

How to Cite:

Arikesh, A., Reddy, G. A., Reddy, M. B. K., & Srihari, G. (2022). RSSI Zigbee based prisoner break monitoring and alerting system. *International Journal of Health Sciences*, 6(S3), 12484–12494. <https://doi.org/10.53730/ijhs.v6nS3.9509>

RSSI Zigbee based prisoner break monitoring and alerting system

Arikesh A.

Assistant Professor (S.G), Department of Electronics and Communication Engineering, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

*Corresponding author email: 18121055@student.hindustanuniv.ac.in and aarikesh@hindustanuniv.ac.in

G. Ajith Reddy

Student, Department of Electronics and Communication Engineering, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

M. Bala Kishore Reddy

Student, Department of Electronics and Communication Engineering, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

G. Srihari

Student, Department of Electronics and Communication Engineering, Hindustan Institute of Technology and Science, Padur, Chennai, Tamil Nadu, India

Abstract--This paper deals with the main objective of tracking the prisoner movement inside a restricted boundary. The above mention objective is achieved with the help of GPS and RSSI. The precise location of the prisoner can be traced by the authorities at anytime and anywhere with the help of IoT devices. If any movement of prisoner is noticed by the IoT device through RSSI, it measures the signal strength. If the signal strength measured are within the permissible limit no action is taken, if it exceeds the permissible limit appropriate action is taken either making an alarm or activating the vibration sensor through Arduino Controller

Keywords--RSSI, GPS, vibration sensor, Arduino UNO, IoT.

Introduction

All governments around the world works on the main objective to provide safety and security to its citizen. If any citizen found breaking the rules and regulations of the respective government, the authority governing the rules and regulation of

the government takes necessary action as the law of the respective government. In some situation the law breakers are put behind the bars for months or years with respect to their crime level. The government of every country has a separate agency / authority to look after the citizen who are behind the bars (jail), the authority has various responsibility that includes the citizen safety, discipline and shelter inside the jail. The jail authority has the responsibility of monitoring and governing the jail, for this purpose the authority monitors all its prisoner activities and movement inside the jail. As the number of prisoners increases in a jail it becomes a difficult task to monitor all the prisoners in the jail with the limited manpower available, also the prisoners are law breaker and there are huge percentage of possibility that the prisoner may disobey the authority's orders. There is a huge possibility that the prisoner can try to escape from the prison/ jail, this may be issue for citizen safety of the country. It is the responsibility of the jail authority to ensure the rules and regulation is followed in the jail and for this purpose the authority use various method. As a part of technology advancement numerous techniques were deployed in prison to ensure the safety of person working in the prison and also to ensure prisoner escaping out of the prison. For monitoring prisoner using advanced technology, many researchers' researched on prisoner location tracking with various wired or wireless method.

Several researchers used Zigbee module with and without RSSI for finding the location of prisoner inside the prisoner. In this approach the location of prisoner is sensed and sent to the controller to take appropriate action [1-5], as the power consumption by the module is less this system was very attractive. The number of routers and coordinators connected to the RSSI mode helps to track the location of prisoner in dynamic manner. Some researcher used RFID based module to track the location of the prisoner [6-11]. Some researcher has used Bluetooth and ad-hoc technology for tracking the location of prisoners. In this method using RFID each prisoner will be attached with a RFID tag, RFID receivers are mounted on various places to be monitored. If the prisoner movement is near to the receiver section, the receiver section senses the RFID tag and send the information to the concern authority. In this method the prisoner is attached with the RFID tag, there is a possibility that the tag can be damage or tampered by the prisoner and RFID receivers can also be tampered or damaged.

