Control System for Smart Traffic Signal using LTE, GPS, RFID for Ambulance

J. Jagadeesan, M Azhagiri, Maheshraj RP, Sanjay B, T Srikanth

Abstract*: Nowadays, Ambulance services are the most affected by the Traffic Jams. This can threaten the health state of the person within the ambulance. It can be resolved by using the Control System for Smart Traffic Signal using LTE, GPS, RFID for Ambulance. This system creates a connection between the ambulance and the traffic signal. So, as to assist the ambulance for a stop free travel to the destination. This system uses Radio Frequency Identification (RFID), Global Positioning System (GPS), Long Term Evolution (LTE) as its key components to implement the control system. The GPS helps in live tracking the ambulance movement in order to change the traffic signal only when the ambulance is nearby the traffic signal. Once the GPS confirms the ambulance is nearing a traffic signal, the cloud instructs the change in traffic signal's mode and the ambulance's lane is granted green signal. Once, the ambulance crosses the signal, it reverts back to its original flow. The RFID tag assists in confirming the passage of ambulance from the traffic signal. Also, this method warns the upcoming signal and changes their signal time based on factors such as ambulance speed, distance and expected arrival time which helps in clearing out the traffic in advance. This is continued until the ambulance reaches its destination hospital. All these processes happen without any human intervention.

Keywords: Ambulance, emergency service, navigation, traffic signal

I. INTRODUCTION

Today the metropolis has a hard time dealing with the traffic. The traffic in the metropolis forces the ambulances to stop now and then. Also, the traffic signal creates a situation where the ambulance would not be able to pass as the traffic ahead of it is blocked by a traffic signal. This poses a great threat to the Ambulance as every second is vital to the healthy state of the patient. One of the effective ways to clear out the traffic ahead of the ambulance is by turning the signal green.

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The signal can be turned green by requesting the traffic signal controller or the cloud. However, this is a very time-consuming process. This won't also be effective as the traffic signal controller won't be able to track the live location of the ambulance so as to know when to turn the signal green which results in changing traffic signal green even if the ambulance is not even near the traffic signal. Also, if the ambulance had to travel for a longer distance comprising of many traffic signals, it is practically impossible to request a change in signal for each and every traffic signal.

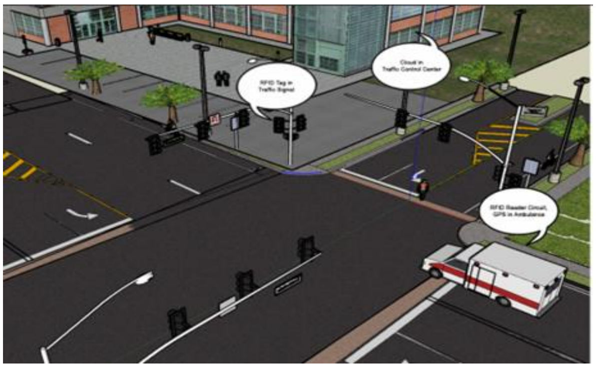

Fig. 1 Architecture of CSSTS Method

These demerits can be handled effectively if the process is automated with the ability to live track the ambulance. The CSSTS method as shown in Fig. 1 comes into action here. The entire traffic signal network is connected to a cloud. A link is established between the cloud and ambulances through the LTE connection. Every traffic signal is made to have two working modes: Emergency mode and Normal mode. A traffic signal turns into emergency mode when an ambulance of emergency status is expected to pass through the traffic signal's lane. Once the traffic signal confirms the passage of ambulance it returns to the normal mode wherein the traffic signal is back to its initial state operated either by a timer or a traffic signal controller controls the signal.

II. LITERATURE SURVEY

An Intelligent traffic control system using RFID [1]: Anuran Chattaraj, Saumya Bansal, Anirudhha Chandra, 2009. Vehicles are fitted with RFID tags and also, the traffic signals are fitted with RFID tag reader to count the number of vehicles. Depending on the count the microcontroller turns the signal green to the most populous lane thus reducing the traffic greatly. However, the working of the system is limited by the readable distance of the RFID Reader and does not have any provisions for emergency situations such as the passing of ambulance.

Design of Intelligent Traffic Light Controller [2]: J R Latha, U Suman, 2015. It consists of input switching matrix, a microcontroller to control the system, a GSM interface for communication purposes, serial communication interface (SCI), Real-Time Clock 1307 and a clock circuit that detects the traffic based on the signal from them and changes the signal suitably. The sensor signal has greater accuracy in detecting the traffic. However, they are not as efficient as they fail to compare the traffic for higher distances.

