PRISON BREAK AND PRISONER MONITORING SYSTEM

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***Abstract*—Very recently certain allegations aroused regarding the security system within the prisons. Prisoners are reported to be indulging in various malpractices even inside the jail boundary that require immediate attention. The traditional methods forgetting the appropriate report usually take long time to process which helps the prisoner to escape. It is observed that applications which require high traceability can very well use RFID (Radio Frequency Identification) technology. This system is developed for high security prison management using the RFID along with the buzzers and real time tracking system to ensure 100% safety.**

***Index Terms*—IoT Application, RFID, Google Earth API**

I. Introduction

At present, the prison has surveillance cameras and few security guards are employed to monitor the illegal movement of prisoners approaching the perimeter wall with the intention to escape from prison. In addition the officers perform head counts of all the prisoners 3-8 times a day to keep a check on the number of prisoners. These approaches can be easily botched by the prisoner to escape from the prison. To control this undesirable situation, techniques like implanting pressure sensors in the perimeter wall, CCTV surveillance with image processing based solutions, Drones etc are used. Deployment of these techniques incurs high cost and does not give exact location of the prisoner. Hence, IoT based prisoner escape detection technique has been proposed in this work.

II. Aims and Objectives

In this report we propose a solution to trace the prisoner getting outside a specific boundary. It allows the prison management authority to keep track of prisoners based on RFID (Radio Frequency Identification) technology. This system assigns a unique ID to each and every prisoner with in prison to access the information about him/her.The cost effectiveness and efficiency make the system reasonable.

The following are the functions mainly handled by the system:

- The system notifies the authority about an escape with the help of buzzer when a prisoner tries to cross a predefined boundary.
- Maintain details of each prisoner like interrogation and citation details, date of custody and remand, parole or bail details, visitors list etc., and manipulate the same using his RFID.
- The system also maintains a track of health of each prisoner like pulse count on a cloud service platform.
- The system is capable of tracking the position of each prisoner using the RFID technology to keep a watch on their movement.
- RFID typically facilitates the investigation process. RFID reduces inmates' violence and property damage since everything is recorded in the system which in return reduces maintenance costs in the prison.

The central prison officials can check the criminal background of a person. The crime department can check the travel history of a citizen at the time of prison break, if needed. All data related to a person are stored under the RFID of that person. Aditionally the system can also be set up to do meal counts. Each wristband also has a RFID tag on it. As each prisoner enters the cafeteria, he scans his bar code in front of a reader. If the same prisoner attempts to come back and get a second meal, an alert sounds.

The RFID tag can also be scanned every time an inmate is given prescription drugs, so the institution knows who got what and when. It can even be tied into the phone system, so prisoners are only able to dial certain numbers based on the unique serial number in their wristband.

III. System Design

A. Hardware Components

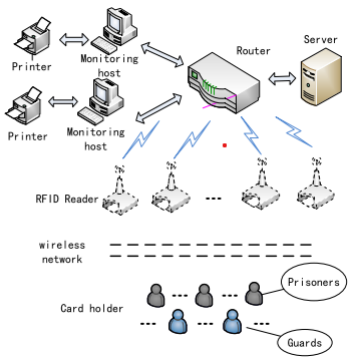
The required hardware of the system includes RFID card reader and an RFID tag, ESP32, Pulse sensor and buzzers. ESP32 is a single-board micro controller with Wifi module. We mainly used this board in order to ease up the process of storing data about the prisoner on cloud.

The wristband with RFID tag, on the prisoners wrists acts as a tamperproof transmitter, each transmitter constantly sends off a unique signal that's captured by the antenna and then processed through a computer software or on cloud, which determines where the subject is at every two seconds.

The system installs a RFID card reader on the boundaries of the security region to enable the administrator to track the security break. This design will also monitor a moving person and report the status of the person on demand.

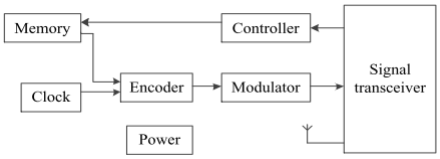
B. Architecture of prison break

The system is mainly composed of the active electronic tags, along with RFID readers.

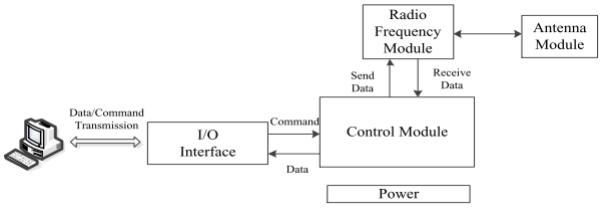


1) Design of tag: Personnel information is stored in RFID tag for identification of a prisoner. Taking into account the particularity of the prisoners, RFID tags in this system are in a non-detachable bracelet form.

