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IoT Based Prison Break Monitoring and Alarming System

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Abstract- Security in prison is an important issue as the conventional monitoring system depends on manual supervision, and no immediate action is taken in such scenarios. This project describes Prison Monitoring and Wearable Tampering Detection System Based on ESP32. The system works to monitor environmental conditions using various sensors like motion sensor, gas sensor, flame sensor, and door sensor. Additionally, a wearable band is used to monitor prisoners. This band is capable of detecting tampering and providing instant alerts. Communication is established using ESP-NOW which does not require internet connectivity.

Keywords: ESP32, ESP-NOW, Prison Security, Wearable Monitoring, Tamper Detection, IoT, And Real-Time Monitoring.

I. INTRODUCTION

Security plays an important role in prisons as it helps maintain the safety and discipline of inmates. Proper monitoring and controlling of prisoners are very crucial in order to ensure proper security. Traditional security systems are primarily based on manual and video surveillance techniques, which can only serve their purpose in a limited manner since they involve lots of manual work and may be subject to errors. Furthermore, manual security measures may not provide immediate responses during any critical situation.

The evolution of Internet of Things (IoT) has led to the emergence of smarter and automated security systems. Using sensors, embedded systems, and wireless communications, the activity and environment around prison areas can be constantly monitored. With the continuous monitoring of activities, any abnormality can be detected immediately and necessary actions can be taken.

In this study, a Prison Monitoring and Wearable Tamper Detection System Using ESP32 Microcontroller is proposed. The proposed system uses various sensors like motion sensor, gas sensor, flame sensor, and magnetic door sensors to constantly monitor and detect any anomaly in the prison environment.

ESP-NOW communication technology is used in the system to ensure quick, efficient, and dependable wireless data transfer without depending on the internet. Thus, operation will continue smoothly without network availability challenges. Alerts will be immediately issued whenever an unusual occurrence is detected, using buzzers, LEDs, and LCD monitors. The proposed system can help increase security in prisons because of the integration of environmental and wearable monitoring technologies that are effective and cost-efficient.

II. RELATED WORKS

In the last few years, many studies have been conducted on real-time surveillance and security for prisons using IoT. The literature on the above topic can be divided into four broad categories: (a) Surveillance & data gathering; (b) Embedded processing & communication; (c) Alert & monitoring systems; and (d) Shortcomings of current systems.

2.1 Surveillance and Data Acquisition.

In most cases, existing systems employ different sensors that can be used in identifying events in the prison. Motion sensors can be used in detecting the presence and movements of people while door sensors are used in identifying any unauthorized entry or opening of the doors. Other environmental sensors that are included in the system are flame and gas sensors for detecting any possible fire or gas leakage. Even though the existing systems can keep collecting data, they work on a regional level and cannot provide individual tracking. The absence of this tracking capability in the existing systems makes it difficult for these systems to monitor prisoners' movements effectively in secure areas. For this reason, there should be a combination of the wearable and sensor-based monitoring systems.

The integration of a centralized processor such as ESP32 can make the monitoring process much easier through real-time processing of data. This will also facilitate wireless communication with sensors and other wearable devices.

2.2 Embedded Processing and Communication.
Embedded systems are critical in the processing of sensor information and making decisions instantly. The microcontroller ESP32 is one of the most popular because of its processing power and wireless capabilities. Different communication methods such as Wi-Fi, Bluetooth, and GSM are employed to send data to the monitoring systems. However, internet-based communication systems have problems such as latency, reliance on networks, and unreliability in constrained environments such as prisons. Thus, a need exists for latency-free and independent communication protocols.

2.3 Alert and Monitoring Systems.
An alerting system is a vital part of a modern security system. Current security systems employ buzzers, LED lighting, and mobile alerting as means of communicating with the authorities concerning any abnormal conditions. Modern technology allows for the use of cloud-based systems as well as mobile applications as a way of providing remote access and control. Despite the advantages that come with these systems, it could result in latency due to networking. In situations like those of prisons where immediate actions are required, there should be alert systems that will enable immediate contact coupled with efficient wireless communication.

