly monitor the prisoner. This study presents an electronic surveillance system that uses a laser alarm, GPS, and GSM. The cell phone whose number is stored in the GSM module at the transmitter will then receive the escaped prisoner's precise GPS coordinates, making it simple to monitor their whereabouts.

Block diagram:

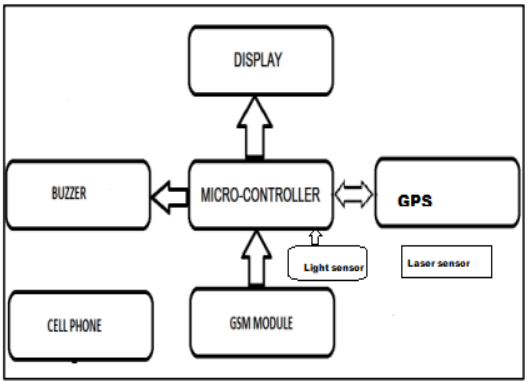

Fig.1. Architecture of proposed system

4.1. Working methodology:

The suggested system operates by fastening an electronic handcuff, or bracelet, to the prisoner's wrist for ongoing surveillance. The transmitter on the bracelet connects with the receiver at the control server as long as it stays within a predetermined signal range when the inmate is on the jail grounds. No alarm is generated if the prisoner remains within this range. However, the signal range is disrupted if the prisoner tries to break free or tamper with the bracelet, setting off an instant alarm and notifying the jail administration via GSM. The GPS module (such as the GPS Neo-6M) is enabled to track the precise location using latitude and longitude coordinates whenever the prisoner leaves the approved area.

The GSM module subsequently transmits these coordinates in real-time to the approved cellphone number, allowing for prompt tracking of the escaped prisoner. Furthermore, by identifying any unwanted movement across limits, a laser alarm system improves security. An Arduino, which interprets signals from sensors, GPS, and GSM, controls the complete system. This automated solution guarantees real-time monitoring, minimizes manual labor, and offers precise tracking under all circumstances.

4.2. Advantages:

1. Real-time tracking: GPS quickly informs the prisoner's precise location.
2. Fast alerts: When an escape attempt occurs, GSM immediately notifies authorities via SMS.
3. Decreased human error: Manual headcount errors are eliminated.
4. Quicker reaction time: With real-time location data, authorities can take prompt action.
5. High security: Unauthorized movement is immediately detected by a laser alert.
6. Broad coverage: Unlike short-range systems, the GSM network operates across great distances.
7. Economical: Lowers labor and monitoring costs.
8. Automated system: Operates continually without the need for human intervention.
9. Accurate monitoring: Offers more accurate tracking than previous systems.
10. Prevents escapes: Prisoners are stopped before they get too far thanks to early detection.

V. PROBLEM STATEMENT

It is extremely difficult for prison officials to keep an eye on inmates and stop escape attempts. In big prison settings, conventional techniques like physical surveillance and manual headcounts are ineffective, time-consuming, and prone to human error. Current systems that use short-range communication technologies, such as Zigbee, have limited range, poor precision, and slow reaction times, and hence are unable to provide real-time position tracking. Because of this, it becomes more difficult to swiftly identify and follow a prisoner who escapes or leaves the restricted area, posing a greater risk to public safety and necessitating expensive and time-consuming labor.

VI.. OBJECTIVES

1. To create an automated GPS and GSM-based prisoner monitoring system.
2. To follow inmates' whereabouts in real time while they try to flee.
3. To create a geo-fencing system that limits the movement of inmates inside a predetermined area.
4. To put in place an alarm system that uses SMS to promptly notify authorities.
5. To incorporate an extra intrusion detection system based on lasers.
6. To lower operational costs, human labor, and monitoring time.
7. To enhance jail security systems' precision, dependability, and reaction speed.

VII. HARDWARE DESCRIPTION

7.1.Arduino Nano:

The system's primary controller is the Arduino Nano. It controls outputs including buzzer, LCD, and GSM communication, processes data from all sensors and modules, and takes decisions depending on preprogrammed situations. It is appropriate for this project due to its small size and simplicity of programming.