A New Approach for Intelligent Traffic Control System using Raspberry pi [3]: P. Nandini Kiran, Suraya Mubeen,2017. An intelligent traffic control system is employed for a smooth flow of traffic. A Radio Frequency Identification (RFID) tag is placed inside each vehicle in such a way that changes such as removing, destroying or tampering cannot be made to the RFID tag. The RFID reader, system-on-chip is made to read the RFID tags that are placed inside the vehicle. The system is made to count the vehicles that pass the signal which is used to control congestion present in the network by regulating the green signal duration of the congested path. However, its range is limited by the RFID Reader.

Modeling Metropolitan-Area Ambulance Mobility under Blue Light Conditions [4]: Marcus Poulton, Anastasios Noulas, et al, 2018. A metropolitan model is used to create an optimized navigation route using the data from the previous events. This model is used for the future navigation of the ambulance. This greatly helps in optimizing the navigation of the ambulance to the nearby hospital. However, it can only help the ambulance to a certain level as it does not have any provisions to conquer sudden traffic surge on the ongoing path.

Chipless RFID for intelligent traffic information system [5]: Stevan Preradovic and Nemai Karmakar, 2011. This chipless RFID system works in the UWB spectrum and thus, resulting in communication which is of high bit rate between the RFID reader and its tags which does not have an IC and a power supply such as a battery. The potential advantage of this application is increased safety in the road, navigation, and regulation of the traffic at a small expenditure. However, Electro-Static Discharge (ESD) damage can act as a threat to the chipless RFID tag.

Dynamic Traffic Control System using RFID Technology [6]: Priyanka Nalawade, Prajakta Waghere, et al, 2017. The RFID technology is used in this system. The RFID tag is placed inside the vehicles and in case if these vehicles cross the traffic junction, the RFID reader of the system will read those RFID tags present in the vehicle. The number of vehicles present controls the signal which gives green signal based upon the collected information and in case of an emergency, this system gives green signal for emergency vehicles such as police, ambulance, etc. Using this system, stolen vehicles can easily be traced. However, the change in signal for the emergency vehicles works only when they are nearby to the RFID tag Reader.

Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance and Stolen Vehicle Detection [7]: Rajeshwari S, Santhoshs Hebbar, Varaprasad Golla, 2015. RFID is used to detect the ambulance and assists in turning the signal green. RFID measures the accuracy was greater however if the ambulance is stuck in the signal farther from the reading capacity of the RFID Reader present in the signal this method would prove useless.

Intelligent traffic signal control system for ambulance using RFID and cloud [8]: B. Janani Saradha, et al, 2017. In order to clear the traffic along the path of the ambulance RFID fixed at the traffic signal which is used to track the ambulances, onto which the RFID tags are set. It then sends the ambulance data to the cloud. The user is made to request through the mobile app to change the particular signal green for some moments. This system has control over the traffic signals and thus, greatly helps in saving time in case of an emergency. Thus, it can effectively save a life by assisting the ambulance movement. However, it's not fully automated and relies on people for input.

Intelligent cross road traffic management system (ICRTMS) [9]: Ahmed S. Salama, Bahaa K. Saleh and Mohamad M. Eassa, 2010. This system is based on long-range distributed Photoelectric Sensors in distances that are placed nearby the traffic lights to alert about the emergency situation. It is based on active RFID based technology. It can be made to run automatically with or without intervention.

RFID-Based Tracking in Supporting Real-Time Urban Traffic Information [10]: Yaying Zhang, 2009. In this system, passive RFID tagged moving vehicles can be located with the RFID readers which are installed near and at the road intersections in order to improve the traffic and forecast it. The individual vehicles' information, helps in knowing the status of the city's roads in an easy manner. However, in this approach is one has to avoid collision of multiple RFID reader problem in order to ensure the traffic sampling data's integrity.

III. CONTROL SYSTEM FOR SMART TRAFFIC SIGNAL METHOD

Control System for Smart Traffic Signal (CSSTS) Method involves in creating a link between the cloud and ambulance by the cellular network. The cloud continuously tracks the ambulance for its location through the GPS present in the ambulance. The GPS helps in creating a navigation route and sends navigation information to the cloud. The cloud assesses the navigation route and changes the traffic signal accordingly so as to free the traffic for the upcoming ambulance. Since GPS can malfunction in certain cases during the navigation this method proposes the use of RFID for decreasing the error probability. The LTE is used to send the navigation information such as source, destination, the navigation route and the crossing of a signal to the cloud. Once, the RFID reader in the ambulance reads the RFID tag present in the traffic signal, the crossing of a signal is confirmed and the next traffic signal is prepared by sending the next traffic signal to the cloud. The CSSTS method uses the SMTS algorithm in order to change the traffic signal and its status based upon emergency.

