Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 7, July, 2021 :13932 - 13944

Research Article

Smart Car with IoT enabled Remote Driving Assistance

E. Seethalakshmi[a], S. Surya[b], G. Jeyalakshmi[c], B. Hemalatha[d], S. Vinoth Kumar[e], K. Praveen[f]

[a] Department of ECE, R.M.K. Engineering College, Kavaraipettai, Chennai, Tamilnadu
[b] Department of ECE, Sri Sairam Engineering College, Tambaram, Chennai, Tamilnadu
[c,d] Department of ECE, Bharath Institute of Higher Education and Research, Chennai, Tamilnadu
[e] Senior Test Engineer, Tecnotree Convergence Private Limited, Bangalore
[f] Department of ECE, Chennai Institute Of Technology, Chennai , Tamilnadu

Abstract

The main aim of this work is to make use of Internet of Thing Technology and eases the task of the driver who drives the car especially when drives for the long distance, the idea is to transfer the control of the running vehicle to some remote drive assistance base station and the driver at the base station drives the car whose control had been transferred to the base station. The driver at the remote base station can do all the things that the driver inside the car can do. All the controls sent from the base station are converted at applied at the car and the intended action is performed, Visual information from the car is sent to the base station through the camera installed at the front and rear side of the car. Which gives the wide angle coverage, Sensors, Processing unit, actuator and IoT gate constitute the entire system, the major challenge is the latency since all the information sent are critical signals, they must reach the destination with in due time.

Keywords: *Internet of things, Remote assistance driving, automated vehicle, IoT gateway, Sensors*

Introduction

A car capable of sensing the environment automatically and moves without any disruption is called autonomous vehicle or driver less car[1], Different range of sensors are used in driverless cars to perceive different parameters, Normally they are incorporated with the assistive devices for navigation[5] and obstacle finding, even though several projects are going on to develop a fully self-driving cars[2], Numerous challenges are there to implement the same. Experiments began at 1920 s trial at 1950 s first semi-automated car developed at 1977.

Safety features like lane control, speed control, and drowsiness detection are there in the modern vehicles , but all of them need human intervention at least up to some extent[1], Even though the system is automatic in some of the newer technology driver need to involve in the driving task ,There is a difference between the term "automated vehicle" and “fully automated vehicle[2], the earlier moves with the data from the sensor automatically[5] and also human intervention is needed then and there , the later one is fully automatic with no human intervention[1] , the earlier is little more reliable and safer than the later, because in case of system failure the human intervention may stop the devastation.

The advent of Internet of Things Technology in automotive industry has made a very big revolution, Through IoT the dash board of the car is available at the car’s owner mobile that increases the security, and safety and makes the life easier, Sensors deployed in the car helps the owner to track them easily[5], No one can enter the car forcefully , IoT technology gives full protection to the car[1] , Provisions are available inside the car that protects and alert in case of emergency[2], Various third party applications are available that can connect the car to any devices and control.

Internet of Things along with other novel technologies revolutionize the complete automotive industry. Maintenance of car has become easier with the help of this technologies[2], with the help of the sensors deployed in the car the problems with in the car are detected earlier and most of the damages are avoided in advanced. Wi-Fi capabilities by 4G LTE powered the telematics[1][10] in IoT based automotive systems, through this long distance transmission of digital data is possible, and also helps the owner to track the vehicle easily

Remote Driving assistance is an automated driving technology where human driver intervention is mandatory but reduces the task of the driver in the car, with the advancement in the communication technology[5][8] , Car can be driven automatically from the remote location, the communication is bidirectional and fully duplex. It eases the work of the driver in the car[2][9] , some other driver drives the car for the person inside the car, the methods , architecture and challenges in this work is articulated in the following session.

Proposed System

The block diagram depicts the overview of the Remote Assistant Driver, It has the Remote driver Assistance station, IoT Cloud, Vehicle unit. The functionality of each block is elaborated in this chapter

(i) Vehicle Unit with ECU and IoT Incorporated

Vehicle unit is incorporated with sensors, actuators and IoT module powered with at least 4G LTE Telematics, with the help of this, data and signals can be sent to the long distances, The function of each block of vehicle unit is elaborated in this section.