Many researches used advanced technology like light source-based approach and geo fencing method with GPS. In light source-based RFID technique, a light source like laser sensor is placed at the one side and in the opposite side with about 10 to 12 m distance and LDR is placed like a invisible gate. If a prisoner crosses this setup the LDR senses this and send information to the concern authority via controller. In the RFID technique with geo fencing, each prisoner is attached with a kit which has GPS, GSM module with processor. This method used the spatial coordinates to locate the prisoner location dynamically. As the dynamic location of prisoner is monitored, if the prisoner is moving near the boundary his location sensed is sent to the concern authority as per the algorithm implemented to take appropriate action. With geo fencing different level of fencing can be created to restrict the movement of prisoner which was very attractive method for implementing in a large prison where different level of restrictions is required.

Several researchers focused on single location sensing method with GPS which can be used to track prisoner inside and outside the boundary with minimal error. This method has an advantage over RFID based technology and RSSI with wifi module in such a way that it uses the real time GPS location with vast area of coverage than short range coverage of RFID and RSSI with wifi module. The RSSI method of tracking is effective when we are tracking prisoner in side short range of boundary and the GPS based system discussed is good in location the prisoner location effectively. In wifi based system the range of wifi is small for locating the prisoner location beyond the boundary is not possible, while with GPS we can locate the prisoner location beyond boundary also. Thus, for the above discussion it is found that the wifi based system has good resolution in short range and GPS based system has good resolution in long range and also GPS has congestion issues in short range were the wifi based system does not have. Apart from the technology development there are various algorithm developed to effectively monitor the movement of prisoners inside the prescribed boundary with many more add-on features.

Most of the wireless system proposed consists of bunch of sensors sensing various parameters and send the details to the controller where algorithm is written, based on the algorithm the controller taken necessary action like sending information to the concern, displaying in central monitor, raising an alarm, actuating any closing signal to gates / doors, triggering vibration to the prisoner etc. In this paper an effective method of monitoring the prisoner is proposed. In the method an RSSI with GPS based technology is implemented with different level of boundaries. In this method and shown in Fig. 1 and Fig. 2 the prisoner is attached with a module with GPS module and vibration module. The GPS module present sends the dynamic location of the prisoner and the vibration module consists of a vibrator motor and its required circuits. The prison is divided into various segments like cell, dining hall, control room, when the GPS send the location of the prisoner the algorithm in the controller receives the signal and measures the location then it identifies the location of the prisoner is neither inside or outside the boundary, even if he is inside which segment, he is situated. The whole system is supported by closed-circuit television (CCTV) surveillance system and other manual monitoring system also. The controller issues the signal to the proper channel depend on the signal received, the details of the signal given is mentioned in the flow chart shown in (Fig. 3)

Proposed Method

The RSSI Zigbee technology aids in the location of the prisoner and provides information on their current location. The RSSI ZigBee and neuron stimulator will always be held by the prisoner to monitor his or her location and position. The suggested method, as shown in Fig. 1, employs RSSI and GPS to pinpoint the exact location of the prisoner. We are locating the location of the prisoner in this system, such as the cell, dining hall, and sports stadium. The nerve stimulator will be activated if the prisoner is attempting to flee the jail at that moment. The prisoner is connected to a module that includes a GPS transmitter, a vibration motor, and its control module on the sending side, and a GPS receiver, RSSI module, and its coding on the receiving side. The GPS module linked to the prisoner continuously sends the prisoner's location to the main control, which

feeds the location of the prisoner to the programme, which then sends the relevant signal to the concerned authorities. The following sequence of actions may be carried out in response to the main control's directive regarding the prisoner's location.

- If the prisoner is inside the prescribed boundary, the location of the prisoner is displayed in the screen and no warning signal is issued.
- If the prisoner is near the prescribed boundary, the location of the prisoner is displayed in the screen and a warning signal is issued to the concern authority.
- If the prisoner is found to cross the boundary, the location of the prisoner is displayed in the screen and the vibration sensor in the prisoner module is activated, the concern authority also given information to take necessary action.