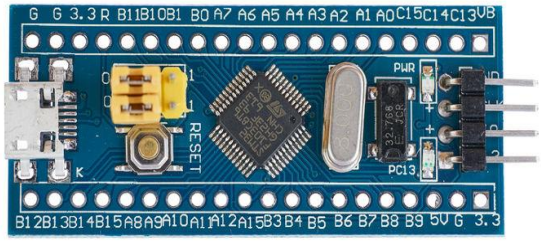

Fig.2. Arduino nano

7.2. LIQUID CRYSTAL DISPLAY (LCD):

Fig.3. LCD

System status information such as "Inside Area," "Outside Area," GPS locations, and alert messages are displayed on the LCD display. It facilitates simple system monitoring and debugging.

7.3. GPS Module (Neo-6M): The GPS module is utilized to determine the prisoner's current latitude and longitude. It aids in tracking the precise location and becomes active when the prisoner crosses the designated limit.

Fig.4. GPS module

7.4. GSM SIM 800C:

Communication is handled by the GSM module. When it detects an escape attempt or boundary breach, it provides GPS locations and SMS notifications to authorized personnel.

Fig.5. GSM SIM 800C

7.5.

Buzzer

- We are using a piezoelectric buzzer
- The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle
- The buzzer produces a same noisy sound irrespective of the voltage variation applied to it

Fig.6. Buzzer

7.6. LDR Sensor:

Laser light is detected by the LDR sensor. The system continues to function normally when the laser beam is continuously focused on the LDR. Intrusion or movement across the boundary is indicated if the beam is broken.

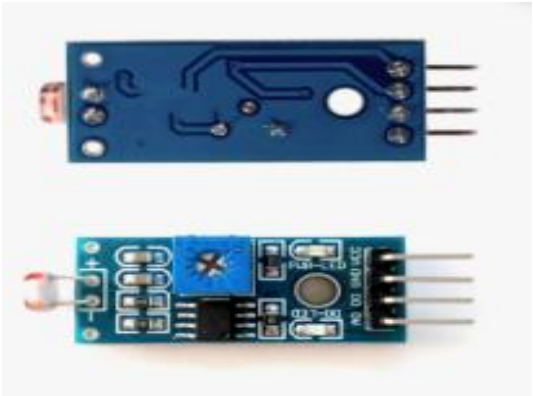

Fig.7. LDR sensor

7.7. Laser Sensor:

A continuous laser beam is directed toward the LDR by the laser diode. It creates a security barrier, and the warning mechanism is activated by any impediment in the beam route.

Fig.8. Laser sensor

VIII. ARDUINO IDE

Code can be written, compiled, and uploaded to Arduino boards like the Arduino Nano, Uno, and Mega using the Arduino IDE, an open-source software platform. It offers an easy-to-use interface that makes working on embedded system projects easier for both developers and novices. The IDE facilitates rapid code writing and verification by utilizing the C and C++ programming languages and incorporating an integrated editor, compiler, and uploader. Additionally, it has a serial monitor that shows real-time hardware data to aid with debugging. Furthermore, a variety of libraries that facilitate the integration of sensors, modules, and other electronic components are supported by the Arduino IDE, which speeds up and improves the efficiency of the development process.

IX. RESULTS AND DISCUSSION

The suggested GPS and GSM-based inmate monitoring system was developed and tested with success. The prisoner's movements inside the specified geographic area might be precisely tracked by the system. The system operated normally and didn't send out any notifications while the prisoner was on campus, indicating that the geo-fencing was working properly.

When the prisoner tried to tamper with the bracelet or crossed the predetermined boundary during testing, the system recognized the breach right away. The approved cellphone number received alarm messages and real-time GPS coordinates from the GSM module. This made it possible to quickly identify and locate the prisoner.

By recognizing any disruption in the laser beam and immediately sounding the buzzer alarm, the laser and LDR-based security system also operated efficiently. This gave the prison grounds an extra degree of security. The suggested method demonstrated a notable improvement in accuracy, response time, and dependability when compared to conventional manual monitoring systems.