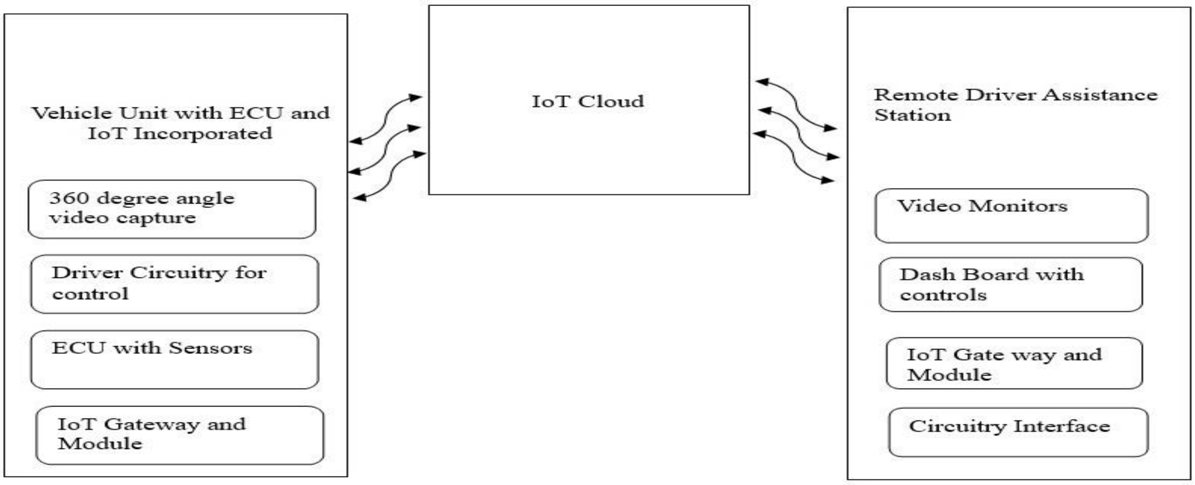


Fig 1 Overview of the Remote Assistant Driver

a) Video Capturing unit

The cameras which are placed at the front and rear side of the vehicle gives almost 360 degree view for the remote driver, the captured video must be compressed[3][5] and sent to the cloud immediately with zero latency , camera has the inbuilt capability to remove the redundant data for fast transmission and effective utilization of bandwidth[9].

b) Driver Circuitry for control

The command sent from the base station will be interpreted and the corresponding will be taken at the car in order to accomplish the intended task [3][8], the command received will be processed and activate the required drive signal like PWM, Serial, Parallel Signals etc.

c) ECU with sensors

ECU used here is the microcontroller with sufficient capability to handle all the sensors and actuators connected to it , moreover it is connected to the IoT gateway which has the network capability[1], All the signal received will be interpreted and direct the necessary module take the required actions to accomplish the task like accelerate , brake , honk etc.

d) IoT Gateway and Module

It is the gate way through which the commands and data are sent to the IoT cloud, normally the processor with computational capability and handling the raw data from various sensors is attached with the IOT gateway which has network capability[3][5], the processed commands and data are directed to the Internet through this device

(ii) Remote Driver Assistance Base Station

In remote control base unit the driver is seated and drives the car virtually, the following parts are there in the remote assistant unit, It is the centre in which the control room receives the request from the driver who drives the car to take control of his car after successful authentication[7][8] and connectivity becomes success the entire control of the car is taken and the assigned remote drivers would drive the car virtually form the remote station

a) Video Monitor

The purpose of the monitor is to view the visibility area all the angle, cameras are arranged in such a way at the vehicle to cover all the areas. Almost 360 degree view is available to the remote driver and the visualizing unit is arranged in such a way that the driver gets the feel that he is inside the car. Normally all that can be seen by the driver in the car can be seen by the remote driver too.

b) Dash board with controls

Several controls like steering , acceleration, brake , honking head lights , wiper are available at the dash board, as soon as the command is sent the same will be reflected in the centralized iot server[3][5], all the data are sent in the form of http request to the server

