GENIUS TRAFFIC CONTROL SYSTEM FOR AMBULANCE

A REPORT ON PROJECT BASED LEARNING

(SEMESTER -II)

Submitted by

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- CERTIFICATE -

This is to certify that the work incorporated in the report entitled **"GENIUS TRAFFIC CONTROL SYSTEM FOR AMBULANCE,"** is carried out by a group of students with Project Id **1B42023** under the subject ***Project Based Learning*** during A.Y. **2022-2023**.

Date: 04/07/2023 **Name & Sign of Project Guide**

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Abstract

Traffic jams at road crossings is a major issue in a populous country like India. During emergency situations this becomes a major obstacle, which needs to be resolved in order to save a lot of lives especially in case of medical emergencies.

In order to solve this problem a lot of researchers and scientists have presented their ideas in various research papers. After analysis of these research papers, along with some corrections and new ideas, solutions and models were proposed.

The different proposed models were again analysed according to transmission and processing. Out of which, one solution which was thought to be best suited, that included RFID tag and reader, was selected. Components along with specifications were listed and costing estimated. Based on infrastructure and location of traffic junction this solution was further classified into 3 types: Overbridge sensor, sideways sensor and on road sensor. These were again studied and limitations were noted of each type.

RFID being placed on each vehicle (special tags for emergency vehicles like Ambulance) are detected by RFID reader. Back-end algorithms were studied and listed which will manage traffic light duration after acquiring live vehicle-congestion data from microcontroller interfaced with RFID reader.

This model aims for a revolutionary change in tackling medical emergencies if this model is implemented perfectly. Although some of the limitations viz. additional infrastructure, installing RFID tags on each vehicle, additional maintenance cost needs to be resolved for this to be implemented in crowded cities of India.

Acknowledgement

First and foremost, we would like to express our gratitude to our Mentor, Prof. Pankaj Patil, who was a continual source of inspiration. He pushed us to think imaginatively and urged us to do this project without hesitation. This endeavour would not have been possible without his help and supervision. Also, we would like to thank Prof. Shivaji Mundhe and Prof. Kaustubh Kulkarni for guiding us with their ideas and comments aided in completion of this project. We sincerely thank Prof. Shrikant Hade for his insights and suggestions.

We would like to thank Dept. of First Year Engineering, PUNE INSTITUTE OF COMPUTER TECHNOLOGY for providing us with the opportunity to work on the project “Genius traffic control system for ambulance.”

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Chapter 1
INTRODUCTION

Traffic congestion at road junctions is a rising problem in a populated country like India. Such scenarios demand a better approach to handle the situations especially for emergency vehicles like Ambulance. A lot of lives can be saved if this problem is handled efficiently. So, to design and implement a genius traffic control system, which will help to create a **green wave**[1] for Ambulance, is the need of the hour.

While searching for solutions to this uprising problem, we came across a lot of research papers in which notable scientists and researchers have expressed their ideas and proposed various solutions to tackle this problem. These papers were thoroughly read and analyzed in order to pave for a better approach to solve the problem.

After going through various research papers, several unique and prospective solutions were proposed. These were classified and analyzed in order to get an accurate, achievable, and economical model for clearance of traffic congestion. The components required for the model are as follows:

1. RFID tag
2. RFID reader
3. Module- ZigBee
4. Microcontroller- Arduino UNO

1.A. Problem Statement:

To design a functionality for automatic traffic control system for clearance of vehicle congestion at road junctions in order to create green wave for ambulance during time of emergency.

1.B. Objective:

1. To provide genius solution for traffic control using live data (especially for emergency vehicles like ambulance)
2. To understand the technology of radio frequency ID (RFID) and its reader.
3. To upgrade traffic lights with emergency symbol that would be displayed during the time of emergency.
4. To understand and analyze traffic signal control.

[1] Green-wave: Wikipedia- A green wave occurs when a series of traffic lights are co-ordinated to allow continuous traffic flow over several intersections in one main direction.

1.C Work Plan:

