Route Clearing System for Emergency ambulance and Medical Service Using Ambubot

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Abstract- *Today's world, traffic jams during rush hours is one of the major concerns. During rush hours, emergency vehicles like Ambulances, Police cars and Fire Brigade trucks get stuck in jams. Due to this rush, these emergency vehicles are not able to reach their destinations in time, resulting into a loss of human lives. Smart cities essentially require state of the art technologies which can provide smart service in various aspects. A system is proposed which is used to provide clearance to any emergency vehicle and a robotic automated external defibrillator to save the human life. The system includes two parts; a robotic automated external defibrillator and IntelligentTraffic Light System. The robotic automated external defibrillator system, in the system an immediate treatment using Automated External Defibrillator (AED) must be administered to the cardiac arrest victim within a few minutes. Hence we used an Ambulance Robot, as Ambubot, which brings along an AED and CPR in a sudden event of cardiac arrest and facilitates various functioning to save someone's life in smart cities. The second part is an intelligent traffic control system helps the ambulance to reach the destination in minimum possible time.*

Keywords- Smart Cities, Smart Healthcare, Ambulance Vehicle, Zigbee Module, Emergency Management.

I. INTRODUCTION

Now a day's time is an important parameter in various applications. Time is a critical issue when dealing with people who experience a sudden cardiac arrest that unfortunately could die due to unavailability of the emergency treatment. Smart cities essentially requires a state of the art technologies, it provides smart services and a robotic system are the key element for such requirement [1]. In practice the time taken to reach the ambulance is far above than the ten minutes. This leads reduced the surviving time of the patient due to many obstructions when dispatching an ambulance. The obstructions such as traffic congestion, difficulty to locate the address, long distance etc. One of the delay lead to increase in the response time [1]. In the situation where someone suffering from cardiac arrest; it is a very hard task for the bystanders to locate the nearest Automatic External defibrillator (AED) center. AED used to help the cardiac arrest victim. It take a long time to get a nearest AED because AEDs are not available everywhere [1].However, the traffic congestion is a major problem in developing Countries like India [5]. Congestion on road results in slow moving vehicles, which increases the time of travel, this stands on of the major problem in cities. Time is an important thing, due to traffic congestion the emergency vehicle spend more time in the traffic as well as the speed of the vehicle must be reduced. This leads to complicate the situation when saving the people life [6].

In this paper, we used a robotic automated external defibrillator (Ambubot) and an intelligent automatic traffic control system. In robotic automated external defibrillator; it an ambulance robot, the AED is a small packet placed in the robot to save lives of cardiac arrest victim. Here use two techniques to keep the cardiac arrest victim alive either by body attached sensors or by mobile phones. When one of the methods is used and immediately sends a warning message as well as the Global Positioning System (GPS) information. The message received in an Ambubot center, and then converts the longitude, latitude ectin the street map. Then generate commands for dispatching the Ambubot, then alert the family members, and also send a rescue message to the hospital. When the Ambubot approaches to the victim, the human operator from the control center gives the detailed instructions to the people surrounding the victim to operate the AED device as well as the CPR in the Ambubot. Also the ambulance is reached to the victim then takes the patient to hospital [1]. In intelligent automatic traffic control system, it helps the emergency vehicle to pass the traffic and reach the destination with minimum time. The zigbee transmitter in the ambulance sends an emergency signal to the zigbee receiver in the traffic junction. It will make the traffic light changes into green. It will help to pass the ambulance. A GPS module as well as the navigation screen in the ambulance also helps the driver to find the best way to hospital [5].

II. RELATED WORKS

In contrast, a mobile robot would be able to travel throughout the environment. Mobile robot is a fully autonomous or partially autonomous machine that capable to move around their environment and also can perform different tasks either with direct control or partial control by human operator [2].

In [9], using multiple sensors for navigation, this robot is able to navigate from a source to a given destination without losing the correct path and not hitting the obstacles. There are different sensors used for autonomous navigation in mobile such as vision and range sensors. This robot can also be used to interact with human to take care the elderly and doing household chores.