2.4 Limitations of Existing Systems.
Despite technological advancements in prisoner monitoring, several challenges persist, even in current systems. First, it should be noted that not all systems for monitoring prisoners possess a module responsible for monitoring individuals and operate using environment monitoring only. Another problem associated with prison monitoring is that the majority of these systems require Internet connection, something that is not always available. Finally, certain limitations include delays in alert notifications and weak interaction between multiple security layers.

In order to solve the issues raised above, it was decided to develop the technology involving multi-sensor monitoring and adding the functionality of detecting tampering on wearables with ESP-NOW communication. By doing so, it is possible to ensure that the designed system works without Internet access, providing reliable and quick results thanks to low latency and promptness.

Existing technologies for monitoring prisoners' movements often lack flexibility and scalability, making them incapable
of adaptation to the peculiarities of specific prison facilities and upgrading accordingly. To make the technology proposed herein adaptable, it is necessary to employ a modular approach based on ESP32.

III. METHODOLOGY

The methodology used for the proposed Prison Monitoring and Wearable Tamper Detection System has been structured in such a way that it can provide an effective means of collecting, processing, transferring, and generating alerts for security information in real time. The methodology is aimed at providing a reliable, fast, and efficient monitoring system of both the prison and its inmates. It consists of various stages outlined below.

3.1 Data Acquisition
There is also a network of sensors placed inside the prison complex that provides information about important aspects like security and environmental conditions. Human presence sensors are installed in order to monitor any movement of people, while the door magnetic sensors check whether the prison doors are locked or unlocked. Gas and flame detectors are installed in the system to sense the presence of gas leaks or fire.

3.2 Wearable Band Monitoring

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In order to achieve monitoring on an individual level, the prisoners are given a wearable band that contains a conductive loop circuit. In normal circumstances, the circuit will remain closed, meaning that everything is working well. However, if the wearable band is detached from the body, then there will be a break in the circuit, and the microcontroller of the ESP32 chip in the wearable band will be able to sense the disruption.

3.3 Data Processing

The ESP32 is the processing unit of the system. It accepts inputs from the environmental sensors as well as from the wearable devices, and based on the processed information, the ESP32 is able to evaluate the situation to determine whether any abnormalities have occurred. The system uses logic to determine when an intrusion has taken place or if there are any threats to the user's environment.

3.4 Wireless Data Transmission

The processed data is sent to the control unit wirelessly through the ESP-NOW protocol. This method of transferring data has low latency, high security, and reliable data transfer without any internet requirement. It is ideal for places like prisons that do not rely on networks but require real-time communication.

3.5 Alert Generation and Notification

In case of detecting any abnormalities, the system produces instant alerts through various output methods. In this regard, a buzzer sounds an alarm so that people can hear about such situations, whereas LEDs give visual signals about the status of the system. Furthermore, alert notifications can be seen on the LCD screen as well.

3.6 Experimental Model

Based on the analyzed data and detected conditions, the system generates immediate alerts and status indications related to security threats such as unauthorized movement, environmental hazards, and wearable band tampering. This real-time alert mechanism assists security personnel in taking prompt actions, improving response time, enhancing overall surveillance efficiency, and ensuring a safer and more controlled prison environment.