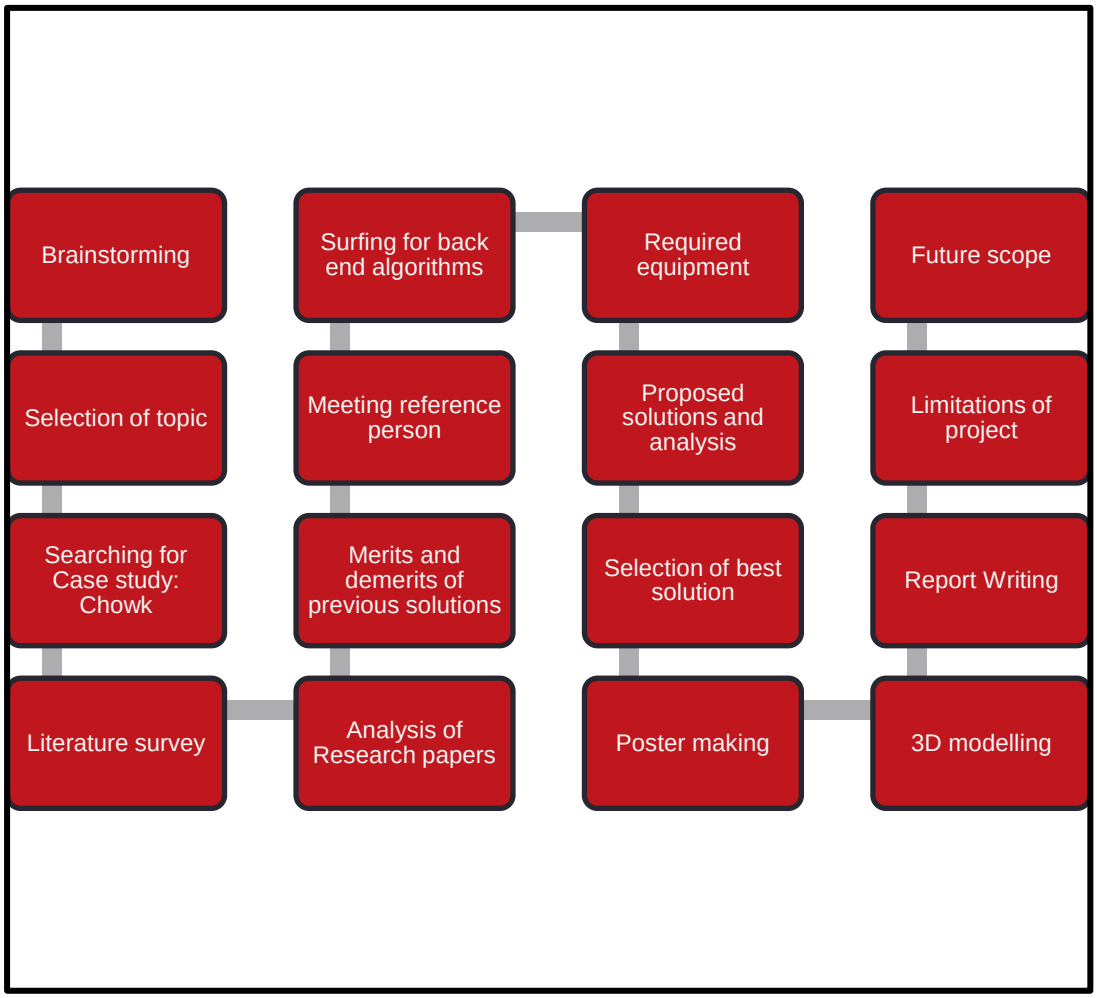

Figure 1: Work Plan of the project

Chapter 2

LITERATURE SURVEY

2.1 Implementing Intelligent Control System for congestion control, ambulance clearance and stolen vehicle detection

Rajeshwari Sundar, Santhoshs Hebbar, (Rahul Pundir) (Mr. Prateek Kumar Jana)*and Varaprasad Golla*

2.1.1 Research paper divided into 3 parts
- i) Automatic signal control
- ii) Emergency vehicle clearance
- iii) Stolen vehicle

2.1.2 Important components: ZigBee Module, Microcontroller, GSM module, RFID reader

2.1.3 Demerits observed:
- i) Data processing is complex
- ii) Congestion analysis not taken continuously hence not accurate
- iii) GSM process time is low
- iv) Vague solution cannot be implemented in all scenarios

2.2 Research Paper: Smart traffic system for fast movement of Emergency Vehicle

Rahul Pundir, Vikash Kumar, Sunil Prakash, Deepak Kumar

2.2.1 Hardware requirement: Microcontroller, AV warning systems consisting of LCD display and audio output devices, RFID

2.2.2 Software requirements: Atmel studio for embedded, GPS & google maps for shortest route detection, Proteus for simulation

2.2.3 Demerits observed:

- i) GSM process rate is slow
- ii) Google maps congestion – it changes routes and will be difficult to control traffic lights with rerouting
- iii) General solution, cannot be implemented for all scenarios
- iv) Management of red lights not taken into consideration in the solution which is equally important as managing green lights

2.3 Intelligent traffic control system for smart ambulance

Mr. Prateek Kumar Jana, Sathwika Chowdary kanagala, K. Karthi Siva Reddy, Yenni Srinivasa Rohith

2.3.1 Features:

2.3.1.1. Ambulances can use network using an Android app which notifies traffic signal servers of an emergency by sending an emergency command along with the ambulance's current location via GPS and its intended direction of movement. The ambulance's current location is used to locate the nearest signal.

2.3.1.2. This system uses IR (Infrared) sensors to control the traffic light.

2.3.1.3. The traffic is controlled by the RF communication.

2.3.1.4. This is a System for Mobile Communication-based devices in the ambulance. This system notifies doctors of the patient's condition and directs them to the nearest hospital, where they can expedite the patient's healing.

2.3.1.5. Components used in this system are:

- Arduino: It is a prototype platform (open-source) based on an easy-to-use hardware and software. Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- Alphanumeric LCD: Liquid Crystal Display also called as LCD is very helpful in providing user interface as well as for debugging purpose.
- IR sensor: The infrared phototransistor acts as a transistor with the base voltage determined by the amount of light hitting the transistor. Hence it acts as a variable current source.
- Relay: Electrically operated switches are known as relays. It repeats the signal from one circuit and retransmits it to a different one.

2.3.2 Demerits:

2.3.2.1. Driver has to direct traffic "manually" using keypad in the ambulance

2.3.2.2. Its challenging to install this system in each ambulance.

2.4 Automatic traffic light controller for emergency vehicle using peripheral interface controller.

Norlezah Hashim, Fakrulradzi Idris, Ahmad Fauzan Kadmin, Siti Suhaila Jaapar Sidek

2.4.1 Features:

2.4.1.1 **PIC (peripheral interface controller)** model 16F877 is used for priority-based traffic light controller.
2.4.1.2 RF is used for wireless signal transmission.
2.4.1.3 This system is economically feasible.
2.4.1.4 It consists of both software and hardware implementation. An embedded program was created using Microcode studio process
2.4.1.5 Push button is installed in ambulance for transmission of RF signal to RF receiver.
2.4.1.6 RF receiver can detect signal up to 55 m.

2.5 RFID and GPS based Automatic Lane Clearance System for Ambulance

Rashmi Hegde, Rohith R. Sali & M. S. Indira

2.5.1 Features

2.5.1.1 When the ambulance leaves the hospital, an RFID card is swiped near the RFID reader. The GPS coordinate transmission is activated When the RFID card is swiped. GPS receiver and transceiver interfaced with Arduino microcontroller continuously receives the GPS co-ordinates of the ambulance.

