International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 07 | July 2021 www.irjet.net p-ISSN: 2395-0072

NOISELESSLY OPERATING VEHICLE AWARENESS(NOVA)

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Abstract - *Today noise pollution has become a major problem in India that has led to serious health threats like hearing loss or impairedness, increasing stress levels, insomnia, hypertension and many more. While Indian traffic has its own problems such as inadequate road infrastructure and congested cities, it is also the major source of noise pollution. However, researches and studies have improved the traffic situations in India over time; it has not solved issues of noise pollution that Indian traffic caused. Here, project Noiselessly Operating Vehicle Awareness (NOVA) aims to introduce a simple radio communication system that incorporates functions that aim to reduce noise pollution in traffic while providing features that aid in smooth traffic and traffic monitoring. NOVA uses simple radio communication between vehicles and transceiver nodes installed in traffic alongside existing traffic systems to implement its features. The features are noiseless horn, a communication system that replaces horn in a no horn area. Emergency vehicle awareness, a system that provide awareness of incoming emergency vehicle from far without using sound or siren. In accident data collection, system that aids in monitoring traffic by collecting information of vehicles involved in a collision. The observation made on the porotype model of NOVA shows promising result to improve traffic conditions as it is cheap to construct and install while being robust and reliable. Since project NOVA uses radio communication, it is flexible and additional features can be easily added.*

Key Words: NOVA, Noiseless horn, Ambulance awareness, Accident data collection, Mesh network radio communication.

1.INTRODUCTION

India has a well-knit and coordinated system of transport, which plays an important role in development of economic activities by promoting fair distribution of produced goods and services and movement of people. India faces large number of road safety issues like road accident, delay of emergency vehicle, sound pollution due to horn, high traffic etc.

According to official statistics 151,417 persons were killed and 469,418 injured in road traffic crashes in India in 2018 (Transport Research Wing 2019). However, this is probably an underestimate, as not all injuries are reported to the police (2009). The actual number of injuries requiring hospital visits may be 2,000,000- 3,000,000. In GBD-2010, it is estimated that there were 2.2 million injuries in India that warranted hospital admission, and 18 million injuries warranted an emergency room visit.

Although there are 18 million injuries warranted an emergency room visit, 5% of these victims gets deceased due to failing of patient transferring to hospital on time. These may be due to delay of ambulance service and traffic that cause free movement of emergency vehicle. The primary role of all ambulance services is emergency pre-hospital medical care, although they generally provide both emergency response and patient transfer on behalf of the health sector. One of the major problems faced by heavy traffic is by ambulances. However, due to heavy traffic, one can often see the ambulances stuck in traffic for long durations thus causing danger to patient's life. Traffic research has the goal to optimize traffic flow of people and goods. As the number of road users constantly increases, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future.

It has been reported that around 70% of noise pollution in the cities is caused by just pointless honking, Traffic Noise- Except for the new generations of electric cars and bikes almost all the vehicles release a high amount of noise. India is already the second most populous country in the world and many people own either a four-wheeler or a two-wheeler vehicle or both. A normal car releases around 85 dB of noise and a bike releases around 90 dB of noise. Additionally, Indians have a bad habit of honking the horn of their vehicles, which additionally causes much more noise pollution. Therefore, as a solution for the above cases NOVA (Noiseless Operating Vehicle Awareness) is introduced. There are mainly three objectives or functions for this project. To implement noiseless horn, emergency vehicle awareness and accident data collection.

2. METHODOLOGY

In this paper, the development of a simple radio communication system for traffic assistance is proposed. The system is realized in an Arduino UNO platform with NRF24L01 module for radio communication. Radio mesh network is the mode of communication. The Arduino ide software was used test and upload all the source codes. The system has 3 features- Noiseless horn, Ambulance awareness and Accident data collection.

2.1 Noiseless Horn

In noiseless horn function, when you press the horn button of the vehicle instead of activating a real horn a radio signal targeted for the address used in the source code for no horn transceiver is octal number 00 open receiving the signal. The no horn transceiver transmits the same data without any target address, thus; all the vehicles in the range of this transceiver receives the signal that a vehicle has indeed pressed the horn. The noiseless horn function is diagrammatically represented in Fig -1.

