IoT Based Intelligent Ambulance Monitoring and Traffic Control System

Chapter · February 2021

DOI: 10.1007/978-3-030-57835-0_20

5 authors, including:

Santhosh Krishna B V
New Horizon College of Engineering
27 PUBLICATIONS **177** CITATIONS

SEE PROFILE

Chapter 20
IoT Based Intelligent Ambulance Monitoring and Traffic Control System

J. Jijin Godwin, B. V. Santhosh Krishna, R. Rajeshwari, P. Sushmitha, and M. Yamini

Abstract The evolving problem of traffic problems is an inevitable situation in wide and rising cities worldwide. Population growth has led to a growth in the number of cars leading to absolute congestion development. Life is sacred and can not be repatriated until lost. The reaction time required by the emergency responders plays a vital role in the face of disasters. This might be a department for medical, disaster, or defense. The greatest challenge they face is congestion from flow. To address this, an intelligent traffic system is needed using a preemptive equation that adapts rapidly to environmental conditions. The aim of this article is to identify the emergency call headed back to the location and to monitor the congestion system in order to provide efficient facilities. This journal also sets out a method that uses a Zigbee component and Internet of Things (IoT) to transmit the treatment request from the ambulance to the nearby hospitals, while ambulance attaining the road junction, the smart traffic system which in turn changes the traffic signal cycle. This system can be implemented throughout the city thereby reducing the delay.

Keywords Preemption algorithm · Traffic congestion · IoT Zigbee module · Smart traffic control system

J. J. Godwin · R. Rajeshwari · P. Sushmitha · M. Yamini
Department of Electronics and Communication Engineering, Velammal Institute of Technology, Chennai, Tamil Nadu, India
e-mail: jijingodwin.j@gmail.com

R. Rajeshwari
e-mail: rajirameshr98@gmail.com

B. V. S. Krishna (✉)
Senior Assistant Professor, New Horizon College of Engineering, Bangalore, Karnataka, India
e-mail: santhoshkrishna1987@gmail.com

V. E. Balas et al. (eds.), *Further Advances in Internet of Things in Biomedical and Cyber Physical Systems*, Intelligent Systems Reference Library 193,
https://doi.org/10.1007/978-3-030-57835-0_20

20.1 Introduction

Traffic congestion reduction is the main goal in the development of efficient traffic control system. Many research works focus in the field of traffic safety control system. In addition, giving priority to the vehicle and changing the traffic signals must be the important functions for all the emergency vehicles to develop the safety measures in the road transportation [1]. Ambulance and police vehicles are the emergency vehicles, must be reach the location without a maximum delay. The principle behind the preemption is that an emergency vehicle is detected by the sensor at each intersection, when a RFID analyses an emergency vehicle, it will transmit the control signal to change the traffic lights turn into green. The advanced development in electronics and communication systems provides different traffic control techniques [2–4].

Traffic control system using Preemption algorithm is designed for giving green light for emergency vehicles and red signal for other vehicles. A centralized mechanism is used for monitoring the traffic control mechanism to clear the traffic congestion and give information about the shortest path for the ambulance services [4]. One of the most efficient traffic control system for freeway system is ramp metering [5]. This paper focuses on traffic control system using preemption algorithm with Radio Frequency Identification (RFID) technology. Another technology (Zigbee module and IoT) is that the conditions of the patient will be pre intimated to all the nearby hospitals, the hospital which is ready to take care of the patient will give an acknowledgement to the nurse present along with the patient in the ambulance [6, 7].

IoT may be implemented in internet-connected embedded applications which interact with one another, goods and services. Most of the monitoring systems that showcasing the status of the patient are frequently in emergency medicine systems like operation theatres. But the doctor cannot be alerted all the time where there is an emergency [8]. Although 24 h monitoring by the doctors are not possible and the details will not be exchanged with other physicians and relatives who are experts in that area. Many technologies that enable both these things are accessible and many people in developed countries can't view and manage them [9]. Hence, the threats will be swept off by using IoT.

Health monitoring system in the ambulance monitoring the different health parameters and these data will be sent to IoT for further analysis [10, 11]. Different sensors are used for measuring those parameters. In the proposed system, various health parameters like Electrocardiogram (ECG), temperature and heart beat rate are monitored and transmitted through wireless technology Zigbee. The details about the different health parameters are collected and transmitted to Zigbee and IoT through Arduino Uno [12].