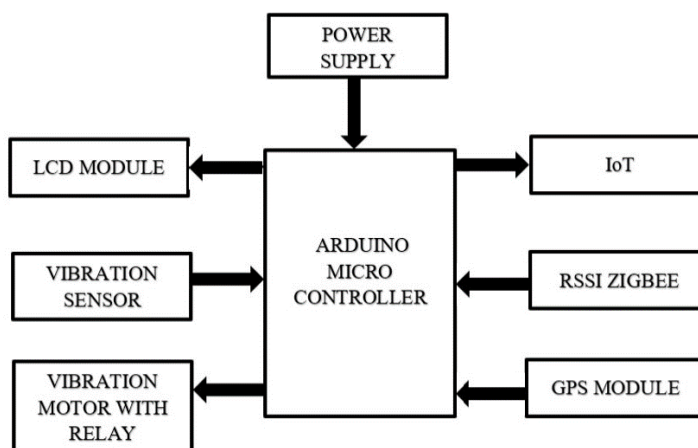


Fig. 1. Proposed block diagram

Control Room:

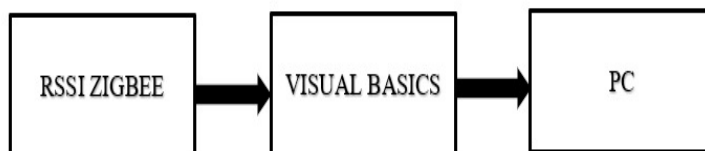


Fig. 2. Control room block diagram

Methodology

The methodology of our project is given below by using the flow chart. From the flow chart show in Fig. 3 we can see that whenever the prisoner is moving from his location, the GPS module sends the information to the controller. The signal is analysed in the controller, and the prisoner's location is compared to the

algorithm to determine whether the prisoner is in a cell, library, dining area, control room, or boundary. The detail sequence is listed below:

- If the prisoner location points cell/library (PR signal less than C), the controller indicates a green light and send message that prisoner is in right place.
- If the prisoner location points dining hall (PR signal less than D but greater than C), the controller indicates a green light and send message that prisoner is in right place for prescribed amount of time, if the time exceed it issues and alarm and inform the concern
- If the prisoner location points control room (PR signal less than CR but greater than D), the controller indicates a red light and send the message that prisoner is at wrong place and the message to send to the concern to take appropriate action
- If the prisoner location points near boundary, the controller indicates a red light and send the message that prisoner is trying to escape and the message to send to the concern to take appropriate action and the nerve simulator is activated if required (optional)
- If the prisoner's vibration sensor is sending signal, the controller indicates a red light and send the message that the prisoner is tampering the kit and the message to send to the concern to take appropriate action and the nerve simulator is activated if required (optional)

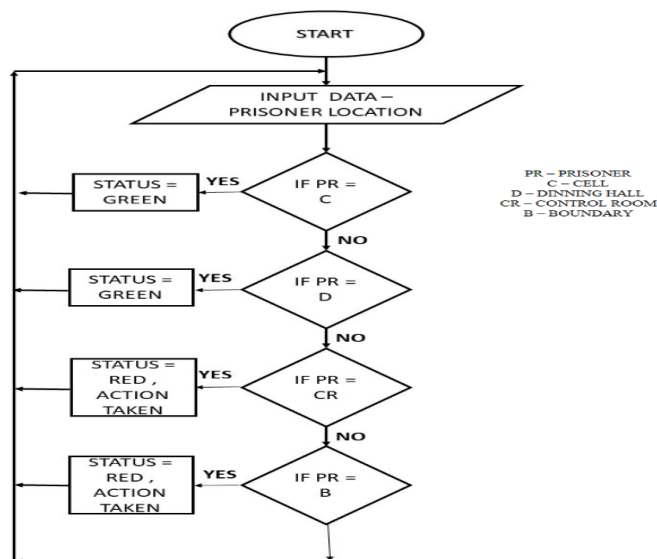


Fig. 3. Flow chart of the proposed logic

Results and Conclusion

The proposed system is simulated using protues software and prototype is developed. In the proposed system, a combination of RSSI method with GPS is used to identify the location of the prisoner and the information is transferred to

the concern authority. Apart from passing information, a vibration motor is activated in the human kit if the prisoner is away from the prescribed area. The overall time taken for the whole process in less than 10 minutes. In future the cost analysis of the proposed system can be analysed and a cost-effective kit can be developed. The simulation results are listed below