2.5.1.2 This system establishes communication between the ambulance and Traffic signal post by using transceivers and Global Positioning System (GPS).

2.5.1.3 This system for ambulance control is fully automated. It includes two units:

a) Ambulance unit:

Components in ambulance unit:

- **Microcontroller (Arduino uno):** It is a microcontroller board based on ATmega328P as to be able to read analog or digital input signals from different sensors and turn it into an output.
- **GPS receiver:** It does not transmit any signals, all it does is receive GPS data, then it uses these signals to give an accurate estimate of the receiver's location.
- **Transceiver (Xbee S2):** It is a RF module designed for wireless communication or data exchange. This module can give range of 40 meters indoor or 120 meters outdoor.
- **EM-18 (RFID reader):** It is used to read unique ID from RFID tags. Whenever RFID tags comes in range, RFID reader reads its unique ID and transmits it serially to the microcontroller or PC. RFID reader has transceiver and an antenna mounted on it. It is mostly fixed in stationary position.
- It is installed in ambulance.

b) Junction unit:

- Installed at traffic post.
- The coordinates of a point at a particular distance are specified in the junction unit's microcontroller programming which when crossed by the ambulance turns traffic signal green.
- LED screen displays the message that an ambulance is approaching.

The GPS co-ordinates of the ambulance are continuously received by the transceiver. The co-ordinate of a specific point at a certain distance before the Junction are pre-specified in the microcontroller program.

During emergency situations, when an ambulance reaches the co-ordinates specified in the microcontroller's program, the Junction Unit is activated and it efficiently turns the traffic signal Green, creating a clear way for ambulance.

2.5.1.4 A suitable delay is also provided in case of unavoidable situations and the signal remains green until the ambulance the crosses the Junction.

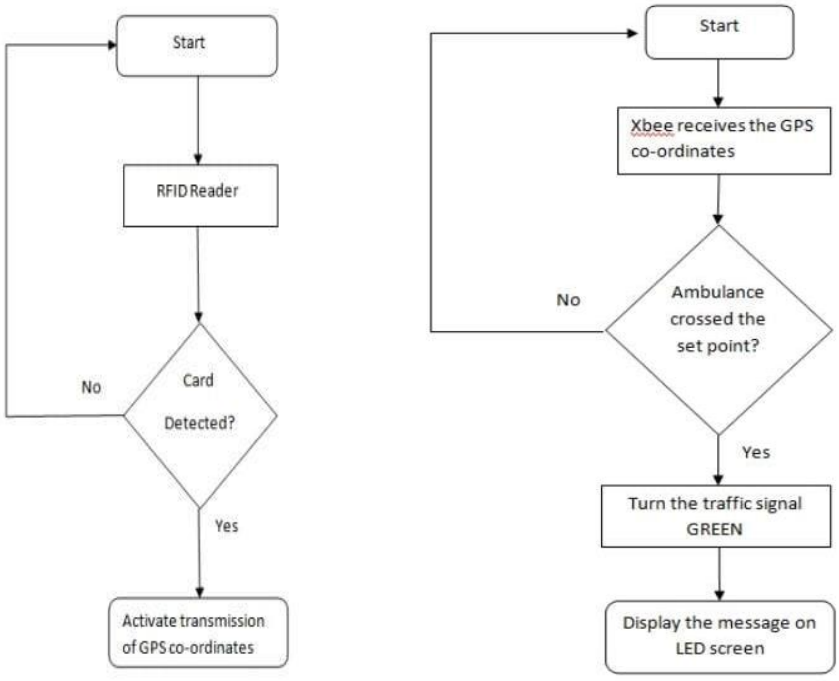

Figure 2: Flowchart of Ambulance Unit and Junction Unit

2.5.2 Demerits observed:

2.5.2.1 Each traffic light needs to be programmed individually in order to note down matching coordinates for controlling traffic light of junction