Acknowledgements from the hospital is received by Zigbee module via Arduino Uno. The IoT architecture functions are served to the clients using uninterrupted web service [13]. The physical connections are interconnected with various sensors like IR sensor, Heart rate sensor and much more. IoT in cloud provides the connection

which is necessary to share the information between the devices. Cloud Computing is another important technology [14]. Cloud enables user to access data from anywhere.

20.2 Proposed System

20.2.1 Block Diagram

The block diagram is divided into three parts: Traffic section, Ambulance section and Hospital section.

The block diagram of traffic section is shown in Fig. 20.1 in which two RFID readers are connected to Arduino Uno to control the traffic signals [15].

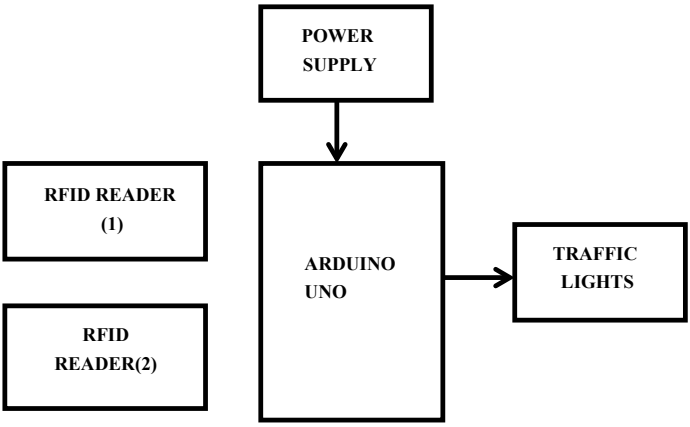
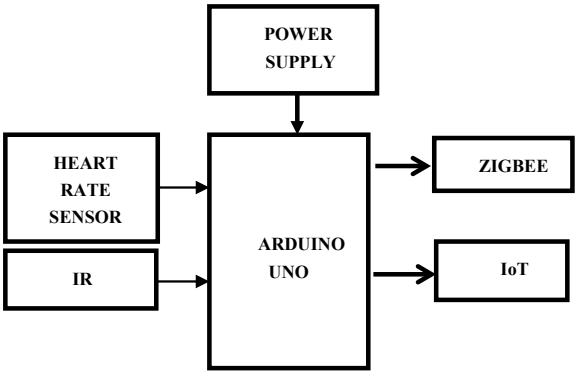


Fig. 20.1 Traffic section

Fig. 20.2 Ambulance section



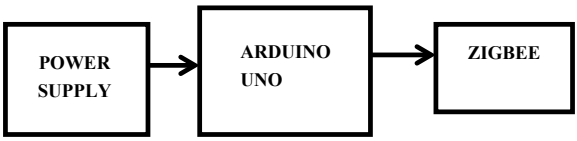


Fig. 20.3 Hospital section

The block diagram of ambulance section is shown in Fig. 20.2 where the heart rate sensor and IR sensor are connected to Arduino Uno which can be used to transmit the information of the patients to the nearby hospitals and receive an acknowledgement from the hospital which is ready to give a treatment to the patient through Zigbee and IoT [16].

The block diagram of hospital section is shown in Fig. 20.3 where the Arduino Uno is connected to Zigbee to receive the request and transmit the response to the ambulance.

20.2.2 Hardware Components

1. Heart Rate Sensor: The device provides optical heart beat production. By using LED light source and an LED light sensor, the heart rate monitor tests the cardiac output in beats per minute (BPM). The sensor tests the light output that reflects back as the refracted through your surface of the skin [17]. The reflection of light is varying as blood pulses under your skin past the light.
2. IR Sensor: An Infrared sensor is an electronic device. An IR sensor can measure the temperature of the patient as well as detects the motion of an object. Here, Passive infrared sensor (PIR) is used [18]. These types of sensors measures only IR rather than emit.
   Infrared Radiation is invisible to the human eyes, which can be identified by the help of IR sensor. The transistor is merely an IR LED and the sensor is merely an IR Photodiode responsive to IR light of the spectrum close to that produced by the IR LED. As IR light reflects on the photodiode, the sensitivity and the dc voltage change proportionally to the intensity of the obtained IR light [19].
3. RFID (Radio Frequency Identification) Reader: It is a machine which uses frequency signals to transmit the information wireless network between it and an RFID tag/label to recognize, characterize and monitor properties. It is used to integrate an RFID tag. In this project, two RFID readers are used, one for detect the normal vehicles and another for detect the emergency vehicles.
   The transmitter and receiver pins of the RFID reader are connected to the transmitter and receiver of Microcontroller respectively. The reader then detects the information from the Tag and sends the perceived data through signal port to the Circuit board. It is one method of Automatic Identification and Data Coupling (AIDC).