A. SMTS Algorithm:

1. Start
2. while s = 1
3. initialize dest, path, s_status
4. evaluate tsignals, etas
5. initialize s_timers = etas
6. while tsignal = 0
7. while s_timer < 10 && rfid = 0
8. goto 4
9. while rfid = 1
10. a_status = 1
11. if rfid = 0
12. a_status = 0
13. evaluate s
14. End

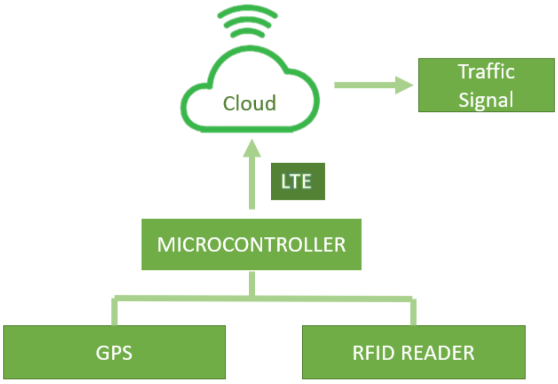

Fig. 2. Flow of data to Traffic Signal

IV. MODULES

A. Microcontroller:

The microcontroller is paired with RFID Reader, GPS as shown in Fig. 2. The microcontroller processes the information from the RFID and GPS and sends a signal to the cloud accordingly. In an emergency situation, the microcontroller receives the source and destination location. It plans the navigation. The route is then sent to the cloud. Also, the microcontroller gathers information from the RFID module in the circuit and determines the crossing of the signal. Also, once the microcontroller determines a signal is crossed, the information is sent to the cloud so as to update the signal status.

Fig. 3. Communication between Traffic Signal and Ambulance

B. RFID System:

The RFID system consists of the following vital parts: a scanning antenna, RFID Reader, RFID tag which contains information of the traffic signal. When the tag present in the traffic signal comes within range of a scanning antenna, electromagnetic (EM) energy triggers the tag to send the data through radio waves. As shown in Fig 3 the radio waves emitted by the tags are picked up by the antenna present in the RFID reader and is sent to the reader which decrypts the waves into information that is understandable by the microprocessor present in the system. As long as the RFID reader can read the RFID tag it is assumed that the ambulance is near the signal. Upon crossing the signal, the ambulance moves away from the RFID range and finally loses the radio waves emitted by the tag. Once the RFID connection is lost, it is assumed that the ambulance has crossed the signal and the signal status is reset to the normal mode from the emergency mode.

C. GPS:

The GPS is a positioning system that provides both time and location information to the user independent of weather conditions, location when there is a line of sight to a minimum of three GPS satellites. The GPS module is placed within the ambulance. The route to the destination can greatly be optimized using the map's data as this can return the shortest route to the destination. GPS helps the cloud in tracking the ambulance in real-time. This data is used to turn the traffic signal green in such a manner that ambulance wouldn't get stopped in the traffic and also the vehicles in the other lane would not have to wait for a time that is more than necessary. Also, using the current location the nearby signals in the route to the destination are detected. This information is sent to the cloud for further changing of the signal.

D. Cloud:

The cloud is linked with all the traffic signals in the metropolis. By doing so each and every traffic signal can be controlled remotely or can be automated. This cloud acts as a link to connect the ambulance with the appropriate traffic signal so as to turn the signal green. The cloud calculates the next signal that is to be crossed and conveys the information to the traffic signal in order to change the signal. LTE connectivity is used so as to avoid poor performance due to network latency.

V. DEMONSTRATION USING ANYLOGIC

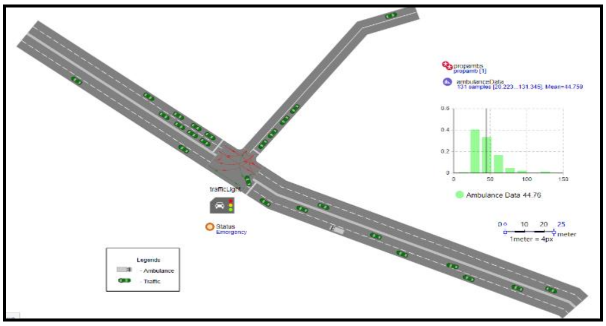

Fig. 4. SMTS Algorithm Simulation

AnyLogic software is used for the simulation of the proposed model. In this model, a road network is built with a traffic signal to control the traffic as shown in Fig.4. Once the traffic signal detects an ambulance nearby to it switches into emergency mode and turns the signal green for the ambulance lane. By doing so, the traffic ahead of the ambulance moves without any stopping. This indirectly helps the ambulance to move free till the destination without any stops.