2.5.2.2 Delay due to GPS transmission.

2.5.2.3 Live coordinates of other vehicles for congestion are not considered for controlling traffic lights.

2.5.2.4 Implementation of this system is difficult for govt. ambulances.

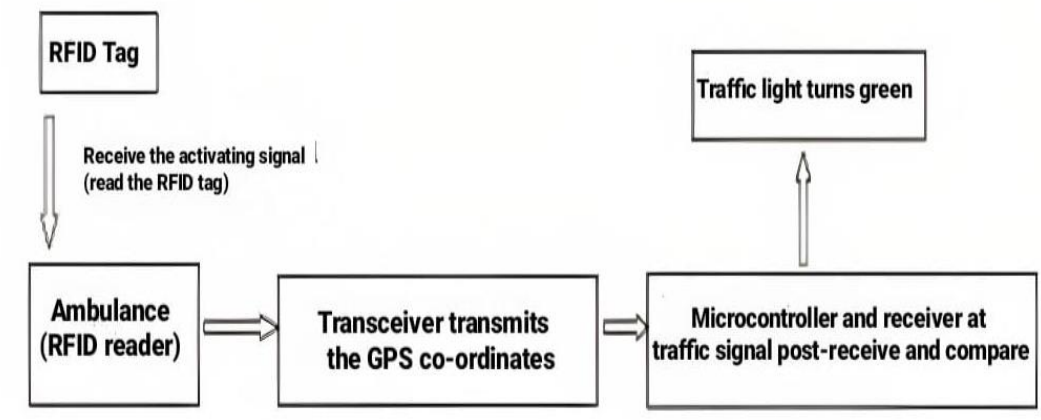

Figure 3: Flowchart for junction unit

2.6 Comparative Analysis on Density Based Traffic Control System

Kanakala Santosh Kumar, Singaraju Gopichand,3Deepika Ghai

2.6.1 Features:

2.6.1.1 Passive infrared sensor (PIR) interfaced with Arduino (micro controller)

2.6.1.2 Image processing is done with the help of webcam

2.6.1.3 Canny edge detection operator is used to operate image processing.

2.6.1.4 RGB to GREY scale transformation (It simplifies algorithm)

2.6.1.5 As vehicle crosses IR Sensor, photo diode is activated and vehicle is detected and counter gets a clock pulse

2.6.2 Demerits observed:

2.6.2.1 Webcam cannot detect vehicle due to rain and fog.

2.6.2.2 When two vehicle is moving parallel to IR Sensor, vehicle is not detected.

2.6.2.3 PIR is insensitive to slow moving vehicle.

2.7 Sensor Based Traffic Control System

Roopa Ravish, Dattaesh Shenoy and Dr. Shanta Ragaswamy

2.7.1 Features:

2.7.1.1 It has two separate control system:

- One which collects vehicle density (data) on the industrial lanes using ultrasonic sensors.
- Then it uses this data in order to control traffic lights.

2.7.1.2 Components used in this system:

Ultrasonic sensor (HC-SR04): It uses sound navigation ranging to determine the distance emergency vehicle. It is not affected by sunlight/ material in dark. It by default calculates the time for ultrasonic wave and return to sensor. Transceiver module (NRF24101): It is a wireless communication for two or more Arduino boards.

2.7.1.3. This system avoids vehicle lining up on one side of the lane as ultrasonic sensors are placed at either side of the lane.

2.7.1.4. This is used to better value the gauge density. It gives priority to the lane with maximum traffic (else lane with emergency vehicle).

2.7.1.5. Arduino mega is used to power the LEDs and Arduino board powers through solar energy /electricity.

2.7.2 Demerits observed:

2.7.2.1 Ultrasonic sensors have a limited range of detection compared to other sensor types like radar.

2.7.2.2 The NRF24L01 requires careful configuration and management.

2.7.2.3 NRF24L01 has complex configuration and can consume relatively high-power during transmission.

Chapter 3

PROPOSED MODELS

The various models for data processing and transmission proposed by the team are as follows:

3.1 RFID tag and reader

This traffic control system model makes use of equipment like RFID tag, RFID reader, Microcontroller, ZigBee module, in which RFID tags are fixed on each vehicle. RFID reader reads the RFID tag attached to vehicles and that collected dada is transmitted to traffic signals using Microcontroller and ZigBee module in order to manage the signal in emergency case.

RFID stands for Radio Frequency Identification. RFID technology works on radio waves that are used to send and receive information through a wireless non-contact manner to transfer data. RFID tags and RFID readers are the main components to collect the live data.

- RFID tag: RFID tags are fixed on each vehicle which will be read by RFID reader. This RFID tags have an integrated circuit and antenna that are used for transmitting data to the RFID reader. These tags are like Fast-Tag which are in use widely.
- RFID reader: RFID reader reads the RFID tags attached to each vehicle and collects the data. The reader then converts these radio waves into a more understandable form of data that can later be analyzed on a computer system. These are placed near the road junctions in order to detect the vehicles and ambulance in case of emergency.

The RFID reader will send the data to microcontroller which would analyze the data and accordingly manage the traffic light timings with the help of ZigBee module.

When the ambulance is detected near a junction at a distance, in accord with used back-end algorithm for traffic lights control, the traffic light will reflect a plus "+" symbol informing the other vehicles that an emergency vehicle is passing. The lanes in route with the ambulance will be displayed with a green plus "+" symbol whereas the other lanes will be displayed with a red plus "+" symbol. The symbols will be reflected till the ambulance went pass the junction.

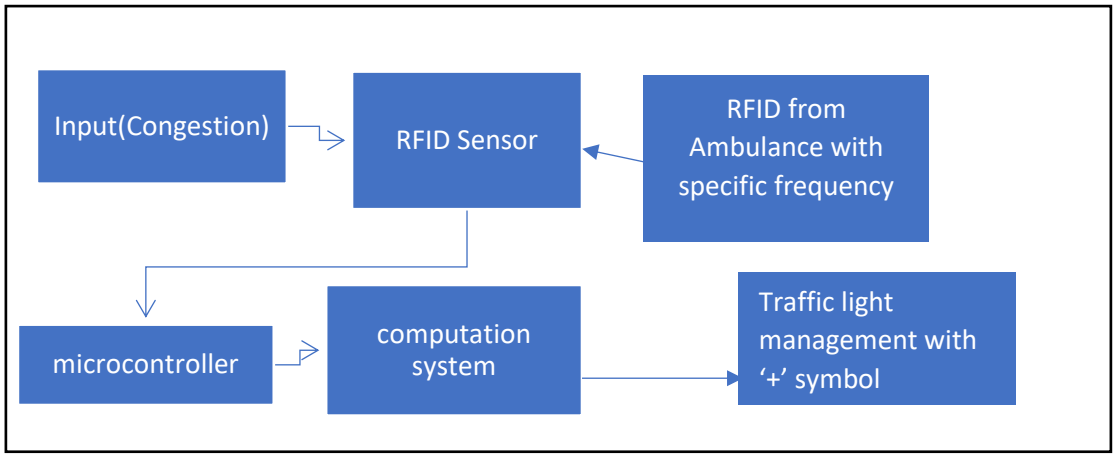

Figure 4:Flowchart for RFID reader and tag model

Being, the most practical solution in case of cities in India, this model thought to be the best solution amongst other ideas. Thus, it is further explained in detail in the chapter: Working model.

3.2 GPS co-ordinates

In this model, the ambulance will send live location using the Global Positioning system (GPS) to the microcontroller interfaced with modules like ZigBee (enhancing IoT) which will track the position of the ambulance and clear the congestion by managing traffic lights in the route of the ambulance.