4. Zigbee Module: It is IEEE 802.15.4 based architecture, low power, low data rate supporting wireless networking standard, which is commonly used for two-way communication between sensors and control system. In this project, this module is used for the communication between the ambulance section for sending a request and hospital section for sending a response.
5. Arduino Uno: It is an open source electronics platform based on easy to use hardware and software. It is an AT Mega 328p based Microcontroller board. It has 14 digital input or output pins in which 6 pins can be used as PWM output pins. USB cable can be used to connect with a computer. It is used in traffic section to control the signals, ambulance section to transmit a request to the hospital and hospital section to transmit an acknowledgement to the ambulance section.

20.3 Algorithm

20.3.1 Preemption Strategy

An efficient preventive signaling and route choice algorithm is expected in this study. This approach direct to Toggle traffic control management method system to clear the traffic congestion before Emergency vehicle (EV) arriving the junction. In order to reduce the travel time, emergency vehicle should resume the transportation without any disturbances. To find the best route from start of the emergency vehicle to the terminal is the aim of the path selection strategy. Shortest path to reach the destination is considered as the best path and it has the least harmful effect on daily traffic.

This logic calculates the minimum detection distance of emergency vehicle using the following equation:

$$T \geq T_{so} + T_m + ST$$

where T is the notification period, T_{so} is the changeover period of the traffic signal head, T_m is the discharge signal cycle, and ST is the safety time interval.

Interval of switching the signal state is said to be T_{so} (Switchover Time). By using the normal length of line and rate of discharge from queue of the emergency vehicle with the help of historical data, discharge time T_m can be calculated. Two seconds is the constant value for Safety time interval (ST).

The necessary green indicator head time on the Emergency vehicle can be used to measure response by the following equation:

$$T_{gr} = T - (T_{so} + T_m + ST)$$

Once the emergency vehicle is figure to detach from the junction, the green time (T_{gr}) can be halted instantly for the unilateral step.

In the category with path crossings, it is presumed that if the gap between two consecutive junctions is less than the shortest distance to detecting emergency vehicles. Then the emergency vehicle detection point for first junction has been affected. The date set for notice has also taken into an considering the release duration of both crossings. The distance of detection for the second intercept is computed equivalent to that of a single intersection when the gap between the two successive collisions is greater than the duration of observation. The flow chart for preemption algorithm has been explained in Fig. 20.4. In the next section, the best path selection will be explained.

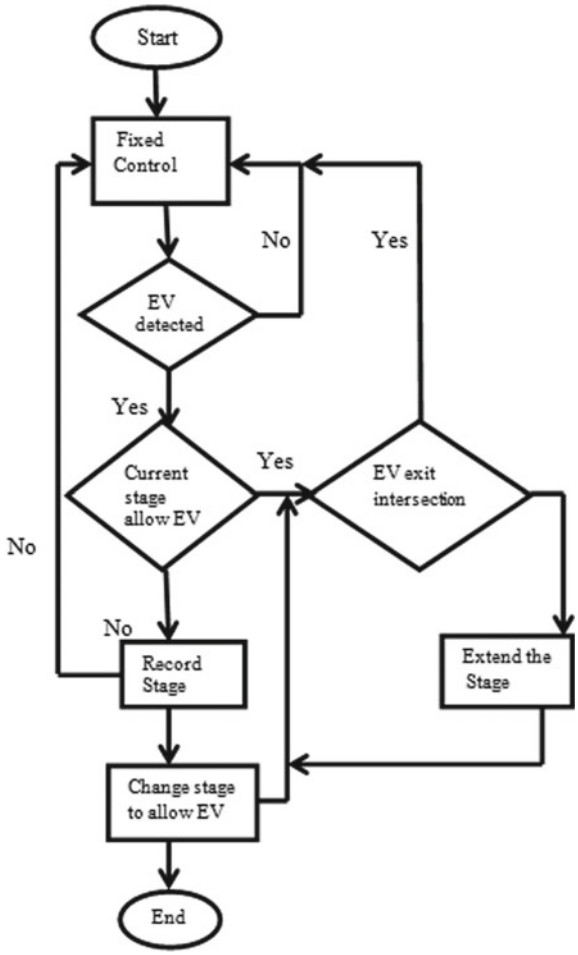


Fig. 20.4 Flow chart for preemption algorithm

20.3.2 Path Selection Strategy

The aim of the best path selection is to reduce the response time. In emergency vehicle preemption, the shortest path selection is always crucial. By using Dijkstra's algorithm, the shortest path from emergency vehicle's origin to the destination will be calculated with the help of location of emergency vehicle and the given destination