Simultaion Results

The simulation of the proposed system using protues software is shown in the Fig. 4 and operation of the proposed system is described below

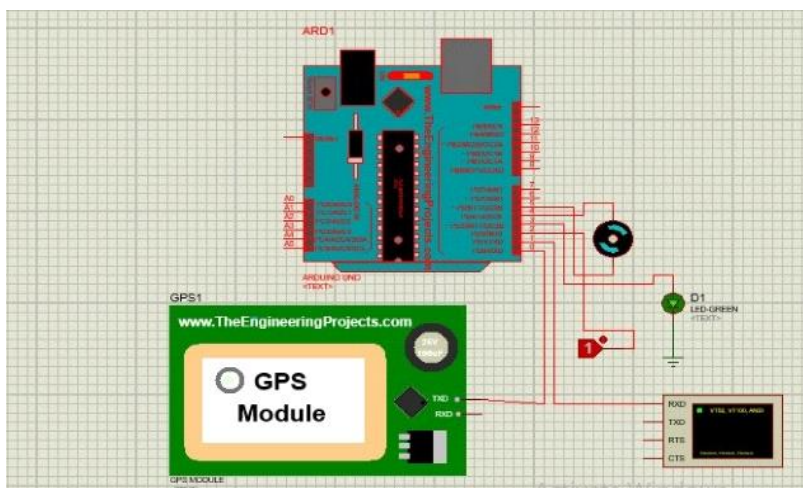


Fig. 4. Simulator showing prisoner near cell / dining hall (indicated by GREEN indicator)

In the first scenario, if the prisoner is near the cell / dining hall indicated by input "1", the controller after receiving the input activates the green LED (Fig. 4) and the virtual terminal shows the latitude and longitude values of the prisoner's location and the vibration motor is not active. In the second scenario, if the prisoner is near the control room / boundary indicated by input "0", the controller after receiving the input activates the red LED (Fig. 5) and the virtual terminal shows the latitude and longitude values of the prisoner's location and the vibration motor is active and information is sent to the concern authority.

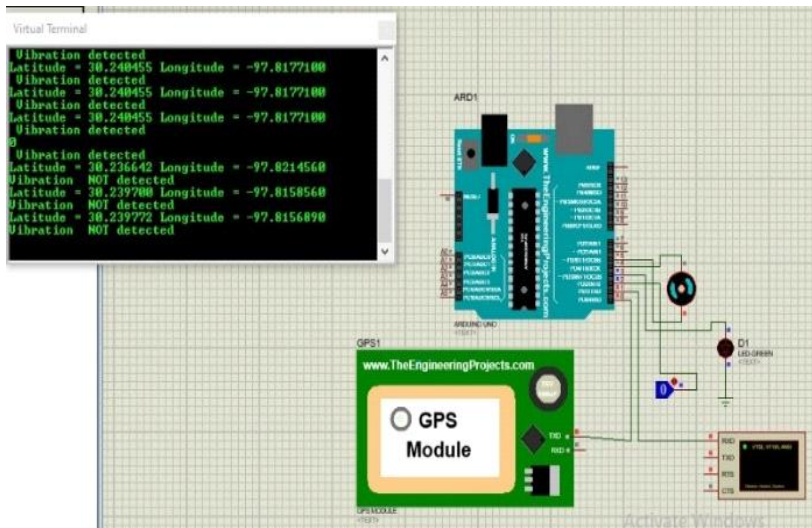


Fig. 5. Prisoner showing near the boundary/tampering device (indicated by RED indicator)