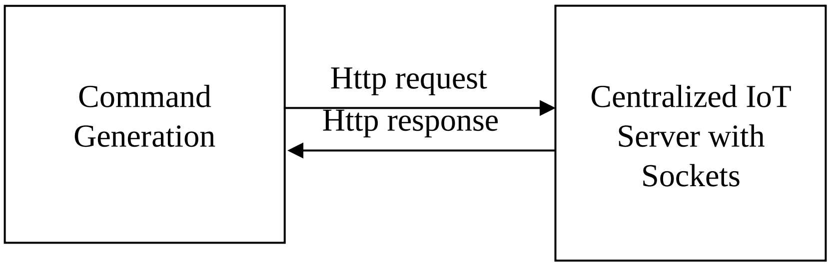


Fig 2. Exchange of commands between cloud and Dash board

The commands are wrapped in the http response and reached the server, and the server in return gives the response and acknowledge the transmitter that the request has reached the server

c) IoT Gate way and module

It is the gate way through which the commands and data are sent to the IoT cloud[8][10], normally the processor with computational capability and handling the raw data from various sensors is attached with the IOT gateway which has network capability, the processed commands and data are directed to the Internet through this device.

d) Circuitry

Circuitry are there at the remote assistant station to generate the command signals like movement of vehicle[3] , direction of movement , additional controls like honking, head light control , wiper etc. the commands received from the IoT module at the vehicle must be fed to the driver circuitry to drive the corresponding driving unit[9] . The circuitry at the car unit is responsible for this task.

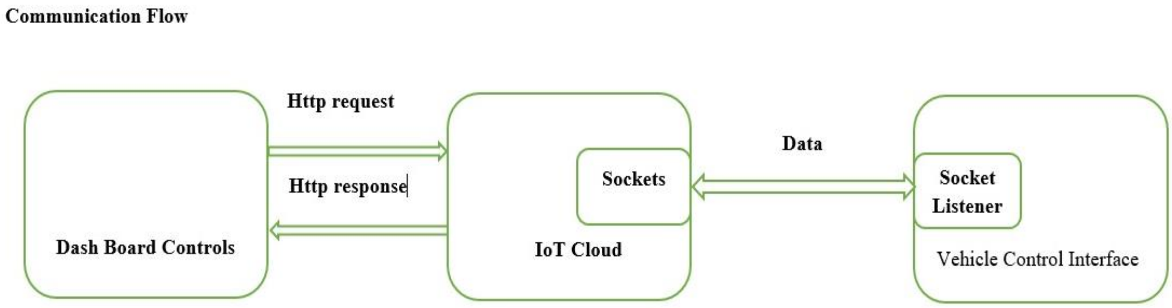


Fig 3. End to end Communication flow diagram

All the commands are generated at the dash board of the base station, The generated commands are wrapped in the http request and send to the IoT cloud upon receiving the request the cloud send back the response to the dashboard and at the same time the way of communication is different at the vehicle end , there is a socket listener at the vehicle end that would listen to the cloud ‘s socket at all the time if there is any commands seen that would be grabbed immediately and sent to the controller which in turn take the action for the command received.

Socket Programming is much faster compare to request response method, Since at the dashboard the command are sent instantly to the cloud by using the http request, but at the vehicle end if the controller reads the command every time by sending the request it will take much time and latency would increase that is not at all desirable at the receiving end[10], the use of socket listener increases the speed and all the actions are taken immediately with no latency[1]