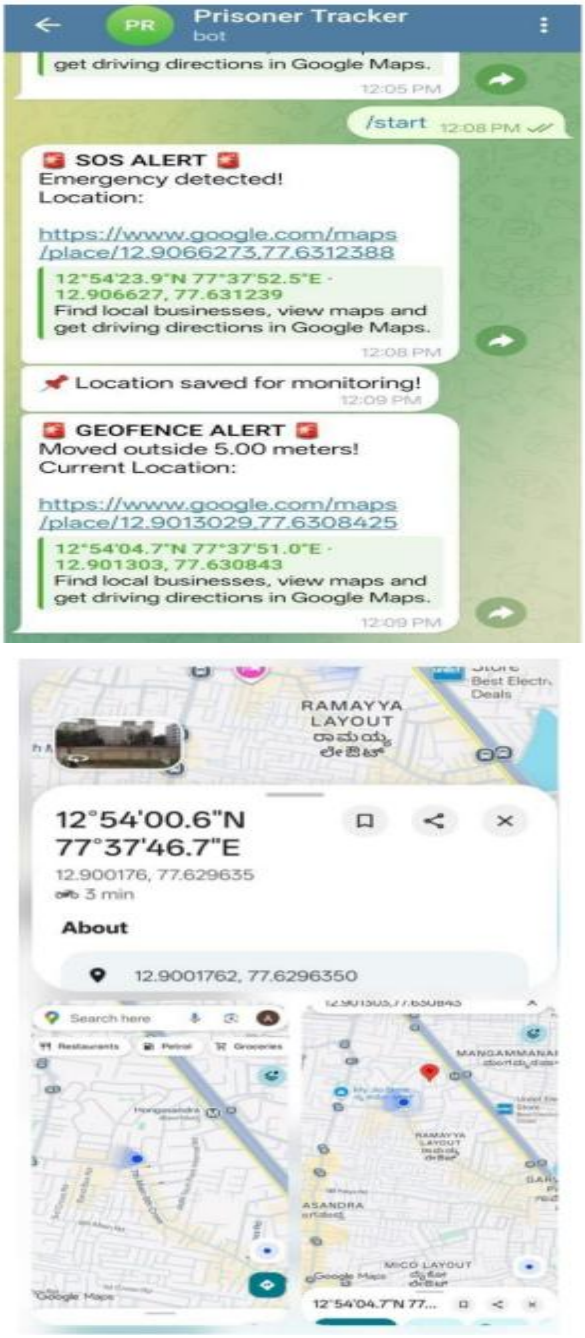

Fig. 9. Prisoner tracking using GSM and GPS

It minimized errors related to manual supervision and decreased human labor. However, under some circumstances, slight delays in GPS signal acquisition and GSM message delivery were noted; these can be resolved in subsequent improvements. For real-time prisoner tracking and security control, the system proved to be dependable, economical, and efficient overall.

X. ADVANTAGES

1. Simple to use.
2. Economical.
3. Find the prisoner's current location.
4. SMS is sent.
5. Turn on automatically.
6. A laser warning

11. Applications:

1. In correctional facilities
2. Cars
3. Security mechanisms
4. Hostels

XI.. CONCLUSION

In the event of a security breach, this system will generate an alert warning. The contact between the two micro controllers will end as soon as the prisoner leaves the designated range of 10 to 30 meters. As a result, it alerts the central control room authorities. In addition to the warning message, our technology gives the escaped convict's exact coordinates every two minutes after he leaves the prison. These GPS coordinates are used to locate the suspect. As a result, the need for manual head counts and record keeping is eliminated, which lowers the amount of money and labor needed for real-time suspect tracking.

It will improve the accuracy of the surveillance system and bolster law enforcement and jail administration. The communication link between the laser sensor alert trans-receiver will fail as soon as the suspect leaves the predetermined range, and the system will send out an alert message in the control room. Every minute, we will receive the precise GPS coordinates of the escaped prisoner in addition to the warning message. We can locate the escaped prisoner with ease using these locations.

XII. FUTURE SCOPE

1) To monitor patients in psychiatric facilities because man-to-man surveillance cannot be maintained continuously.