Hardware Results

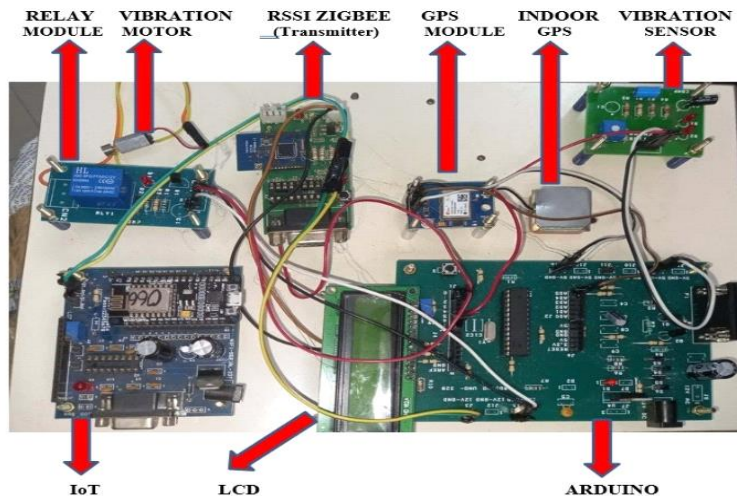


Fig. 6. Overall demonstration kit of the proposed method

The overall prototype is shown in Fig. 6, which consists of an Arduino UNO board, LCD monitor, RSSI module, vibration motor, vibration sensor, GPS module and relay module as shown in Fig. 6. Also, for prototype a visual basic based application is developed and the output of various scenario is shown below. In VB based platform a front panel is created as shown in Fig. 7 with the input and output terminals showing RSSI details, distance, led status etc. The status of the prisoner in control room / boundary is shown in Fig. 7, the status of the prisoner in cell/library and dining hall is shown in Fig. 8 and Fig. 9 respectively