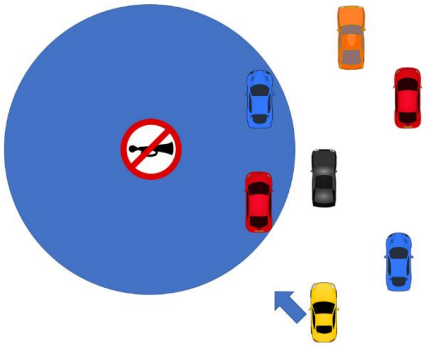

Fig -1: Noiseless horn

2.2 Ambulance Awareness

The second operation is ambulance awareness, diagrammatically represented in Fig -2. High traffic roads are extremely noisy, so the sound of the siren from an ambulance may be lost in the ambient noise. In such cases, the siren is only heard when the ambulance come closer thus making it difficult to clear a path for the ambulance. The ambulance awareness function tries to solve this issue.

The ambulance along with the siren also transmits a radio signal targeted to the master node installed at the roadsides. The address for the ambulance and master nodes is octal numbers 021 and 011 respectively. Upon receiving the signal, the master node transmits a non-targeted signal, which is received by the vehicles in its range, and thus these vehicles become aware of the arriving ambulance. The master node also communicates with an adjacent master node thus the vehicle in the range of the second master node also receives the signal. The master node can also communicate with traffic signals thus turning them green for the ambulance to pass without interference.

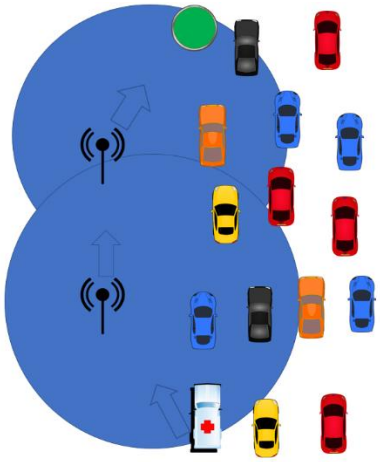

Fig -2 : Ambulance awareness

2.3 Accident Data Collection

The third function is data collection during accidents. When an accident occurs, the vibration modules installed in the vehicles involved in the collision are activated. This triggers a radio transmission from these vehicles, which is received by the master node. The same master nodes used for the ambulance awareness is used here. The received data contains the chassis number and these vehicles can be used to identify the vehicles. This data can be sent to the authorities to avoid hit and run cases. Fig -3. is the diagrammatic representation of accident data collection.

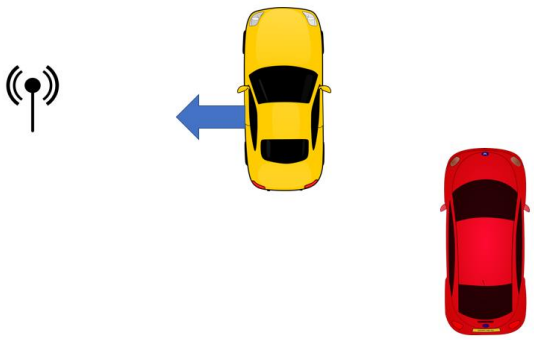

Fig -3 : Accident data collection

3. SYSTEM COMPOSITION

Project NOVA is basically composed of the following components- Arduino UNO, NRF24L01 radio communication module, vibration sensor module, LCD module with I2C pairing, push button and LED. The functions of the components are explained below.

3.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328.It has 14 digital input/output pins (of which six can be used as PWM outputs), six analog inputs 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header, and a reset button. It is used as the base of each node used in this project.

3.2 NRF24L01

NRF24L01is a Radio transceiver module. It uses the 2.4 GHz band. It can operate with baud rates from 250 kbps up to 2 Mbps. If used in open space and with lower baud rate its range can reach up to 100 meters. The module can use 125 different channels, which gives a possibility to have a network of 125 10 independently working modems in one place. Each channel can have up to six addresses, or each unit can communicate with up to six other units at the same time. It is used for all the radio communication between each nodes.

3.3 LCD with I2C

The LCD display is used to display information that otherwise would be displayed on the dash screen of a car. In short it represents the dash of a car. In order to connect LCD to a microcontroller, you would need at least 6 pins – RS, EN, D7, D6, D5, and D4 (with R/W pin permanently grounded for write operation). Which makes circuit more complex. In such situations, I2C LCD comes handy making use of only 2 pins (SDA & SCL) to talk to MCU, thereby saving at least 4 pins. LCD can be controlled by I2C using an I/O expander PCF8574, that communicates with the micro-controller by I2C.