Flow of Data in the Vehicle

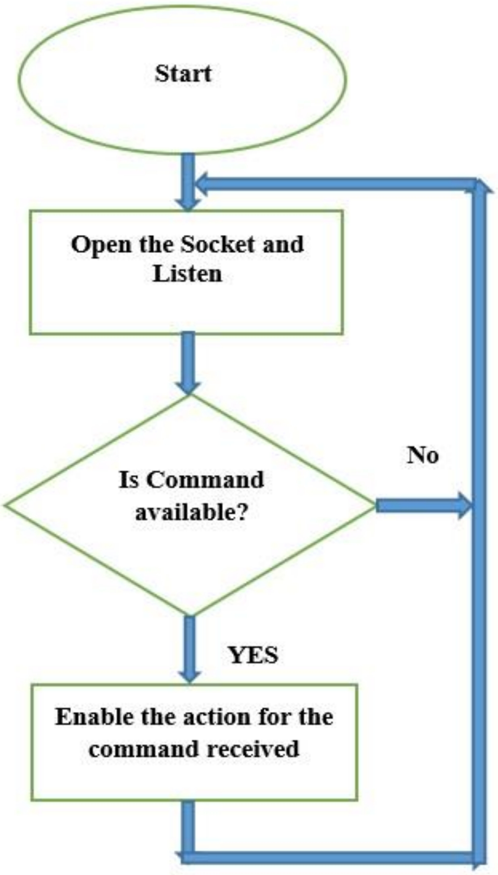


Fig 4. Flow of Data in vehicle Unit

Algorithm

Step1: Open the Network socket and listen to the data availability from the IoT Cloud
Step2: If command is received interpret it and send to the control circuitry
Step 3: Enable the action required for the command received
Step 4: Activate the corresponding mechanism until further changes in the command
Step 5: Repeat from step 1

Flow of data in the Remote Station

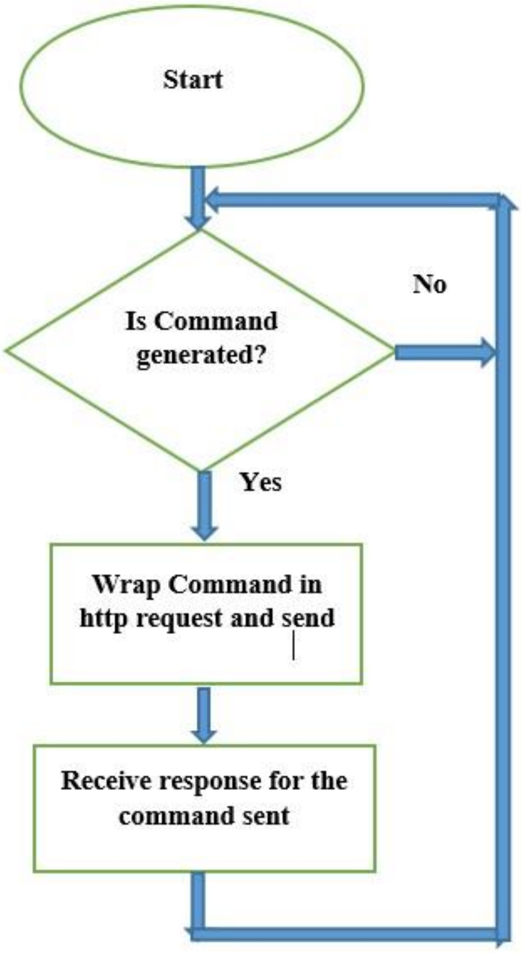


Fig 5 . Flow of Data in Base Station

Algorithm

Step 1: Inspect the video continuously with less latency
Step 2: Generate the commands by varying the corresponding Parametric Control knob
Step 3: Wrap the commands with the http request and send to the server with specific address
Step 4: Receive the response for the command sent and ensure the delivery of the command
Step 5: Do Step 1 to 4 repeatedly