In future smart cities [3], mobile robots can take over some time-consuming tasks. Most rescuers occur shortly after the event happens. In that event, human rescuers will organize the rescue planning for the happened areas, find out the victims, and help them as fast as possible. They have very short time to find the victims in any situation; otherwise the finding of the victims still alive is nearly zero. In such a critical situation, technology can be used to support rescuers in different tasks. Intelligent mobile robots and cooperative multi agent robotic systems are used in different ways to find and save the victims in a faster and more efficient way. The robot that can do such tasks is known as a rescue robot.
Rescue robot [10] is a robot that has been designed to do rescuing jobs in situations that are doesn't handle by the human, for instance rainstorms, collapsed buildings, obstructions, and dangerous substances. In the case of health emergency situation, it is common to call the emergency helpline to seek for assistance which often the ambulance will be dispatched to the scene in average of ten minutes time [6].

In [7], green wave system was discussed, it is used to provide path to the emergency vehicle by turning on the green light, then providing a complete green wave to the emergency vehicle. A 'green wave' is the green phase of the traffic signals. With a 'green wave' arrangement, the emergency vehicle passing through the junction, a green signal will continue to receive green signals as it travels down to the road.

In [8], it proposed a RFID and GPS based automatic clearance system for ambulance. The focus of this work is to reduce the delay in traffic junction when arrival of the ambulance to the hospital by automatically clearing the traffic in the junction. This can be achieved by turning the signal, in the path of the ambulance, to green when the ambulance is at a certain distance from the traffic junction.

In [13], currently a video traffic surveillance and monitoring system in Bangalore city. The data are manually analyzed by the traffic management team to find out the traffic light duration in each junction. It will communicate with the same to the local police officers for the necessary actions.

III. PROPOSED SYSTEM

From the current problem section, it can be seen that, existing technologies are insufficient to handle the problems of traffic control and the emergency medical service for cardiac arrest. To solve these problems, we used an Intelligent Traffic Control System and an Ambubot for automatic defibrillator. It mainly consists of two parts [1], Robotic Automated External Defibrillator and Intelligent Automatic Traffic Control.

A. Robotic Automated External Defibrillator

First part is robotics automatic defibrillator for emergency situation. Here we use an Ambubot as a platform to save peoples life during cardiac arrest. There are two techniques that used to save the life of cardiac arrest victims either by body-attached sensor or by mobile phone application. However one of them is used, they will send immediately a warning message as well as the Global Positioning System (GPS) information to Ambubot center. The message will received in the Ambubot center and convert the longitude and latitude coordinates into a street map location using a GPS and GIS parser [6].

In the case of using the body-attached sensor, the basic information about the victim such as personal contacts and characteristics, blood type, height, weight, and photograph to generate the complete information needed for search. After processing the data packet in the Ambubot center, it will generates three commands namely the first command for dispatching the Ambubot from the station to the victim to save the people life before ambulance arrival. Other command is for delivering an emergency message to family members via Global System for Mobile Communication (GSM) so they can obtain the important information of the falling person. The last command is for delivery an emergency message to the hospital for the ambulance [1].

Ambubot comprises of three different sections [15],Patient Section Ambubot Section and Control Section.

i) PATIENT SECTION

This section mainly consist of GSM and GPS units followed by a Micro-Processor which is connected with the

Heart beat sensor and a gyro sensor [6]-[15]. Then body-attached sensor integrated in the objects that a person continuously using wearable devices such as glasses frames, belts, and watches [4] without disturbing the person daily lives. The heart beat sensor is used to measure the heartbeat of the person. The gyro sensor is used to sense the patient collapse, and then the microprocessor will transmit short message family members to notify the details of the person collapse. The gyro sensor is integrated with accelerometer thus act as fall sensor. This fall sensor is used to monitor a person's movement and posture so it may help to identify people at risk of falls [6].