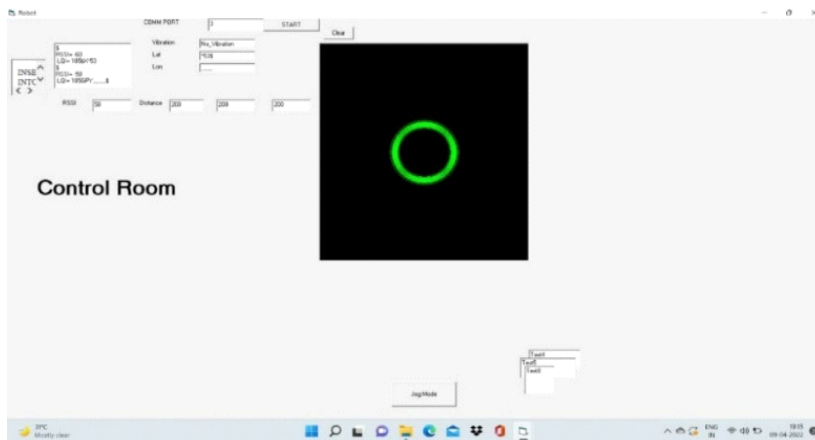


Fig. 7. Simulator showing prisoner near the control room

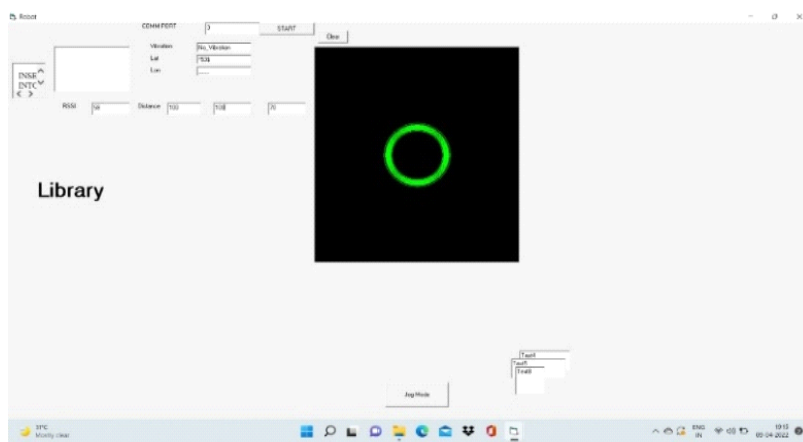


Fig. 8. Simulator showing prisoner near the library/cell

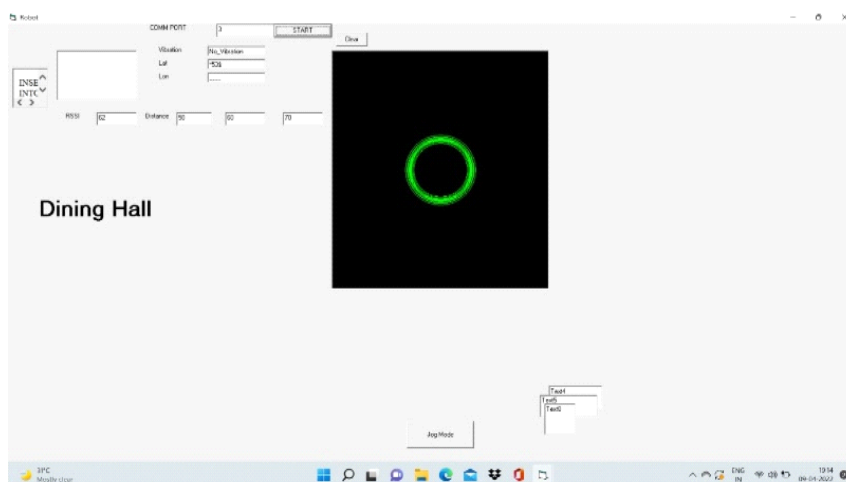


Fig. 9. Simulator showing prisoner near the Dining Hall

From the above three figures we can able to find the exact location of the prisoner by moving the kit and we are used to change the threshold values to determine the location of the prisoner by using the real time location by using our internet and IoT cloud platform which is given below. The real time location detail of the prisoner is also stored to the cloud as shown in Fig. 10 and Fig. 11 respectively.

LogID	DATA	Logdate	LogTime
111	VibNo_Vibration_Lat*535_Lon*...Room Dining Hall	04/06/2022	17:01:00
112	VibNo_Vibration_Lat*535_Lon*...Room Dining Hall	04/06/2022	17:01:10
113	VibNo_Vibration_Lat*535_Lon*...Room Dining Hall	04/06/2022	17:01:20
114	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:01:30
115	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:01:40
116	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:01:50
117	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:02:00
118	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:02:10
119	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:02:20
120	VibNo_Vibration_Lat*535_Lon*...Room Library	04/06/2022	17:02:30

Fig. 10. real time location of prisoner in dining hall

LogID	DATA	Logdate	LogTime
281	VibNo_Vibration_Lat*535_Lon*...Room Control Room	04/09/2022	18:06:33
282	VibText3_LatText3_LonText3_Room	04/09/2022	18:06:38
283	VibNo_Vibration_Lat*535_Lon*...Room Control Room	04/09/2022	18:06:43
284	VibText3_LatText3_LonText3_Room	04/09/2022	18:06:48
285	VibNo_Vibration_Lat*535_Lon*...Room Control Room	04/09/2022	18:06:53
286	VibText3_LatText3_LonText3_Room	04/09/2022	18:06:58
287	VibNo_Vibration_Lat*535_Lon*...Room Control Room	04/09/2022	18:07:03
288	VibText3_LatText3_LonText3_Room	04/09/2022	18:07:08
289	VibNo_Vibration_Lat*535_Lon*...Room Control Room	04/09/2022	18:07:13
290	VibText3_LatText3_LonText3_Room	04/09/2022	18:07:18

Fig. 11. real time location of prisoner in control room

Future Work

We have studied a single prisoner with an RSSI Zigbee setup in this work, as well as deploying the entire system in a sluggish IoT-based network. The same system can be developed for numerous user-based systems in the future; the network can be high-speed Sigfox or LoRa-based for high-speed networking. The main

control that we have created is based on Arduino UNO, which has a limited number of ports; however, in the future, when implementing in large scale sophisticated processors such as ARM, Raspberry Pi, and so on, can be considered.