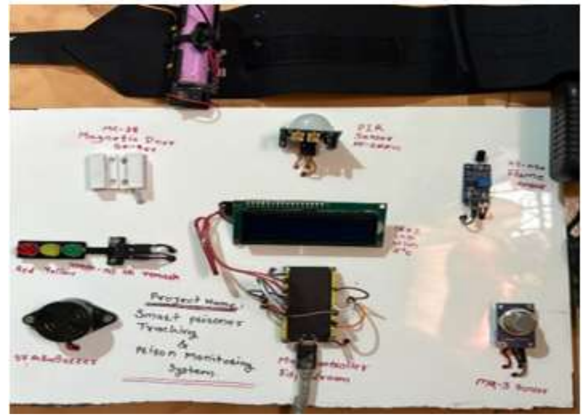

Fig. Hardware Setup

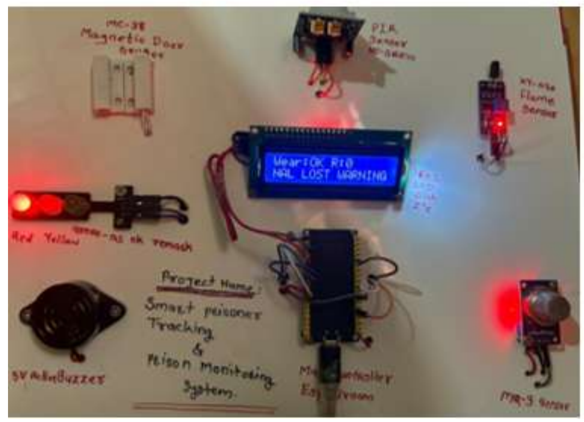

Fig. Working Model

Block Diagram

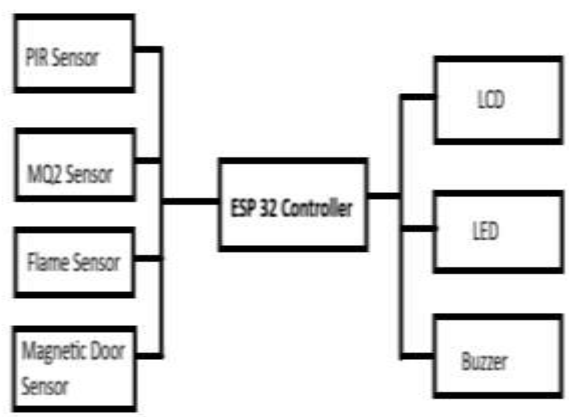

Fig. Block diagram

This block diagram presents the design structure for the proposed Prison Monitoring System. The control unit comprises of an ESP32 microcontroller coupled with sensors including motion sensor, gas sensor, flame sensor, and magnetic door sensor. They are used to monitor the security and environmental conditions inside the prison.

The information captured by the sensors is then analyzed using the ESP32. If there are any abnormal conditions such as intrusion, fire outbreak, gas leak, or door breach, real-time alerts will be issued by using buzzers, LEDs, and LCD screen displays.

Flowchart

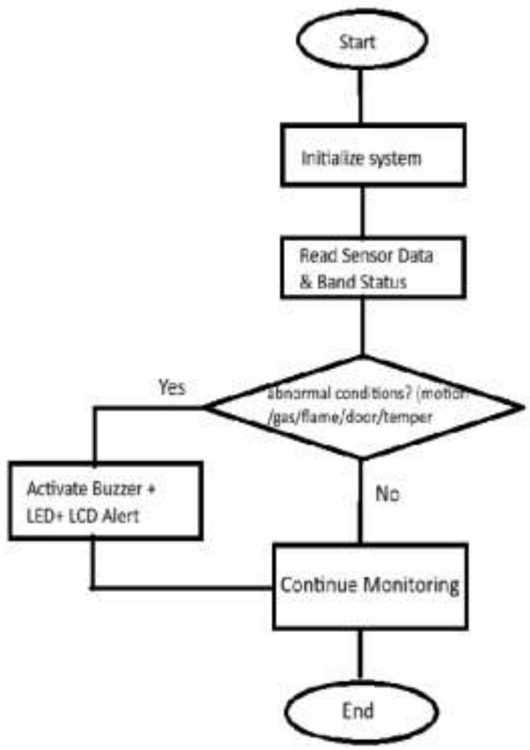

Fig. Flow Chart

This flowchart gives us an overview of how the Prison Monitoring System works. First of all, the prison monitoring system initializes its components like sensors, esp32 microcontroller, and wearables band. Then it starts monitoring data coming from different sensors like motion sensor, gas sensor, fire/flame sensor, and door sensor along with the wearables band.

The data acquired is analyzed and compared to pre-defined criteria in order to recognize any abnormal behavior like intrusion detection, gas leakage, fire detection, door or band tampering. Any abnormality recognized in this manner results in alarms being generated by means of buzzer, LED, and LCD display. The process continues in a similar fashion indefinitely.

IV. SYSTEM ANALYSIS

The system analysis process entails assessing the capabilities and viability of the proposed Prison Monitoring and Wearable Tamper Detection System. It will serve the purpose of ensuring that the system offers effective real time monitoring and alert creation for improved prison security.