When the ambulance is located near a junction at a distance, in accord with used back-end algorithm for traffic lights control, i.e., the co-ordinates of a specified position match with those of the ambulance, the traffic light will reflect a plus "+" symbol informing the other vehicles that an emergency vehicle is passing. The lanes in route with the ambulance will be displayed with a green plus "+" symbol whereas the other lanes will be displayed with a red plus "+" symbol. The symbols will be reflected till the ambulance went pass the junction.

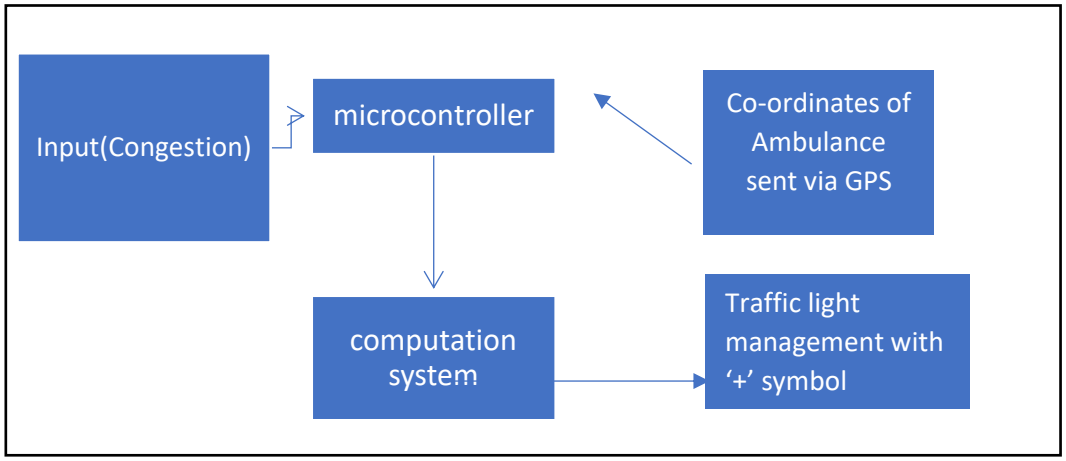

Figure 5:Flowchart for GPS co-ordinates model

3.3 Siren sound frequency

It is a sensor-based traffic control system model in which, specific frequency of siren from ambulance is detected and alert signal is transmitted to microcontroller for further control management of traffic lights at junction.

It consists of two separate control systems: one to acquire congestion at junction using Ultrasound sensors and the other to get alert from ambulance using siren frequency.

In the first system, the distance of the obstacle (in this case, vehicle) is determined using the duration from micro-controller:

$$Distance = Duration * \frac{340}{2000}$$ [11]

A transceiver module is used to communicate between two or more microcontrollers in order to obtain and compile congestion from different lanes at a junction.

When the ambulance is detected near a junction at a distance, in accord with used back-end algorithm for traffic lights control, the traffic light will reflect a plus "+" symbol informing the other vehicles that an emergency vehicle is passing. The lanes in route with the ambulance will be displayed with a green plus "+" symbol whereas the other lanes will be displayed with a red plus "+" symbol. The symbols will be reflected till the ambulance went pass the junction.

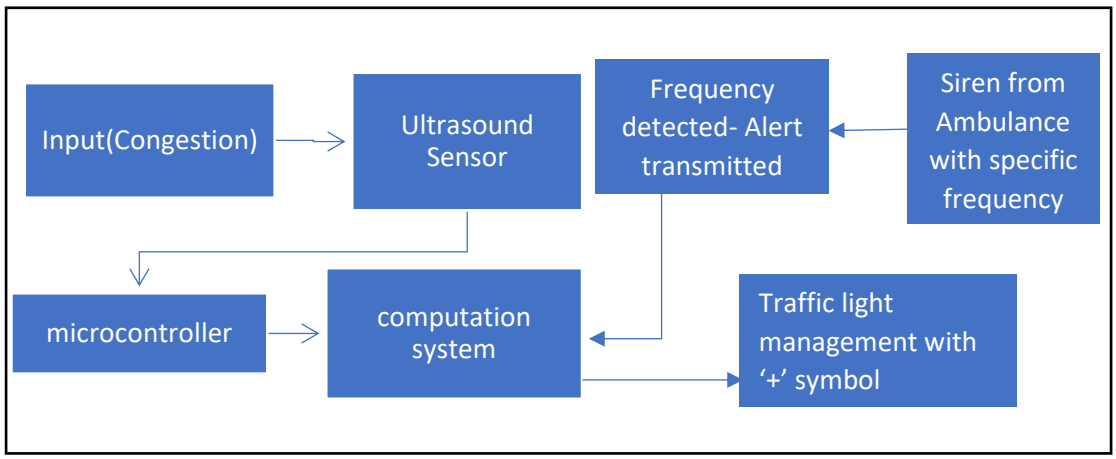

Figure 6: Flowchart for Siren sound frequency model

3.4 Image processing using webcam

Webcam is used to record images of the vehicles, which is positioned at the junction of two roads. It is capable of snapping pictures even when the vehicles are at high speed. For further processing, the acquired image is changed to a greyscale version. After which, the grayscale image is transformed into a binary image. This image is known as the threshold image. RGB Scale is used to simplify the algorithm and do the further processing.