$$T(i, j) = Li[1 + C(i, j)]$$

$$C(i, j) = \sum Bk[P(k, j) \cdot V(k, j)]$$

$$[1 + V(k, j)]$$

where V(k, j) is the Passenger amount reached regulator k on the link i during j; Bk is the weight for the detector k in the link i

$$\sum Bk = 1;$$

$$Li = [0 - 1];$$

P(k, j) = {1: if detector k is occupied by a vehicle at the end of j; 0: otherwise.}

where T (i, j) is the connection transport expense I during the period interval j is determined from the duration of the link Lj and the traffic flow level C (i, j) during period j.

20.4 Result and Discussion

The proposed output has been explained using Figs. 20.5 and 20.6.

In ambulance section, whenever, the accident takes place, ambulance has to come to the accident spot and pick the injured person, IR sensor is used to detect the patient on stretcher, once detected heart rate sensor is used to monitor patient's pulse rate. Through serial monitor the Nurse has to input the type of injury, so that request is continuously send to the near by hospitals.

ARDUINO SOFTWARE IDE is used for searching the hospital, once the nurse entered the type of disease the message sent to all nearby hospitals (Fig. 20.7).

In Hospital section, it has facility for that injury will respond to ambulance (Fig. 20.8).

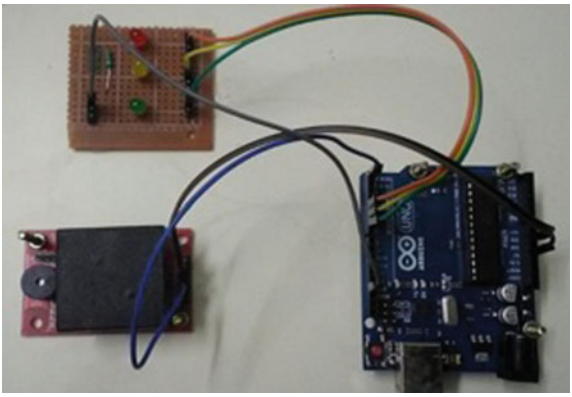


Fig. 20.5 Traffic section

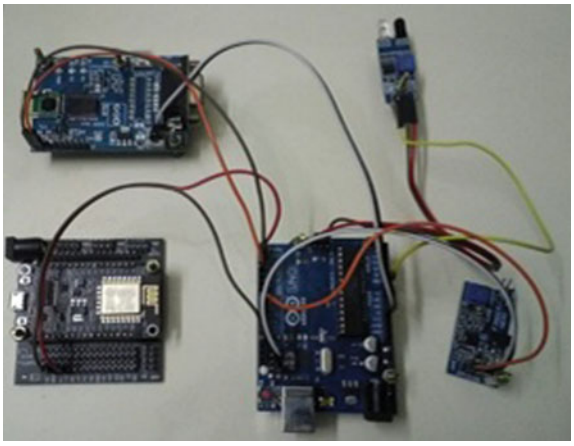


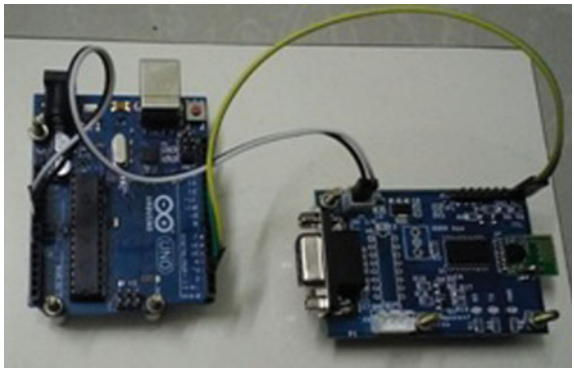
Fig. 20.6 Ambulance section

20.5 Conclusion

This article represents controlling the traffic congestion to give freeway systems for Ambulance and monitoring the ambulance. Preemption algorithm is used to control the traffic congestion automatically. The request sent to the hospital from the ambulance and the acknowledgement send to the ambulance from the hospital is done by IoT. The main advantage of this project is that the request from the ambulance and response from the hospital is done efficiently by IoT and automatic traffic freeway system for ambulance done by preemption algorithm formulates normal and emergency traffic control strategies. Internet of things-based emergency surveillance is a new technologies which works for people. In future, new methods can be developed for complex road networks.