Circuit Diagram Remote Station

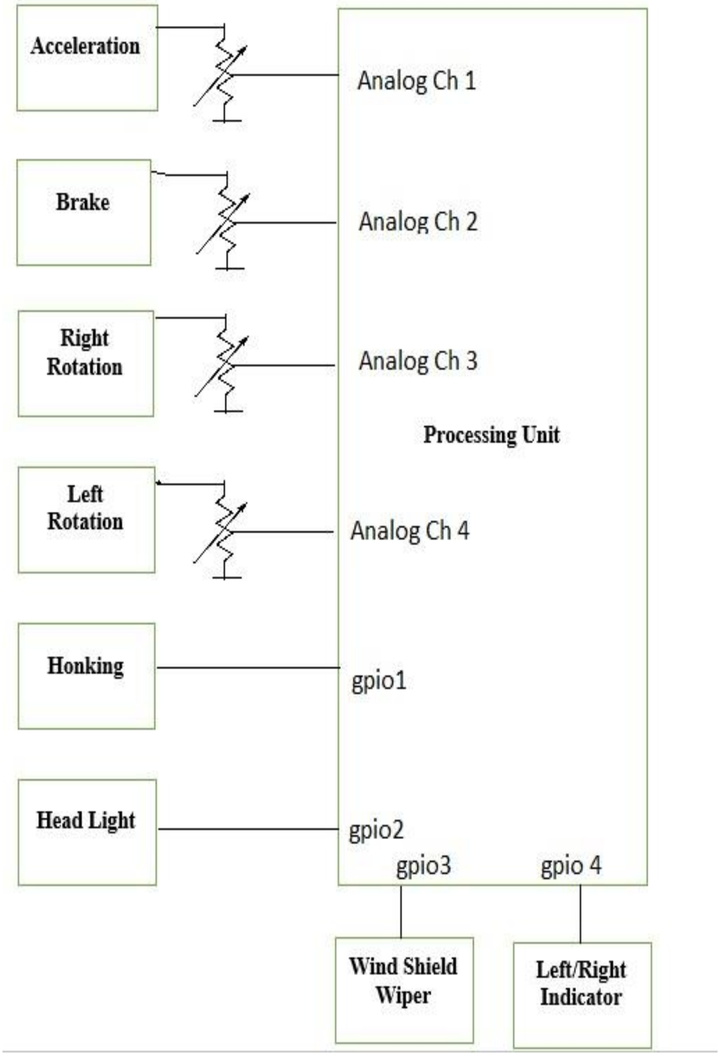


Fig 5 . Circuit Abstract – Base Station

The control inputs to the vehicle is generated at the base station dashboard and sent to the vehicle unit through the cloud, most of the commands are analogue in the form that must be converted it to digital before sending them to the cloud, A type of parametric conversion is done at this stage, the acceleration ranges from minimum to maximum in between that instantaneous values exist. The number of instantaneous values depends upon the resolution of the ADC, in this case it is 10 bits that gives 2^8 = 256 different samples means the value 0 represents no acceleration and 255 represent maximum acceleration, the acceleration in the form of voltage is fed to the analog channel of the controller[3] , where it is converted it to digital data for further processing[8] , Brake is also the same it does have the instantaneous values similar to the acceleration , brake value in the form of analog voltage is fed to one of the analog channel of the controller. Which in turns converts that to digital data and send to the cloud for further processing[7].

For turning the vehicle to right and left tilt sensors are placed at the steering wheel setup , the angle in which the steering wheel rotated towards left or right is mapped to the analog voltage, the overall angle range is from 0 to 70 degree , depending on the angle voltage is generated. Since 10 bits ADC is used the value corresponding to 0 degree tilt is 0 and for the maximum 70 degree is 255. The same is fed to the analog channels of the controller and then sent to the cloud[3][9]. Honking, headlights, windshield wiper and Left/Right Indicators are directly controlled by the switches connected at the dashboard, they are directly connected to the digital IO pins of the controller.