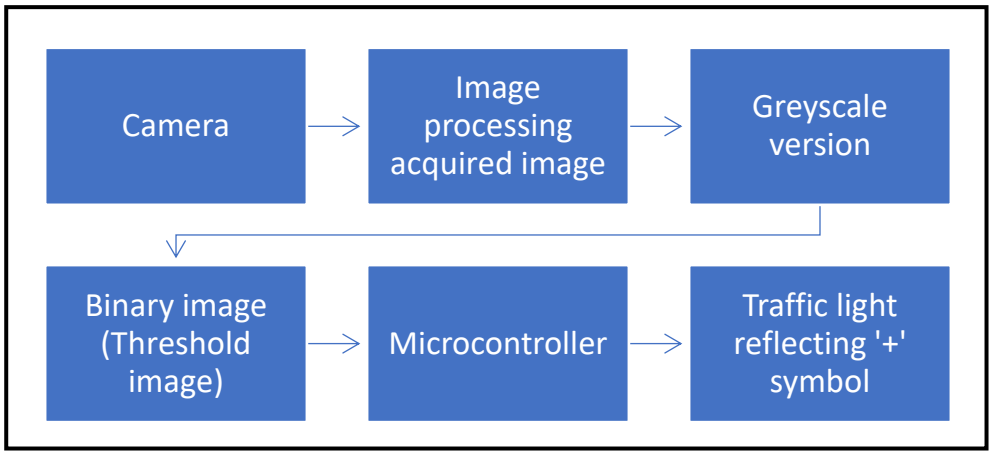

Figure 7:Flowchart for image processing using webcam model

From the above ideas, **RFID tag and reader** model was thought to suite as the best possible solution to the problem of congestion clearance in case of emergency.

Figure 8:Main poster of the proposed model

Chapter 4

WORKING MODEL

"Genius traffic control system for ambulance" model aims to create a GREEN WAVE for an emergency vehicle like ambulance by clearing the congestion at a junction before the ambulance reaches the junction.

4.1 The model comprises of components as follows:

4.11 RFID (Radio Frequency Identification) Tag:

- Type-Passive
- Frequency-300 MHz to 3GHz

4.12 RFID (Radio Frequency Identification) reader: EM 18

4.13 ZigBee Module

4.14 Micro-controller: Arduino Uno

4.2 Radio Frequency Identification (RFID) is a form of wireless communication that incorporates the use of radio frequency to uniquely identify an object, animal, or person. It uses radio frequency to search, identify, track, and communicate with items and people.

4.3 RFID TAG:RFID (radio frequency identification) tags are small electronic devices that wirelessly identify and track physical articles through radio frequency interaction with RFID readers. Each tag contains a minimum of an integrated circuit and an antenna. The RFID tags will be placed on each of the vehicle. Special tags will be placed on emergency vehicles like ambulance.

Here are five key features of RFID that makes it an ideal choice:

- A unique Id
- No need for batteries
- Can detect 'hidden' objects
- Multiple tags can be read at once
- Rugged and weatherproof

4.4 RFID READER: RFID readers retrieve the information from RFID tag which detects the tag and reads or writes the data into the tag.

4.5 MICRO-CONTROLLER: It helps in managing the traffic lights according to the location of ambulance by acquiring information from RFID reader.