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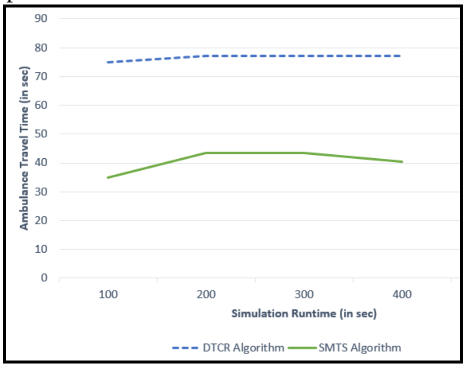
This method is proved to be very effective when compared to the previous OEVTA algorithm and DTCR algorithm and graph 1 is plotted from its results.



Graph 1. DTCR Algorithm vs SMTS Algorithm

VI. RESULT

Table 1. DTCR Algorithm vs SMTS Algorithm

Evaluation Factor	DTCR algorithm	SMTS Algorithm
Range	varies based on RFID used	varies based on network coverage range
Ambulance Clearance Time (in sec) (from Demo Model)	63.22	41.913

The current system differs from the previous by the identification methods employed in identifying the ambulance. The OEVTA algorithm identifies the ambulance based on the image from the camera and the siren sound. This can fail in case of heavy noise from the traffic and during the night time where the light lacks. The DTCR algorithm grants a green signal to the ambulance when the RFID reader present in the ambulance reads the RFID tag in the traffic signal. However, if the ambulance is stuck in traffic outside the RFID Reader's range this algorithm would fail. The CSSTS method has a great advantage as it is not limited by time or traffic as the algorithm communicates about the ambulance wirelessly which is effective when compared with the others.

VII. CONCLUSION

Human life is precious and every second saved by optimizing the ambulance route greatly increases the probability of saving a life. By using the CSSTS method, we can pave way for uninterrupted movement of ambulances. This system is cost-effective and many further advancements can be made to the proposed system framework. Future advances can be made using artificial intelligence so, as to assist when to turn the traffic signal green rather than using a predefined value.

REFERENCES

1. Chattaraj, A., Bansal, S., & Chandra, A., "An intelligent traffic control system using RFID", IEEE Potentials, vol 28(3), 2009, pp 40–43.
2. Latha, J. R., Suman, U., "Intelligent Traffic Light Controller", International Journal of Emerging Engineering Research and Technology, vol 3(3), 2015, pp 38-50.
3. Nandini Kiran P, Suraya Mubeen., "A New Approach for Intelligent Traffic Control System using Raspberry pi", International Journal of Innovative Research in Technology, vol 4(6), 2017, pp 394-399.
4. Poulton, M., Noulas A., Weston D., & Roussos, G., "Modelling Metropolitan-area Ambulance Mobility under Blue Light Conditions", IEEE Access, vol 7, 2018, pp 1390-1403.
5. Preradovic, S, & Karmakar, N., "Chipless RFID for intelligent traffic information system", 2011 IEEE International Symposium on Antennas and Propagation, 2011.
6. Priyanka Nalawade, Prajakta Waghere, Nisha Vanare, Prajakta Kalbhor, Jadhav, A. J., "Dynamic Traffic Control System using RFID Technology". International Journal of Advanced Research in Computer and Communication Engineering, vol 6(1), 2017, pp 66-68.
7. Rajeshwari S, Santhoshs Hebbar, Varaprasad Golla, "Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance, and Stolen Vehicle Detection". IEEE Sensors Journal, vol 15(2), 2015, pp 1109-1113.
8. Janani Saradha, B., Vijayshri, G., & Subha, T., "Intelligent traffic signal control system for ambulance using RFID and cloud", 2017 2nd International Conference on Computing and Communications Technologies, 2017.
9. Salama, A. S., Saleh, B. K., & Eassa, M. M. "Intelligent cross road traffic management system", 2010 2nd International Conference on Computer Technology and Development, 2010.
10. Zhang, Y., "RFID-Based Tracking in Supporting Real-Time Urban Traffic Information", 2009 Fifth International Joint Conference on INC, IMS and IDC, 2009.

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