This sensor will be containing a tag that contains the patient identification code. Each patient can be identified by using the identification code once registered. The identification tag include the information of a person such as the patients name, date of birth, age, photographs, relatives contact information and personal health history will be generated by Ambubot center to help to ensure the patients safety. The GSM communication module is a communication channel, used to transmit emergency rescue messages to Ambubot center and receive commands from the server. Since the body-attached sensor requires a certain amount of power to proper functioning [1]. The GPS location module is used to provide exact location information of the person to find the shortest path to reach victims, such as longitude, latitude coordinates, and direction into a street map.

ii) AMBUBOT SECTION

Ambubot is a mobile robot with simple in design. It is reliable to operate in indoor and outdoor surfaces. Ambubot is capable of driving up to 10 km/hour and passing slopes up to 45 degrees [1]. Ambubot contain a microcontroller, an automated external defibrillator, CPR, GSM and the GPS. Ambubot is capable of driving up to 10 km/hour and passing slopes up to 45 degrees. With faster maneuverability, this robot can be driven on rough terrains and capable of climbing up the staircases to mitigate the late-ness problems of the ambulance [6].

iii) CONTROL SECTION

The control section used to control the all function of the Ambubot. The alert message is received in the Ambubot control center, along with the message it also include the global positioning information of the victim. The Ambubot control center converts it into longitude and latitude coordinate into a street map location using GPS and GIS parser [1]. From the body attached sensors also collect the personal information regarding the victim such as blood group, photograph, height, weight, and personal contact number. The control center process the data packets and generate three command; one for dispatching the Ambubot, second for alerting the family members, and third for the hospital to requesting an emergency vehicle (ambulance). There are various ways of dispatching Ambubot to reach a destination, such as tele-control, partially autonomous and fully autonomous [6].

a. TELE-CONTROL

Tele-control is used to assists a human operator to direct the Ambubot to reach the destination using a visual display and a control pad. In general, the main function of the tele-control system is to assist the human operator to perform and accomplish the complex uncertain tasks, and less structured environments [6]. In this method, an Ambubot needs a driver who will control the robot by using a remote control device that resembles a controller panel. The control panels watches the real-time video stream from two cameras attached to the Ambubot. It helps to navigate, locate, and approach the victim. When the Ambubot approaches the victims, the human operators from the control center provide detail instruction to the people in the surrounding of the victim to operate the AED and CPR device that was attached by Ambubot [1].

b. PARTIALLY AUTONOMOUS

In this part, the flexibility and human intelligence are the key factors in controlling the robot for partially autonomous. It is due to the Ambubot is not intelligent to make the complete task, safety issue is another concern. Hence, the human operator should help the Ambubot in accommodating task procedures to the real environment. Humans surroundinthe victim play an important role in applying AED and CPR to the victim chest [6].The Ambubot control center receives the GPS information regarding to victim, the main server findout the shortest path to reach the victim and transmit the Ambubot. The Ambubot reports the current situation and displays Ambubot reports the current situation and displays the motion through two cameras attached to the robot one in front of the body and the other one on the arm. It helps the human operator; they can easily understand the movement of the robot and how to send data to the robot. The human operator is used to deliver some information to robot and the human operator not needed for controlling the robot [1].

c. FULLY AUTONOMOUS

In this mode, Ambubot can move and perform desired tasks without continuous human guidance. The main difference is on the execution of AED and CPR. In the partially autonomous, the people surrounding the victim applied the pads of AED and CPR by themselves on victim's chest. However, in this mode Ambubot executes AED by itself without continuous human guidance [1].

In the process of developing Ambubot, we focused on developing the first mode of the Ambubot when it can be used as a rescue robot for AED. This system includes the robot located in the station and the control server equipped with computer. Ambubot center service platform includes three servers that are implemented on three independent server systems; they are database server, message controller, and GIS server. To enhance the system security all the servers are located within a firewall. Database server is used for data storage and management [6].