3.4 Vibration Sensor

The vibration sensor module is used for the detection of collision. The serves the purpose of a collision detector in a vehicle. The SW-420 vibration module operates on 3.3V to the 5V. The sensor uses LM393 comparator to detect the vibration over a threshold point and provide digital data, Logic Low or Logic High, 0 or 1. During normal operation, the sensor provides Logic Low and when the vibration is detected, the sensor provides Logic High. A potentiometer is available which can be further used to 11 control the threshold point of the vibration. The connection diagram of vibration sensor module to Arduino Uno in given. Where GND and VCC are connected to Arduino GND and 5V and I/O pin to Arduino analog pin A5.

4. CIRCUIT DIAGRAMS

Circuit diagrams for all the nodes used in the Radio mesh network to demonstrate the functions of project NOVA are as follows. The pin connections used here are determined according to the pins defined in the source code.

4.1 No Horn Transceiver Node

The no horn transceiver acts as the hub that makes communication between vehicles possible in a no sound horn area. The function of the No horn transceiver is to listen for incoming data and transmit the received data such that the vehicles in the range of its transmission receives it. The circuit requires an Arduino UNO board and an NRF24L01 module. The circuit diagram is represented in Fig -4.

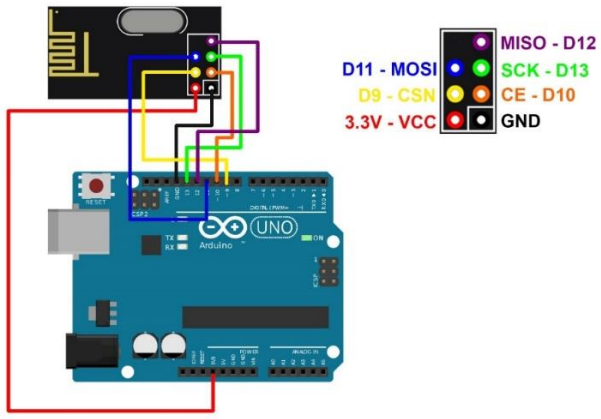

Fig -4 : No horn transceiver

4.2 Master Transceiver Node

There are two functions for the master transceiver. They are; to provide awareness of incoming emergency vehicles and to collect data during accidents. Similar to no horn transceiver, the function of the master transceiver is to listen for incoming data and transmit it. But unlike the no horn transceiver, the master transceiver only listens to data from emergency vehicles and vehicles involved in a collision. The circuit for the master transceiver requires an Arduino UNO, a NRF24L01, LCD panel with I2C to display the received collision data and a LED indicator that represents traffic lights as represented in Fig -5.

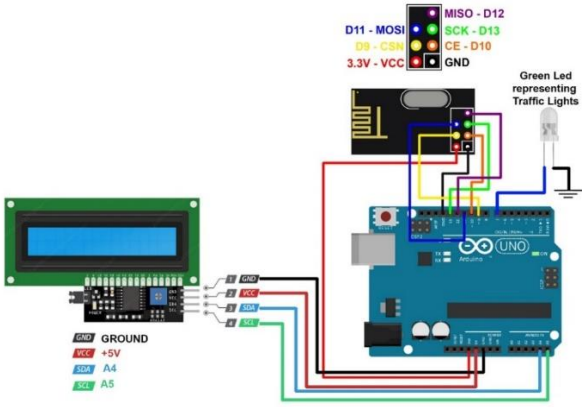

Fig -5 : Master Transceiver

4.3 Ambulance Node

Ambulance node, as the name suggests represents an ambulance. It is used to simulate the scenario when an ambulance is approaching a high traffic area. The circuit for an ambulance node requires an Arduino UNO, a NRF24L01 module and a switch that is used simulate turning on and of the siren as shown in Fig -6.

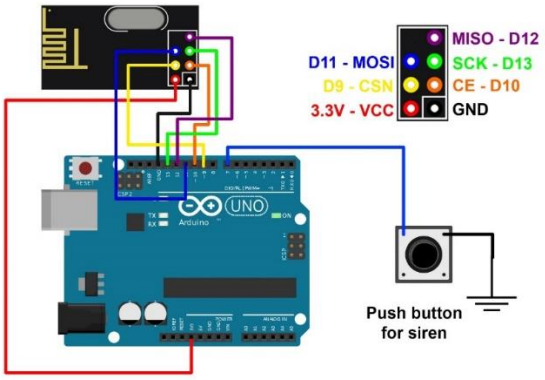

Fig -6 : Ambulance node

4.4 Vehicle Node

The vehicle nodes represent the general civilian traffic. The circuit used requires an Arduino UNO, NRF24L01, LED indicator, LCD panel with I2C to display information, push button and a vibration sensor. The circuit diagram is show in Fig -7.