2) In situations like house arrest, where there are no set borders like in jails, this system is quite helpful. It is very difficult to confine someone in a certain region while they are in such a situation. It is made possible by this system.

REFERENCES

[1] "Design and Implementation of a security system created by RF using controllers with sensors", Yoni D. Huaynacho, Abel S. Huaynacho, Yaneth Chavez |2020 X International Conference on Virtual Campus (JICV)| DOI:10.1109/JICV51605.2020.9375655

[2] “Smart Prison - Video Analysis for Human Action Detection”, Peter C.K. Law, Lawrence C.K. Poon, Andy W.C. Chung | IECON 2020 The 46th Annual Conference of the IEEE Industrial Electronics Society | DOI: 10.1109/IECON43393.2020.9255402

[3] "ARREST: A RSSI Based Approach for Mobile Sensing and Tracking of a Moving Object", Pradipta Ghosh, Jason A. Tran, Bhaskar Krishnamachari | IEEE Transactions on Mobile Computing | DOI: 10.1109/TMC.2019.2909020

[4] “RF-Based Analytics Generated By Tag-To-Tag Networks”, M. Stanacevi , Y. Karimi, G. Feng, J. Ryoo, A. Athalye, P. M. Djuric | ICASSP 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)| DOI:10.1109/ICASSP.2019.8682459

[5] “Alert, Monitoring and Tracking for Electronic Device Prototype”, Rini Handayani, Fakhri Ramdana, Adri Wahyudi | 2017 11th International Conference on Telecommunication Systems Services and Applications (TSSA) | DOI: 10.1109/TSSA.2017.8272921

[6] “Smart Patient Management, Monitoring and Tracking System Using Radio-Frequency Identification (RFID) Technology”, Hangaw Qader Omar; Abdulqadir Khoshnaw; Wrya Monnet | 2016 IEEE EMBS Conference on Biomedical Engineering and Sciences (IECBES)| DOI: 10.1109/IECBES.2016.7843411

[7] "Multiple Target Tracking with RF Sensor Networks", Maurizio Bocca, Ossi Kaltiokallio, Neal Patwari, Suresh Venkatasubramanian |2014 IEEE Transactions on Mobile Computing (Volume: 13, Issue: 8, August 2014) | DOI: 10.1109/TMC.2013.92

[8] "The Application Research of Wireless Sensor Network in the Prison Monitoring System", Wan Zhou, Zhang Xuehua, Xiong Xin, Wu Jiande | 2010 Faculty of Information Engineering and Automation Kunming University of Science and Technology| DOI: 10.1109/IITSI.2010.160

[9] "Connection Set-up and Synchronization in RF Memory Tag System", Joni Jantunen and Michael Pelissier | Nokia Research Center, Helsinki, CEA Leti–MINATEC | DOI: 10.1109/RWS.2011.5725468

[10] "A RF Source Localization and Tracking System", Will Tidd, J. Weber Raymond, Yikun Huang, Yufei Zhao, 2010 - Milcom 2010 Military CommunicationsConference, DOI:10.1109/MILCOM.2010.5680188

[11] GEOfencing in IOT: Enhancing Location-Based Services — Anand Kumar Vedant ham (2024).

[12] Improving Vehicle Tracking Systems Using GPS - Zainab Naser Azeez (2025).

[13] Real Time Vehicle Tracking System - Implementing Geofencing - Rohit Mishra, Amit Kumar Tiwari, A. S. Singh, K. Gupta, Kaushiki Srivastava & Abhishek Srivastava (2024).

[14] IoT-Based Wristband for Automatic People Monitoring, Contact Tracing, and Geofencing During COVID-19 — Sharanya Mahapatra, Vishali Kannan, Srinidhi Seshadri,Visvanathan Ravi, S. Sofana Reka (2022).

[15] Smart Shield: IoT-Based Solution for Fall Detection, Tracking, and Health In this section, we review another Monitoring Using ESP8266 — Ashish Mahendra Nath Pathak, Vinayak Iragonda Patil,Vaishali Patil, Vaishnavi Pujari (2024)