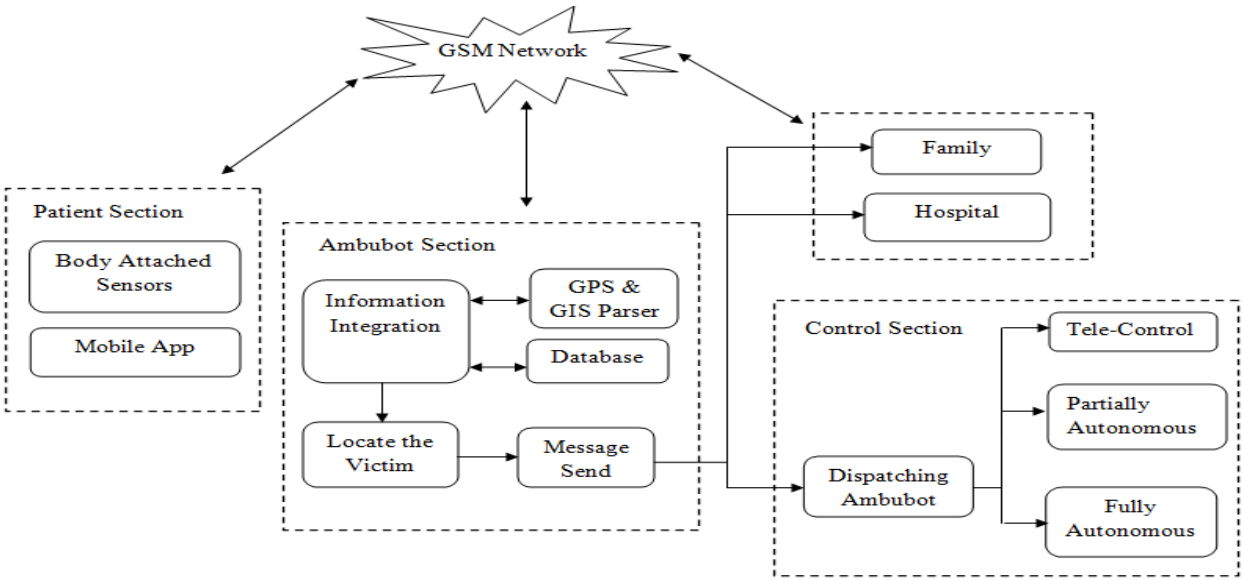

Fig 1: System Architecture

A message controller server is connected to the message server to improve the efficiency of message processing. The other server is Geographic Information Server (GIS) used to convert the GPS longitude/latitude coordinates to location information in street map contains important landmarks, allowing family members, hospital and the Ambubot to efficiently acquire geographical information concerning the patient and dispatch the Ambubot more effectively. In addition, this server is responsible for helping the Ambubot to find the shortest path to reach near the victim. Since the system is connected to the GSM network, it will allow the system to overcome the GPS problem in terms of invalid signal. The system will utilize GSM-locating service provided by a local GSM network to trace the location of victim [1].

B. Intelligent Automatic Traffic Control System

Second part is the Ambulance clearance system. In this module, there are 2 parts, first part which is ZigBee transmitter is placed at the ambulance. The transmitter contains PIC16F877A microcontroller and ZigBee module is shown in figure 2 [12]. When the switch is pressed in the emergency situation, it will transmit the signal. The signal contains unique id and security code. The microcontroller sends the commands and the data to the ZigBee module via serial communication. Second part is the receiver, which is placed at traffic junction. It also contains PIC16F877A microcontroller and ZigBee module is shown in figure 3 [12].