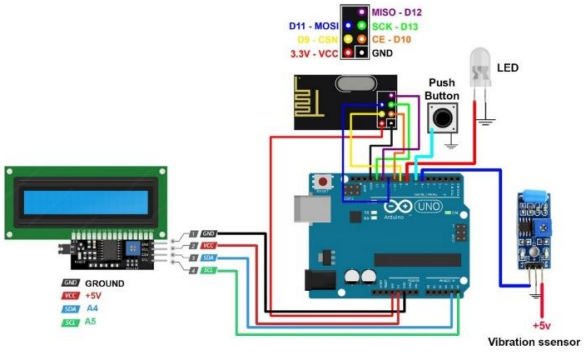

Fig -7 : Vehicle node

5. SOFTWARE IMPLEMENTATION

Project NOVA relies on radio mesh network communication for implementing its features. For radio communications, NRF24L01 transceiver module is used in an Arduino UNO platform. The prototype contains four nodes namely, no horn transceiver, master transceiver, vehicle and ambulance node. Since the prototype is realized in Arduino platform, the Arduino IDE software is used to develop and upload the source code.

5.1 Common Code Lines

Each node in the network requires separate source code, which are different from each other in terms of function, but shares a few common lines of codes.

```
#include<RF24.h>
#include<RF24Network.h>
#include<SPI.h>
#include<Wire.h>
#include<LiquidCrystal_I2C.h>
```

The line of codes mentioned above are required including the libraries SPI.h library handles the SPI communication while RF24.h and RF24Network controls the NRF24L01 module and its network connections. The LiquidCrystal_I2C.h library is the one that controls the 16*2 LCD panel spliced with I2C module.

```
LiquidCrystal_I2C lcd(0X3F,16,2)
RF24radio(10,9);//CE,CSN
RF24Network(radio);
const uint 16_t this node=011;
```

The line of codes given above are used to define the LCD and NRF24L01 modules. The code “RF24radio(10,9);” names the NRF as radio and uses digital pins 10 and 9 as CE and CSN pins of the NRF modules respectively.”RF24Network (radio);” is used to assign the mode of communication as network type which enables to and forth communication

between the nodes."CONST uint 16_t this node=011" is used to assign the address of the node as an octal digit.

```
int button=7;
int led=8;
int vid=6;
```

The lines above is used to initialize the LCD and radio network communication. The line "network.begin (90, this_node);" initialize the network communication through channel 90 along with assigning the address of the node using the octal digits defined previously.

```
pinMode(button, INPUT- PULLUP);
pin Mode (led, OUTPUT);
pin Mode (Vib, INPUT);
```

The section of the source code above defines the mode of the assigned digital pins of the Arduino.

```
lcd.init(); initialize LCD
lcd. backlight():
SPI begin();
network. begin (90, this _node); //(channel, node address) //
```

The lines above is used to initialize the LCD and radio network communication. The line "network. begin (90, this_node)" initialize the network communication through channel 90 along. With assigning the address of the node, using the octal digits defined as previously.

5.2 Working of Noiseless Horn

The working of noiseless horn operation is based on the interaction between the vehicles nodes and no horn transceiver node. At least two or more vehicle nodes are to be used for the demonstration.

```
While(digitalRead(button)==low)
        {
        const char sent[10]="V1 horn";
        RF24NetworkHeader header1(nohorn);
        network.write(header1, &sent, size od(sent));
        delay(500);}
```

The codes given above are a portion of the loop section of vehicle 01 source code, which is concerned with sending data to no horn transceiver. A while loop is opened when the digital pin assigned the button is pushed low. This is because the button is assigned as an INPUT_PULLUP type pin mode where the digital state becomes low when the button is pushed. Inside the loop, a character array is defined as "V1 horn" and can be changed according to the vehicle number used. The "network.write(header1, &sent, size of(sent));" sent the data targeted to the no horn transceiver. According to this while loop, as long as the button is pressed the data is continuously sent towards the no horn transceiver. The line "RF24Network header1(no horn);" assigns the target address as the no horn transceiver address.

```
network update();

While(network.available())
        {
        RF24NetworkHeader header;
        const char incomingData[10];
        network.read(header, &incomingData, size of
        (incomingData));
        RF24NetworkHeader header1;
        network.write(header1, &incomgData, size of
        (incomingData));
        }
```