Fig. 20.7 ARDUINO SOFTWARE IDE

Fig. 20.8 Hospital section



References

1. Huang, Y.S., Weng, Y.S., Zhou, M.: Design of traffic safety control systems for emergency vehicle preemption using timed Petri nets. IEEE Trans. Intell. Transp. Syst. **16**(4), 2113–2120 (2015)
2. Qi, L., Zhou, M., Luan, W.: A two-level traffic light control strategy for preventing incident-based urban traffic congestion. IEEE Trans. Intell. Transp. Syst. **19**(1), 13–24 (2016)

3. Pasquale, C., Sacone, S., Siri, S., Papageorgiou, M.: Optimal control for reducing congestion and improving safety in freeway systems. IEEE Trans. Intell. Transp. Syst. **19**(11), 3613–3625 (2018)
4. Rajeshwari, S., Hebbar, S., Golla, V.: Implementing intelligent traffic control system for congestion control, ambulance clearance and stolen vehicle detection. IEEE Sens. J. **15**(2) (2015)
5. Gnanaraj, V.V., Ranjana, P., Thenmozhi, P.: Patient monitoring and control system using internet of thing. Int. J. Innov. Technol. Explor. Eng. (IJITIEE) (2019). ISSN: 2278-3075
6. Hari Kishore, K., Surendra Nath, K.V., Hari Krishna, K.V.N., Pavan Kumar, D., Manikanta, V., Basha, F.N.: IOT based smart health monitoring alert device. Int. J. Innov. Technol. Explor. Eng. (IJITIEE) (2019). ISSN: 2278-3075
7. Priyadharshini, K., Manikandan, S.K.: Automatic traffic control system based on the vehicular density (2019)
8. Patil, S., Pardeshi, S.: Health monitoring system using IoT. Int. Res. J. Eng. Technol. (IRJET) (2018). e-ISSN: 2395-0056, p-ISSN: 2395-0072
9. Bhilawade, V., Ragha, L.K.: Intelligent traffic control system. Int. J. Sci. Res. Publ. (2018). ISSN: 2250-3153
10. Kumar, G.H., Ramesh, G.P., Avadi, C.: Novel gateway free device to device communication technique for IoT to enable direct communication between homogeneous devices. Int. J. Pure Appl. Math. **118**(16), 565–578 (2018)
11. Shahada, S.A.A., Hreiji, S.M., Shamsudheen, S.: IOT based garbage clearance alert system with GPS location using Arduino. Int. J. MC Square Sci. Res. **11**(1), 1–8 (2019)
12. Kumar, G.H., Ramesh, G.P.: Intelligent gateway for real time train tracking and railway crossing including emergency path using D2D communication. In: 2017 International Conference on Information Communication and Embedded Systems (ICICES), pp. 1–4, Feb 2017. IEEE
13. Badawi, W.A.: Underground pipeline water leakage monitoring based on IOT. Int. J. MC Square Sci. Res. **11**(3), 01–08 (2019)
14. Babu, V.H., Balaji, K.: Survey on modular multilevel inverter based on various switching modules for harmonic elimination. In: Intelligent Computing in Engineering, pp. 451–458. Springer, Singapore (2020)
15. Kumanan, T.: Link quality and energy-aware metric-based routing strategy in WSNS. In: Intelligent Computing in Engineering, pp. 533–539. Springer, Singapore (2020)
16. Manikandan, G., Anand, M.: Radix-2/4 FFT multiplierless architecture using MBSLS in OFDM applications. In: Intelligent Computing in Engineering, pp. 553–559. Springer, Singapore (2020)
17. Sundaram, A., Ramesh, G.P.: Investigation of solar based SL-QZSI fed sensorless control of BLDC motor. In: Intelligent Computing in Engineering, pp. 779–787. Springer, Singapore (2020)
18. Snehalatha, N., Shiny Angel, T.S., Amudha, S.: Remote display access using remote frame buffer and IO streaming. Int. J. MC Square Sci. Res. **8**(1), 23–40 (2016)
19. Rajesh, D.: CH panel based routing scheme for mobile wireless sensor network. Int. J. MC Square Sci. Res. **8**(1), 183–198 (2016)