Functional Analysis

The system monitors the status of the prison facility through the use of various types of sensors including motion sensors, gas sensors, fire sensors, and door sensors. Meanwhile, the inmates are tracked using a wristband that is able to detect tampering. Through the combination of environmental monitoring and inmate tracking, the system is able to detect any suspicious activities.

Moreover, the control unit utilizes ESP32 to process all the information gathered by the sensors and ensure smooth communication among the modules. Whenever an anomaly arises, the system generates an alarm or notification immediately to enable timely responses.

Hardware Analysis

The hardware section of the system includes ESP32 microcontrollers, sensors, wearable band, buzzer, LED, and LCD. The motion detection is done using a PIR motion sensor, and the environmental threats like smoke and fire are detected using the gas and flame sensors. The door sensors are used to monitor the unauthorized entry through doors. The ESP32 microcontroller works as a controller and processes all sensor data. The tampering of the wearable band is detected using the conductive loop system.

Moreover, the hardware devices have been connected in such a manner that it facilitates real-time monitoring of prison conditions. The buzzer and LED are used for immediate local alerts, while the LCD shows the system status and sensor values for easy monitoring.

Software Analysis

Components of the software subsystem include the embedded software, the cloud software, and the user interface. The embedded software component is responsible for managing communication with sensors, processing the acquired data, and transferring data wirelessly. The cloud software manages data storage, processing, and the creation of alerts.

Performance Analysis

The system is constructed to monitor in real time without delay from data collection to the creation of alerts. With continuous functionality, abnormal situations like motion, gas leakage, fire detection, and tampering with wearable bands can be detected promptly. Data processing and communication via ESP-NOW allow faster operation while using less energy, making the system ideal for real-time prison security purposes.

Metric	Observed Value	Expected Value	Remarks
Response Time	1–2 seconds	1–2 seconds	Met expectations; suitable for immediate alerts.
Detection Accuracy	95–98%	>95%	Sensors accurately detected threats.
False Alarm Rate	<5%	<5%	Calibration effective; minimal false alerts.
Environmental Hazard Detection	90–95%	>90%	Fire and gas sensors functioned reliably.
System Uptime	99%	99%+	Highly reliable over continuous operation.

Performance Metrics Summary

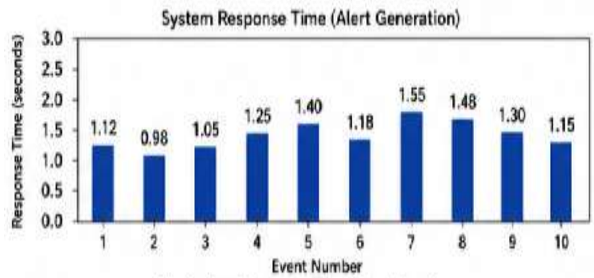

Fig. System Response Time Over Events

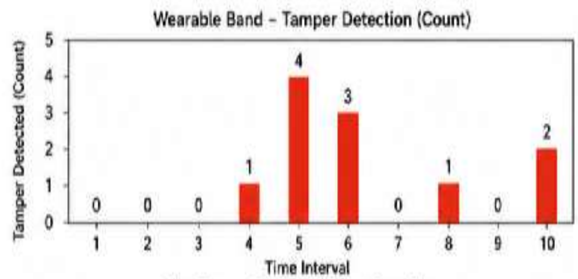

Fig. Tamper Detection Count Over Time

The first graph represents the time taken by the system to generate an alert after detecting an event. The response time is consistently low (around 1-1.6 seconds), ensuring real-time monitoring and quick action.

The second graph is of the wearable band, monitors the integrity of the band. The graph shows the number of temper events detected. Increase in count indicates attempts to remove or damage the wearable band.

Feasibility Analysis

The proposed system is feasible from both technical and economic perspectives. The ESP32, sensors, and actuators used in the system are cheap and easy to obtain, thus the system is feasible in terms of costs. The system works independently and does not rely on internet connection; hence, its operations become simpler and cost-effective.

The straightforward design of the system makes it easy to install, maintain, and scale up. In addition, the system can be installed in any prison facility with minimal changes. The overall system is thus feasible for real-time applications.