References

1. M. Rajkumar, G. Sandhiya, P. Shobha Rani, A. Gnanasekar, K. Padmapriya, K. Sangeetha, Localization of wireless sensor network in RSSI Zigbee independent monitoring system in prison for prisoners, *Materials Today: Proceedings*, xxx(xx), October 2020
2. P. Vijayaragavan, R. Ponnusamy, M. Arramuthan, RSSI-Based ZIGBEE Independent Monitoring System in Prison for Prisoners, 34, January 2020, 1292-1304
3. Elavarasan.K, Mohammad Nawaz M.A, Dr.Hemajothi.S, Prisoner Localisation Using RSSI Algorithm , *International Journal of Advance Research, Ideas and Innovations in Technology*, 5(2) , 2019, 2395-4396
4. Venkateswararao .P, Vengatesh D, Vetrivel R, Haresh R, Ajay Karthik B, Tracking the prisoner location and escape prevention, *International Journal of Advance Research, Ideas and Innovations in Technology*, 5(2), March 2019.
5. Gokulabrinndha.B , Arul Jothi.S, Prof. Saranya.S , Utilization Of Zigbee Module In RSSI Localization application Inside Prison, *IOSR Journal of Engineering*, 2018, 25-31
6. M. Vodel, M. Caspar, and W. Hardt, Wake-Up-Receiver Concepts - Capabilities and Limitations, *Journal of Networks*, 7(1) , 2012, 126-134.
7. X.-F. Chen, L.-J. Wu, X.-M. Zhang, A low-power low frequency wakeup receiver for tire pressure monitoring system, *IEEE 11th International Conference on Solid-State and Integrated Circuit Technology*, October 2012, 1-3.
8. M. Boccadoro, F. Martinelli, and S. Pagnottelli, "Constrained and quantized Kalman filtering for an RFID robot localization problem, *Auto. Robots*, vol 29, nos. 3- 4, 2010, 235-251
9. M. Shaterian, A. Abrishamifar, and H. Shamsi, A programmable true piecewise approximation logarithmic amplifier, *International Conference on Microelectronics - ICM*, December 2009, 90-93
10. Y. Melamed, A. Even-Chen and S. J. Spiegel, Systematic design of RSSI and logarithmic amplifiers circuits, 2009 *IEEE International Conference on Microwaves, Communications, Antennas and Electronics Systems*, Tel Aviv, 2009, 1-4.
11. R. Tesoriero, J. A. Gallud, M. D. Lozano, and V. M. R. Penichet, Tracking autonomous entities using RFID technology, *IEEE Trans.Consum.Electron.*, 55(2), , May 2009, 650-655.
12. Nyandra, M., Suryasa, W. (2018). Holistic approach to help sexual dysfunction. *Eurasian Journal of Analytical Chemistry*, 13(3), pp. 207-212.
13. Rinarta, K., & Suryasa, W. (2017). Comparative study for better result on query suggestion of article searching with MySQL pattern matching and Jaccard similarity. In 2017 5th International Conference on Cyber and IT Service Management (CITSM) (pp. 1-4). IEEE.

14. Gandamayu, I. B. M., Antari, N. W. S., & Strisanti, I. A. S. (2022). The level of community compliance in implementing health protocols to prevent the spread of COVID-19. *International Journal of Health & Medical Sciences*, 5(2), 177-182. <https://doi.org/10.21744/ijhms.v5n2.1897>