4.6 ZIGBEE MODULE: ZigBee Modules are devices that are used to transmit and receive radio signals.

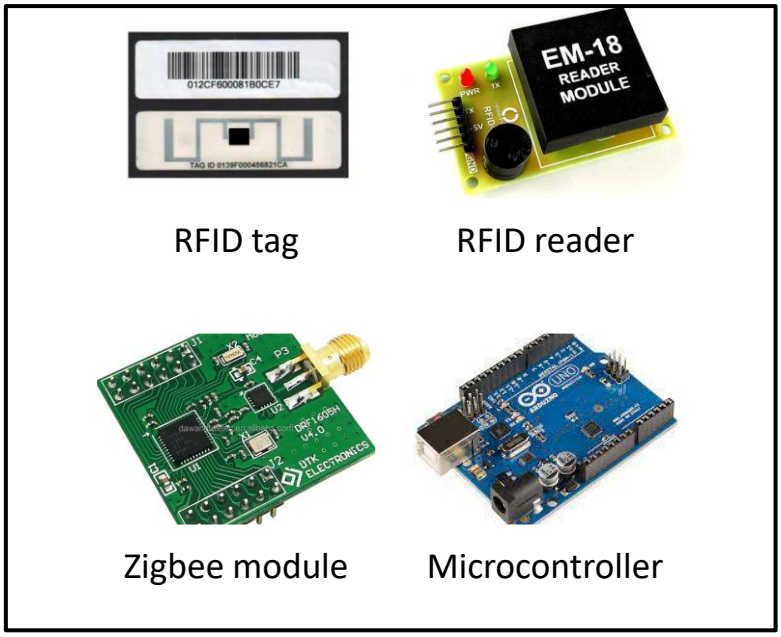

Figure 10: Components required in the model

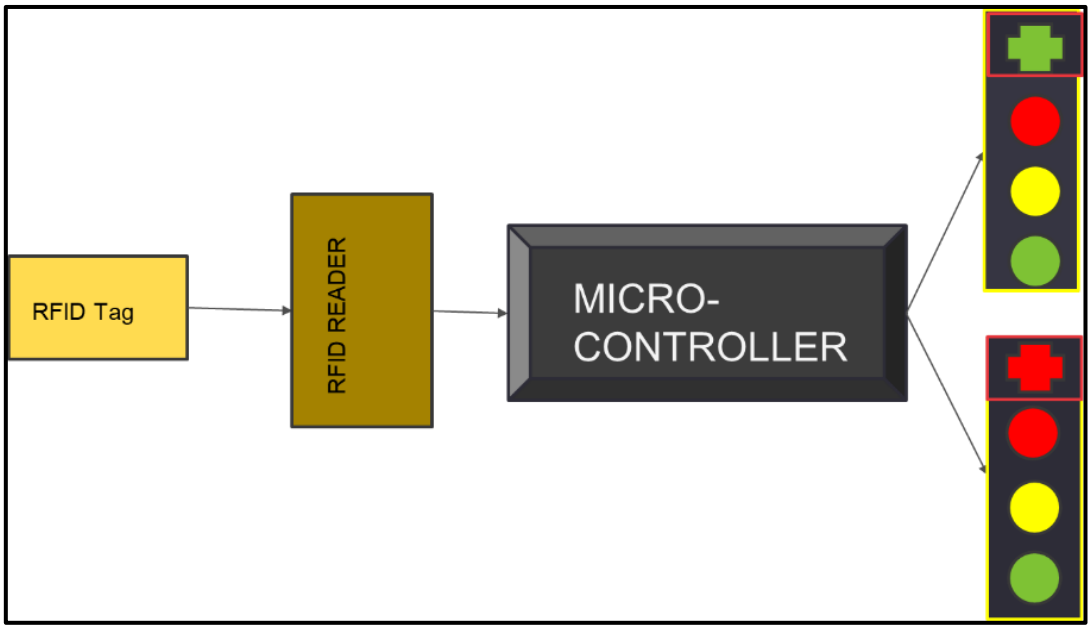

Figure 9:Flowchart for RFID proposed model

4.7 Costing of the model:

- Reader: - Rs.300-600
- Tag
  - Metallic – sideways: - Rs. 50-60
  - Windshield tag – overbridge: - Rs. 300-500
  - On metal rivet, Flexi – on road: -Rs. 50-60
- Zigbee module – 2000-3000
- Microcontroller -2000-3000

4.8 Based on the location of RFID tags on the vehicles, RFID readers would be placed at different locations on the road. Following, are three proposed cases with respect to the location of the tag and the reader.

4.8.1 On sideways of the road:

The sideway railings are installed with RFID sensors which will help in catching the RFID tag placed on each vehicle.

In this case, the RFID tag is placed on either side of the vehicle.

Here are some merits and demerits of this case:

MERITS:

- Estimation of traffic more accurately
- The tag being scanned does not necessarily have to be within the direct line of sight.
- Can operate effectively in hostile environments where the tag may be contaminated with dirt and grease.

DEMERITS:

- Infrastructure not practical (number of readers)

Approximate cost of model- ₹6500 – ₹11000

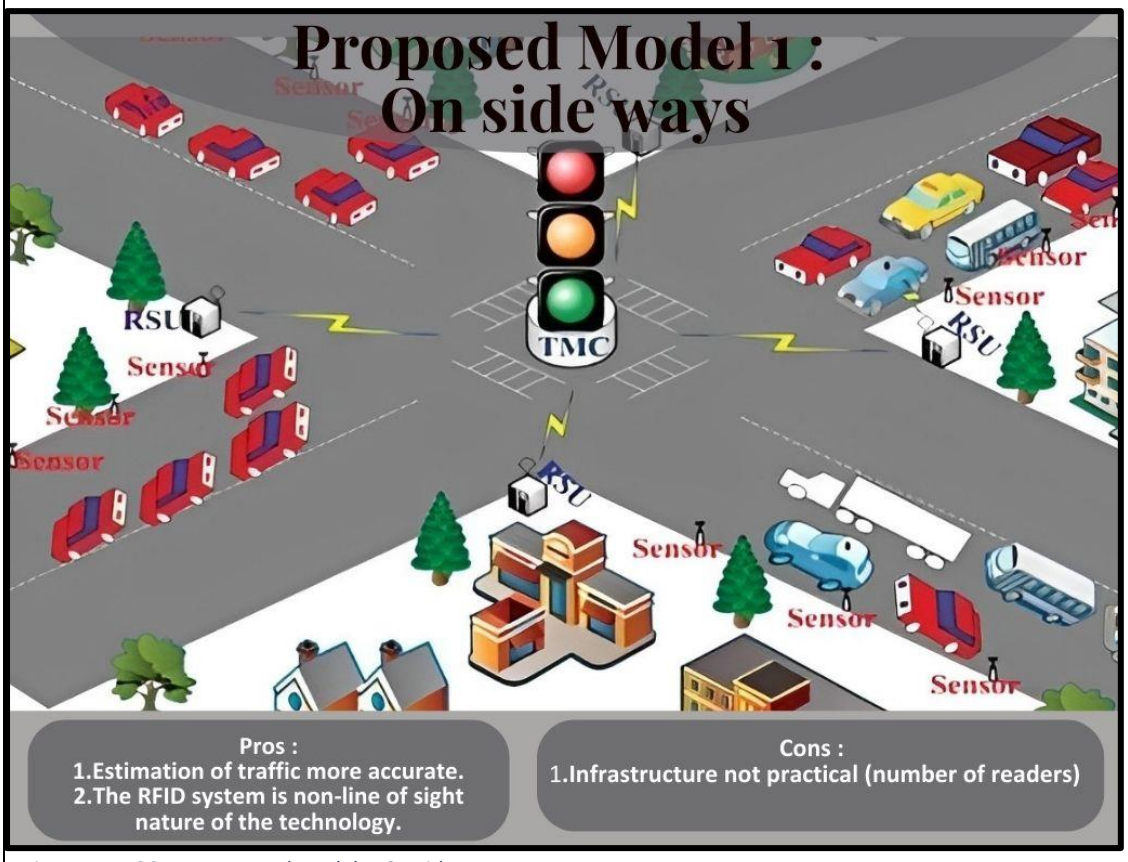

Figure 11:POSTER Proposed model 1-On sideways

4.8.2 On Overbridge:

The RFID readers are installed at a certain distance on the overbridge which will detect the vehicles passing underneath it.

Here are some merits and demerits of this case:

MERITS:

- No damage to RFID reader.

DEMERITS:

- Infrastructure complex.
- Economically not feasible.