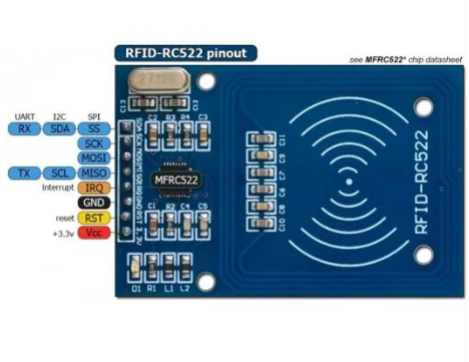
Electronic tag is an important part of RFID system, which is mainly composed of the antenna and the chip. The chip is composed of a memory, a controller, an encoder and a modulator. Tag uses 433MHz band, and its maximum identification distance is 150m, effective distance 80m. The electronic tag hold the personal information.



2) Design of readers: The reader is the key terminal of the RFID system, which transmits the radio frequency modulation signal to the electronic tag by the antenna and receives the radio frequency modulation signal which containing information returned from a tag by the antenna. The signal is transmitted to the application system after be processed. The typical reader terminal consists of antenna module, radio frequency module, control module, interface and so on.

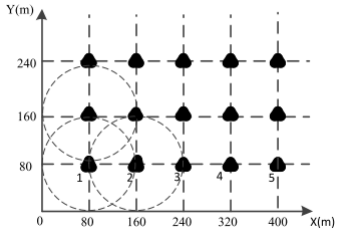


For this system we would be using the following RFID reader as shown in the diagram.

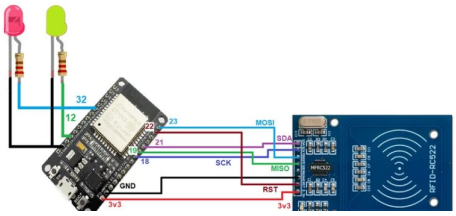


3) Position of readers: For tracking the prisoner using the RFID technology we implement the following strategy to place the readers. The area of prison is generally approximated as a rectangle. Put a reader at coordinate (80, 80), and put other readers according to the principle that the span of adjacent two readers is 80 meters. The recognition range covers the whole prison.

When the person wearing the tag enters the reading range of the reader, the reader reads the information in electronic tag, calculates the position information and updates the data. For calculating the position of the reader localization algorithm can be used.



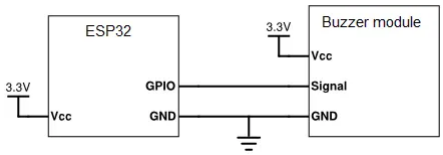
4) Connections of RFID reader with ESP32: Using the following connections listed below we can read the data of RFID tag.



The link contains the algorithm to read and write to the RFID tag with the help of RFID Reader and ESP32. Useful information about the prisoner like the ID, no of meals, medical prescription are stored in the tag of each prisoner.

5) Connection of buzzer with ESP32: When the RFID readers near the perimeter of the wall receive a signal implies that the prisoner is trying to escape as he is in the forbidden region. In such scenario the buzzers connected to the ESP32 will generate an alert to notify the prison management authority of the escape. The below diagram

shows the connection of a buzzer to the ESP32.



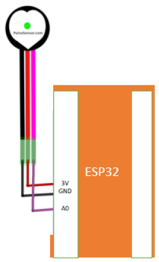
6) Connection of AWS with ESP32 to store data: We need to connect ESP32 to AWS to store the data monitored by the system. For this ESP32 needs an active internet connection, so the code mentioned in the link is required for storing data collected by esp32 to the cloud. By importing a library to make JSON files in the Arduino IDE we can directly upload files in JSON format to AWS

C. Architecture for prisoner monitoring

Active RFID technology possesses the sensing ability between label and reader, interaction ability between label and reader, anti-collision ability, ability of avoiding the influences from human body, metal and fluid, ability of loading sensing technology and data security, etc.The positioning computation of active RFID technology is conducted by maximum likelihood method by the formula $\hat{X}=(A^TA)^{-1}A^TB$. RFID tag worn by the prisoner would contain the information as shown in the below table.

Field name	Content	Type	Length	Remarks
ID	Card no.	Text	5	NOT NULL
DoorID	Gate no.	Text	4	NOT NULL
InDate	Entry date	Date	8	NULL
InTime	Entry time	Time	6	NULL
OutDate	Exit date	Date	8	NULL
OutTime	Exit time	Time	6	NULL
State	Access control state	Yes/No	2	NULL
Alart	Alarm	Yes/No	2	NULL

For monitoring the health of the prisoner we use a pulse sensor which is present on the bracelet worn by the prisoner. Sensor would collect data after a fixed interval of time. This data would be stored on AWS database for monitoring the continuous health of the prisoner. Below circuit shows the connection of the pulse sensor to the ESP32.



IV. Correctness and Performance Measurement

Based on the following parameters our system could be tested:

- The system should produce an alert when a prisoner tries to go out of the cell.
- When alert is received the system should switch on the buzzer.
- The system should correctly monitor the prisoner's heartbeat and other data.
- The performance of our system can be checked by measuring the speed of monitoring and accuracy in storing the data.
- Our system should detect the prison break before it gets too late.