V. RESULTS AND DISCUSSION

The proposed Prison Monitoring and Wearable Tampering Detection System was tested to assess its effectiveness during real-time security surveillance operations. The system proved effective in monitoring the environment and the status of the wearable bands, showing that it worked reliably and consistently under various test scenarios.

Results

The system accurately sensed occurrences like movement, gas leak, flame sensing, door status, and tampering of the wearable band. Alert signals were triggered instantaneously via the buzzer, LEDs, and LCD screen.

The system responded quickly with virtually no latency, in just 1–2 seconds. The ESP-NOW protocol facilitated effective data transfer between the wearable band and control unit. Data was transmitted continuously without any interruptions, ensuring robust system operation.

Discussion

T The results indicate that real-time monitoring is more efficient than the conventional methods for security purposes. The real-time monitoring via sensors and the wearables allows the system to detect any abnormal activity and prevent security threats.

With the incorporation of several sensors alongside the tampering detector, the system provides efficient monitoring of the surroundings. In case of minor differences caused by environmental issues, sensors need to be calibrated periodically. Nonetheless, the proposed system operates effectively and efficiently and hence can be incorporated in real-life time monitoring in prisons.

Moreover, the system shows remarkable reliability in terms of operational efficiency with minimum delays. With the introduction of a control unit like the ESP32, there will be rapid communication and processing of data.

VI. CONCLUSION

The suggested prison monitoring system along with the wearable tampering detection is an effective measure that could be used in improving prison security through real-time monitoring and generating alerts in case any abnormal condition takes place.

ESP32 chips and ESP-NOW communications ensure fast and stable transmission of the sensor data without the necessity of an Internet connection. Thus, the system shows its efficient work by providing a high speed of reaction, energy-saving capabilities, and operational reliability.

As a result, the presented prison monitoring system is capable of increasing the effectiveness of surveillance, reducing the necessity for manual control, and ensuring high security inside the correctional institution.

VII. FUTURE WORK

There are a few elements that can be added or modified to improve the proposed Prison Monitoring and Wearable Tamper Detection System. For example, improvements to the scalability and performance capabilities of the system should be considered. The ability to create the system that will work with several wearable units at the same time is quite attainable. This way, many prisoners can be monitored with the help of the developed system simultaneously.

Effective methods can be used to ensure proper communication between all of the devices and the central control system. As well as this, power management can be implemented to increase the operational capabilities of the system. By doing so, the developed system will be capable of continuous monitoring prisoners without requiring constant battery recharging. Additionally, a centralized interface can be created to make monitoring easier.

In order to ensure maximum safety of the collected and processed data, encryption algorithms must be implemented into the developed system. Advanced data processing techniques will significantly increase the performance capability of the system.

Finally, some modifications might relate to the implementation of AI-powered analysis algorithms to increase the efficiency of the monitoring process.

REFERENCES

[1] Gevana Lynn Salinas, "Prison Management Models and the Texas Prison System" Texas State University- San Marcos, Dept. Of Political Science, Public Administration Program, Summer 2009.

[2] Rahul Singh, Sr. Consultant, KPMG, "Prison Management System for Arthur Road Jail" 2010.

[3] Paul Rock, London School of Economics, London, UK" Prison Life, Sociology of", volume 18, pp. 12055–12059, 2001.

[4] Goffman, E., 1961. Asylums. Doubleday Anchor, Garden City, NY. Irwin, J., Cressey, D., 1962. Thieves, convicts and the inmate culture. Social Problems 10, 145 155.

[5] Jacobs, J., 1977. Stateville: The Penitentiary in Mass Society. University of Chicago Press, Chicago.

[6] Liebling, A., Hulley, S., Crewe, B., 2012. Conceptualizing and measuring the quality of prison life. In: Gadd, David, Karstedt, Susanne, Messner, Steven F. (Eds.), The Sage Handbook of Criminological Research Methods. Sage, Thousand Oaks, CA, pp. 358–372.

[7] Morris, T., Morris, P., 1966. Pentonville : A Sociological Study of an English Prison. Routledge, London.

[8] Sykes, G., 1958. The Society of Captives. Princeton University Press, Princeton, NJ.