Approximate cost of model-₹5500 – ₹9000

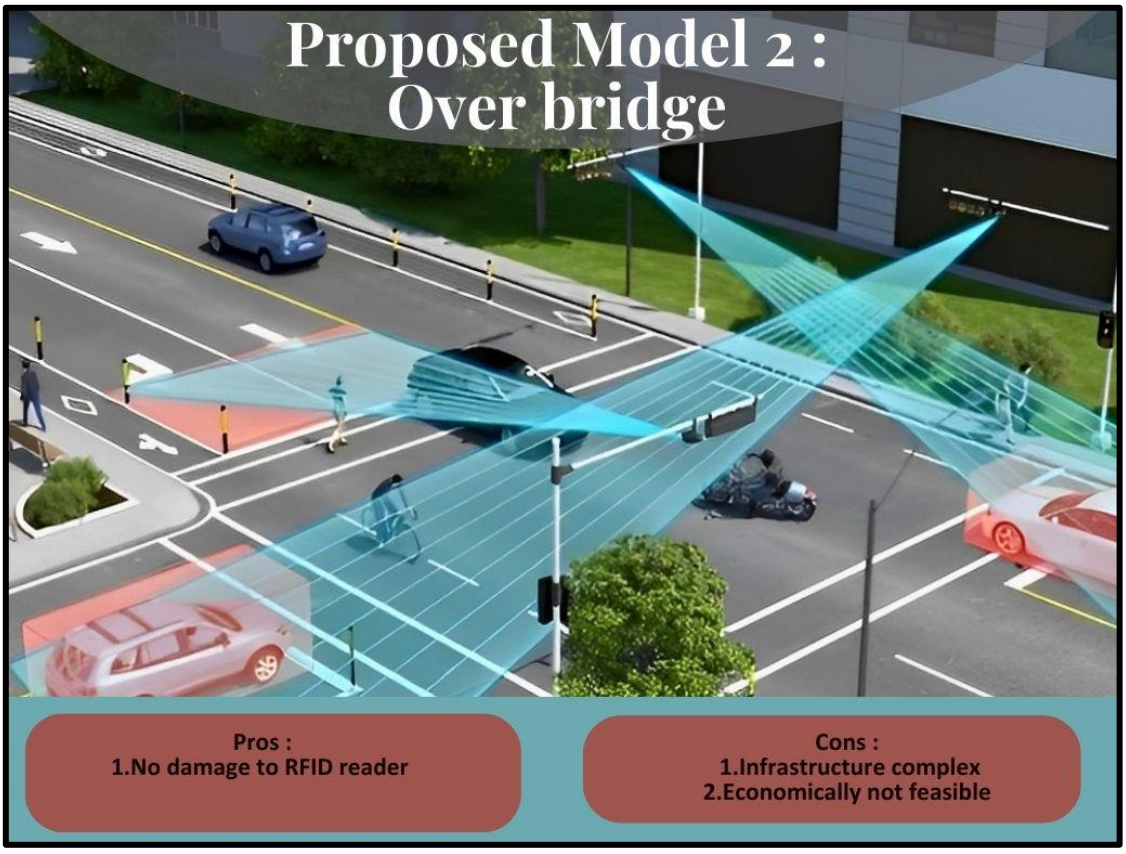

Figure 12:POSTER Proposed model 2 - Overbridge

4.8.3 On Road:

In this, the RFID readers are installed on the road surface.

MERITS:

- No jamming issues
- No extra infrastructure required

DEMERITS:

- Sensors can be damaged

Approximate cost of model- ₹5500 – ₹8500

Figure 13: POSTER Proposed model 3 - On road

4.9 Algorithms: The RFID readers continuously collect data by scanning the RFID tags. Thus, live congestion data is collected ceaselessly. When an emergency vehicle like ambulance approaches, the RFID readers which are placed at a specific distance from the junction instantly detect the special RFID tag on the ambulance. The ZigBee module is activated which sends a signal to the microcontroller that an ambulance is approaching. The traffic signal of the side of the ambulance must be turned green while intelligently turning the rest of the signals to Red. This process is carried out in an algorithmic manner by taking into consideration various parameters like width of the road, number of vehicles currently at the junction, length of each vehicle, distance of ambulance from the junction, speed of the ambulance. The algorithms which can be used for the efficient co-ordination of the traffic signals are:

- Control of Networks by Optimization of Switchover (CRONOS) [13]
- Artificial Fish Swarm Algorithm (AFSA) [7]
- Ant Colony Algorithm [2]
- Fuzzy Logic based Traffic Intensity Calculation Function
- YOLO Model [3]
- Intersection over union (IOU) process

A “GREEN WAVE” is thus created and the ambulance can cross the junction without any delay.

Chapter 5
CONCLUSION

In conclusion, implementing a traffic control system for ambulances using RFID tags and readers improves emergency response and ensures timely medical assistance. RFID technology offers advantages over other solutions like push buttons and GPS coordinates by providing clear pathways for ambulances, enhancing safety, and reducing the risk of accidents. However, it is essential to consider the associated limitations, such as the cost of implementation, maintenance, and the limited coverage and range of RFID systems.

The future scope of a traffic control system for ambulances using RFID tags and readers holds immense potential. The integration of RFID technology with the Internet of Things opens opportunities for real-time communication and information sharing among ambulances, traffic control systems, and other connected infrastructure.

In summary, the traffic control system for ambulances using RFID tags and readers represents a significant advancement in emergency response capabilities. Despite certain limitations, its implementation enhances safety, efficiency, and holds promise for further advancements in emergency response and traffic management, particularly through integration with IoT technologies.

Resources:

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2. https://www.best-microcontroller-projects.com/16F877A.html#:~:text=The%20popular%2016F877A.,the%20other%20more%20modern%20PIC's
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[5] **Comparitive analysis on density based traffic control system** [Journal] / auth. Kanakala Santosh Kumar Singaraju Gopichand, 3Deepika Ghai.

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