The code given above is the section of source code of no horn transceiver node, which governs the receiving and transmitting function of the nohorn transceiver. The "network update();" continuously checks for incoming data. A while loop is opened when an incoming signal is detected. The incoming data is then stored in a character named incomingData. This received data is then transmitted as a non-targeted signal using the lines "RF24NetworkHeader header1" and network.write(header1, &incomingData size of (incomingData);".

```
While(network.available())
{
RF24NetworkHeader header;
const char incomingData[10];
network.read( header, &incomingData, size of
(incomigData));
        if (header from node==0)
        {
        lcd.setcursor(4,0);
        lcd.print(incomingData);
        digitalwrite(led,high);}}
```

The portion of code above is the receiving section of vehicle node that controls the noiseless horn function. A while loop is opened when an incoming signal is detected. The received data is stored in a character array. Moreover, an if loop is opened the data is received from the no horn transceiver address which is octal digit "00" whose decimal counterpart is "0". The incoming Data is printed in the LCD and a led is programmed to light up at the same time.

5.3 Working of Ambulance Awareness

The vehicle node, ambulance node and master transceiver are involved in the working of ambulance awareness operation. The sequence starts when the button as ambulance is pressed.

```
while(digitalRead(button)==LOW)
        {
```

```
const char sent[10]="Ambulance";
Rf24NetworkHeader header1(master);
network.write(header1, &sent, size of (sent));
delay(500);
}
```

The lines of code above are the section of the ambulance node source code that sends the data from ambulance. A while loop is opened when the button on ambulance is pulled LOW. A character array "Ambulance" is then programmed to be send towards the master transceiver node.

```
while(network.available()
{
RF24NetworkHeader header;
const char incomingData[10];
network.read(header, &incomingData, size of (incomingData));
        if(header from node==17)
        {
        digital write(led,HIGH);
        RF24NetworkHeader header1;
        network.write(header1, &incomingData, size of (incomingData));
        delay(500);
        digital write(led,LOW);
        }
}
```

The line of codes above deals with receiving and transmission part of the master transceiver. The receiver data is stored in character named incomingData. An if loop is opened to check if the decimal counterpart of the address of ambulance which translates to octal digits 021. If the check is satisfied, the received data is transmitted without any target address.

```
if(header from node==9)
        {
        lcd.setcursor(0,0);
        lcd.print(incomingData);
        lcd.setcursor(0,3);
        lcd.print("arriving");
        }
```

The if loop shown above is the receiving part of the vehicle. The if loop checks whether the header of received data is from address of which is the decimal counterpart of the address of master transceiver which is an octal digit 011. If the loop is satisfied then "ambulance arriving" signal is displayed in the LCD screen of the vehicles which received the data.

5.4 Working of Accident Data Collection

The working of accident data collection involves the vehicle involved in the collision and the master transceiver node.

```
While (digitalread(vib)==high)
        {
        const char sent[10] = "V1";
        Rf25NetworkHeader HEADER1(MASTER);
        network.write(header1,&sent,size off (sent));
        delay(500);
        }
```

When the vehicle is involved in a collision, the vibration module is turned high. A while loop is opened when the digital pin connected to vibration sensor module is turned high. In the loop, codes are provided to send a data targeted towards the master transceiver node. The data sent is character array "V1" which can be perfectly chassis number of the vehicle. The data received on the master transceiver can be then stored in a collective hub, which can be sent to authorities and the vehicle owner. For simplicity, the data is just on the LCD for demonstration.

6. RESULTS

As mentioned, Noiselessly Operating Vehicle Awareness (NOVA) a has three functions, noiseless horn, ambulance awareness and accident data collection. The accident data collection function was simulated individually in proteus software using serial communication instead of radio communication as the simulation model for NRFL01 module was not available for proteus. For the accident data collection simulation three Arduino UNO was inter-connected serially by defining additional pins as serial TX and Rx pins using software serial library. Out of the three Arduino boards, one represented the master node which has an LCD display attached to it for displaying information. The other two Arduino was spliced with vibration sensor module which represented vehicle nodes. The vibration module was activated to simulate an accident using logic state switch. The other two functions; noiseless horn and ambulance arrival required more nodes and the source code was much complicated due to witch the simulation could not be done on real time and output was not obtained. Due to these limitations of proteus software, the other two functions could not be simulated. Simulation results of accident data collection are given below in Fig -8.