V. Survey of a Similar Project

Calipatria State Prison, a maximum-security facility tucked in the desert in the southeast corner of California, has been testing the system since last October. It foiled at least one escape, identified prisoners involved in a riot and provided other benefits.

A transmitter, which looks like a large industrial wristwatch, is strapped to the wrist of each prisoner. The device holds a 900 MHz RFID transmitter with a battery that sends out a signal every couple of seconds. The transmitter is housed in a tamperproof casing and strapped with screws with tamper-resistant covers. If the band is cut or a prisoner manages to slide the band off, an alarm is automatically triggered at a central monitoring station.

Readers with antennas are set up around the prison yard and throughout the interior of the building. For example a prison in California has about 60 readers, which pick up signals from every transmitter in the facility. At least three readers may pick up a signal from each inmate, but its usually many more to provide redundancy in the system. The signals are sent to a collector node, which calculates the person's location to within a few feet and puts a time of arrival stamp on the information and forwards it to computers software, which is used to establish the conditions for alerts. A TSI software could be used for processing data. The system can handle up to 24,000 units, according to TSI. The readers can process hundreds of signals virtually simultaneous, because the signals are transmitted up so quickly.

VI. Challenges

The following were the challenges we faced:

- Main challenge in deploying this module is battery life. Therefore, power to the wearable device can be derived through solar energy, kinetic movements wireless charging etc.
- We were not able to figure out how to reduce the size of the bracelet. However we could use an Arduino Programmable Smart Bracelet that features ESP32-PICO-D4 SiP(it includes ESP32, 4MB SPI Flash, Crystal Oscillator, Passive components)

VII. Future Works

A. Web Application

For tracking the prisoners in real time, we would be developing a a website which would have a google map view of

the prison along with the defined boundaries. The information about the location of prisoner obtained through the RFID tag would be converted to latitude and longitude format on the AWS platform.This information would be used to track real time position of the prisoner.

1) System Design and Working: The first part of the system work depends on the work of the RFID, which is an electronic device consists of RFID reader, antenna and tag. The RFID reader reads the tag number (ID associated to a individual person) when the tag being in the coverage zone of the reader antenna, then RFID reader sends this information to the computer (PC), the software program in the computer takes this information then updates it's Database and sends the (longitude/ latitude) to the Google Earth program. When Google Earth receives (longitude/ latitude) it finds the person location then displays that location on the screen of the that computer .

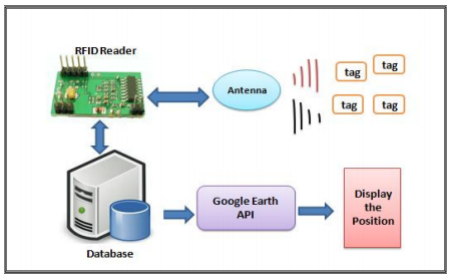


Fig. 1. Block Diagram of System

To complete implementation of this system we use the following programming language:
a.) Database:
This system need a Database system to store, update information, etc we use Dynamo DB here .

b.) Javascript:
We use java script language to manage Google earth API, also to control and change the setting of required features and how to display it. The link to the javascript code for geolocation is present in the link below [6]:

c.) Google Earth API:
Google Earth API standard for Google earth application programming interface. The Google Earth applications can be embedded into web pages by using Google Earth API with JavaScript code. With this API plug in installed, the applications can work interactively in web browsers. Javascript code need to be written to implement the Google Earth API applications in the web pages. In order to run the applications in browsers, developers and end users need to install the Google Earth plugin. The API can display lines, placemarks, overlays, polygons, and 3D models on the imagery.
The working steps of the system are defined as follows:

1) Display the location of the current/dedicated person:
   When the person who carries the Tag move in the location which contained the RFID Reader its position will be displayed.
2) So the Data Base will be update in the same time:
   In addition to display the position of the current person, the exact time and date of person's existence in that position and other information of this person will be recorded in the data base.
3) Searching for any person and show the information dedicated to him or her:
   We can show the information about any person we need, with the help of the person Tag ID and information recorded in the Data Base.

Fig. 2. Map Marker showing the location of prisoner

B. Results

At the end of implementation, we would get a fully functional website which would be accessible only by the warder or the prison authority. By looking at the website from his room he would be able to track every movement of each prisoner and would be able to take precautionary measures if any suspicious movement is encountered.

VIII. Conclusion

Thus overall we can say that correctional facilities have benefited plenty from integrating RFID technology within their system. It has reduced violence by 65% creating a safer environment, reduced failures to report to job incidents by 100% and reduced theft and property destruction by 40%. RFID has definitely proved its worth as a security tool for prison management systems. With prisons having to deal with overcrowding, RFID could be a necessary piece of equipment in the future to track and monitor the health of the prisoners.

Acknowledgment

I wish to record a deep sense of gratitude to Prof Sanjay Srivastava, my supervisor for his valuable guidance and constant support at all stages of my study and related research in Internet of Things course.

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