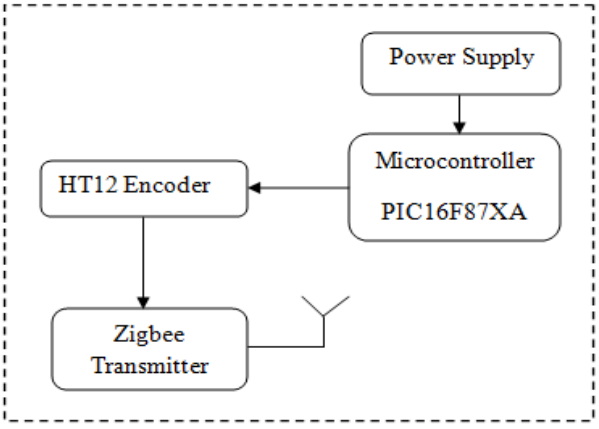

Fig 2: Block Diagram of Zigbee Transmitter

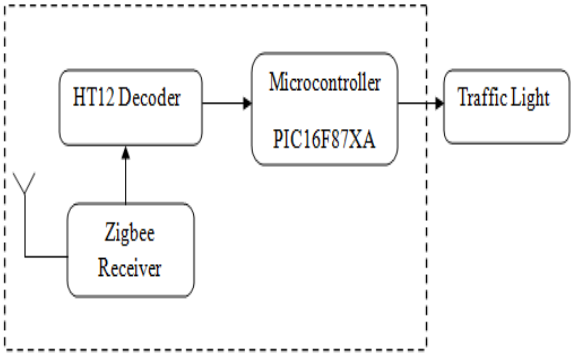

Fig 3: Block Diagram of Zigbee Receiver

ZIGBEE MODULE

Here, we uses CC2500 ZigBee module and it has transmission range of 20 meters. The CC2500 is a RF module and has transreceiver, which provides an easy way of RF communication at frequency 2.4 GHz. Every CC2500 is equipped with a microcontroller, which contains a Unique Identification Number (UIN). This UIN is based on the registration number of the vehicle. The microcontroller and CC2500 communicate via serial communication. Rx pin of CC2500 is connected to Tx of microcontroller and Tx pin of CC2500 is connected to Rx pin of microcontroller. It is used to transmit and receive the data at 9600 baud rate [5].

MICROCONTROLLER

PIC16F series has a lot of advantages as compared to other series. It executes each instruction in less than 200 nanoseconds. It has 40 pins and has 8K program memory and 368 byte data memory. It is easy to store and send UINs. At the junction, it is easy to store large number of emergency vehicles. It is easy to switch any time. It consumes less power [5].

IV. CONCLUSION

This paper uses a novel ambulance robot called Ambubot and an intelligent automatic traffic control system. The system provides the service of an ambulance with AED as well as CPR and also provides the ambulance clearance in traffic congestion. Sudden cardiac arrest occurs when the heart has stopped beating effectively due to an electrical malfunction of the heart. Early access to the AED can be a life saving measure in the event of a person suffering in cardiac arrest. Immediate treatment must be carried out in the first few minutes after a person suffering from sudden cardiac arrest. In this paper, the Ambubot is intended to improve a manual search assistance for the finding AED, so that an immediate treatment can be delivered to the cardiac arrest victims. It contains three sections namely patient section, Ambubot section and control section. In patient section, uses two techniques to make the cardiac arrest person alive either by a body attached sensor or by a smart phone. An immediate message is send to the Ambubot section. In the Ambubot section, the message is contains the GPS information and convert the GPS information into latitude, longitude and dispatching the Ambubolt to the victim.

At the control section, it control all the operation of the Ambubot. There are three methods for dispatching an Ambubot to reach location of victim by tele-control, partially autonomous, and fully autonomous. Tele-control is used to assists a human operator to direct the Ambubot to reach the destination using a visual display and a control pad. When the Ambubot approaches the victims, the human operators from the control center provide detail instruction to the people in the surrounding of the victim to operate the AED and CPR device that was attached by Ambubot. For data management, an Ambubot center service platform consisting of database server, message controller, and GIS server.

In the intelligent automatic traffic light control system, made sure that the ambulance has passed through the traffic junction without having to wait on its way to the hospital. This is done by turning the traffic signal to green. The system then turns the signal back to its previous state when the ambulance far away from the traffic signals. This proposed model provides a solution for the problems faced by ambulances due to traffic jams at junctions. The system has two parts: first is transmitter placed at the ambulance and the second part is a receiver placed at the traffic junction. If in the case of an emergency the transmitter in the ambulance transmit an emergency message to the receiver. Then it will make the traffic signal to green and the ambulance is far away from the junction the traffic signal back to its current position.

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