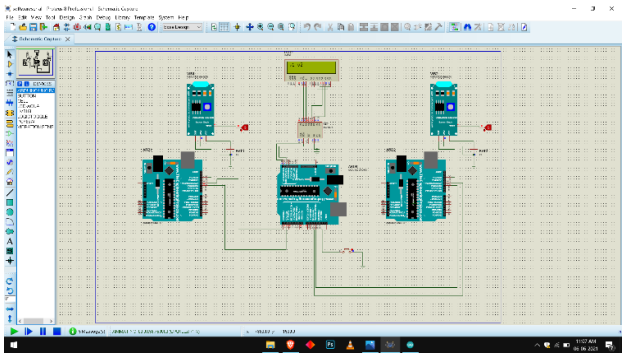

Fig -8 : Simulation model for accident data collection

All the simulated source codes were converted to hardware source codes by adding the libraries and codes for NRF24L01 which governs the radio communication. Each function of the project (noiseless horn, ambulance awareness and accident data collection) was individually tested and rectified using trial and error method. Then all the working source code were compiled to provide a seamless ecosystem of radio communication between all the nodes.

For the working of Noiseless, horn a no horn transceiver node and two vehicle nodes were used. While the no horn transceiver node was on, both vehicles received a horn signal when the horn button was pressed on either of the vehicle as shown in Fig -9 (a) and (b). When vehicle2's horn button was pressed, data is transmitted and is received by the no horn transceiver. The no horn transceiver retransmits the signal such that vehicle1 receive the signal. The same function will work when the horn button of vehicle1 is pressed, thus vehicle2 will display vehicle1 horn signal. The same source code of the vehicle nodes can be used to add any number of vehicle nodes with minor adjustments to the source codes.

Fig -9 : (a) No horn transceiver and (b) vehicle1 node displaying vehicle2 horn signal

For the working of ambulance awareness, an ambulance node, two vehicle nodes and master transceiver node were used. Both vehicle nodes display an ambulance arriving signal when the button on ambulance node were pushed as shown in Fig -10 (a) and (b). The ambulance node represents basically any emergency vehicle. More ambulance nodes can be added to the network by using the same source code with minor adjustments like assigning a new address to the node. The button on the ambulance node represents the siren switch. When the button is pressed a radio signal is transmitted towards the master transceiver node which re-transmits this signal thus all the vehicle nodes displays the information.

Fig -10 : (a)Ambulance node and (b) vehicle nodes showing ambulance arriving signal

The working of accident data collection required the master node and two vehicle nodes. An accident was simulated by colliding the two-vehicle node together. The master transceiver node successfully received and displayed the data when collision occurred as shown in Fig -11. The same master node for ambulance awareness function is used here. Additionally, any number of master transceiver nodes can be added by using the same source code of the master transceiver without any modifications.

Fig -11 : Accident data collection in master transceiver

7. CONCLUSIONS

Noise pollution is a serious threat. In India, the major source of Noise pollution is congested traffic. Project NOVA tries to reduce noise pollution from traffic while also providing traffic assisting and monitoring features. The functions included in the project are Noiseless horn, Ambulance awareness and Accident data collection. Simulation of the functions were tested in Proteus software. Hardware prototype was constructed using an NRF24L01 radio communication module in Arduino platform. The system uses simple radio mesh network communications for its operation. Since project NOVA is based on radio communication, it is flexible, robust and reliable and thus adding new features is easy. During accident data collection,

a GSM module shield can be used along with the master transceiver node to send the accident data to the authorities or to the ambulance service to provide immediate assistance. Similar to the operation of no horn function, radio signals can be sent for overtake permission, turning indication and U turn permission. Additionally, traffic signals can be modified to transmit radio signals while changing lights that can be received and displayed on vehicle dashboard to avoid accidental signal violation or to help handicapped drivers. India spends a sizable sum yearly on traffic maintenance and clearing traffic congestions. The present monitoring system uses CCTV cameras for traffic monitoring which are expensive equipment. Project NOVA offers a cheap and reliable alternative to these conventional methods. If proper equipment and resources are used, the production cost of these node can be further reduced and once implemented with the correct strategies, project NOVA could one day save lives.

ACKNOWLEDGEMENT

The authors would like to acknowledge the Department of Electrical and electronics engineering, Adi Shankara Institute of Engineering and Technology, Kalady, Kerala, India for their support and guidance throughout this work.

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