Circuit Details Vehicle Unit

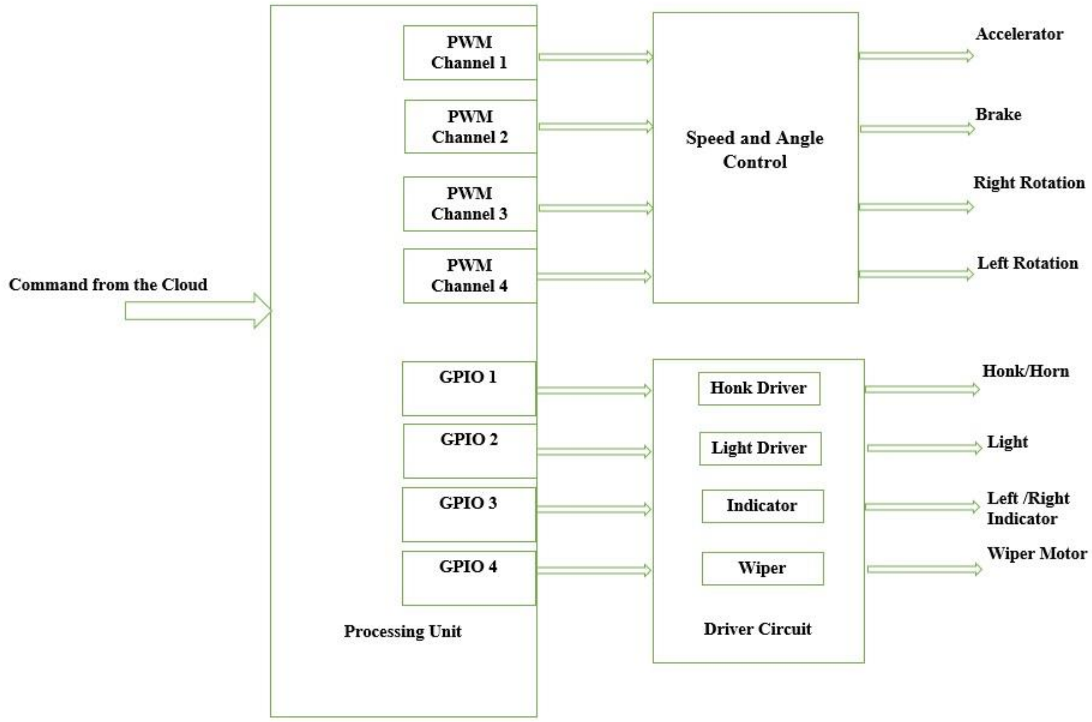


Fig 6 Circuit Abstraction Vehicle Unit

Once the cloud received the data from the dashboard they are directed to the vehicle unit through socket connections, For Speed and angle control PWM signals are needed, by varying the duty cycle of the pulse the speed of the vehicle and the angle of rotation can be controlled, Depending on the PWM duty cycle the acceleration[3] to the vehicle varies , PWM duty cycles varies from 0 to 100 % when it is 0 the minimum or no acceleration applied and when it is 100 % then it refers to maximum speed , the

same mapping for rotation also. when the PWM cycle for angle control is 0 then the angle tilt in the steering is none , for 100 % it is 70 degree either on the right or left side rotation. All other commands are digital and the corresponding relays get triggered when the signals received from the cloud.

Computational Algorithm With Results:

Measuring Parameters and values

The important control parameters and their mapping and the type of signals are specified in the following table.

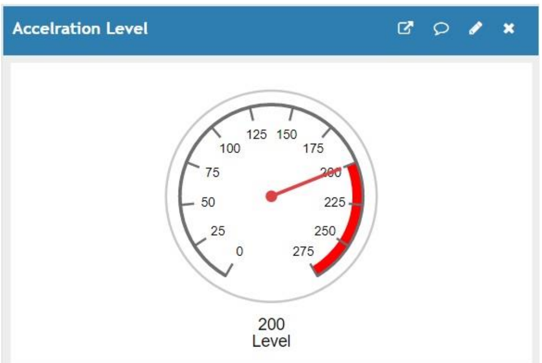
	Range	**Mapping**	**Nature of the Signal**

Acceleration	0-255	0-Min ,255- Max	Analogue
Brake	0-255	0-Min ,255- Max	Analogue
Right Turn	0-255	(0-0 deg),(255-70 deg)	Analogue
Left Turn	0-255	(0-0 deg),(255-70 deg)	Analogue
Honking	0/1	0-OFF , 1- ON	Digital
Head Light	0/1	0-OFF , 1- ON	Digital
Windshield Wiper	0/1	0-OFF , 1- ON	Digital
Left /Right Indication	0/1	0-OFF , 1- ON	Digital

Table 1 Data types of the Control Parameters

Step1: Initialize the sensors and ports
Step2: Measure the quantity of the content in all the racks
Step3: if(weight[i]<thrsheold[i])
{
Send Notification to the Users for the ith item;
Update the content value in the cloud;
}
else
{
Update the content value in the cloud for all the indexed items;
}
Step 4: if(quality [i] > quality threshold[i])
{
Send Notification to the Users for the ith item;
Update the quality value in the cloud;
}
else
{
Update the Quality value in the cloud for all the indexed items ;
}
}

Result s



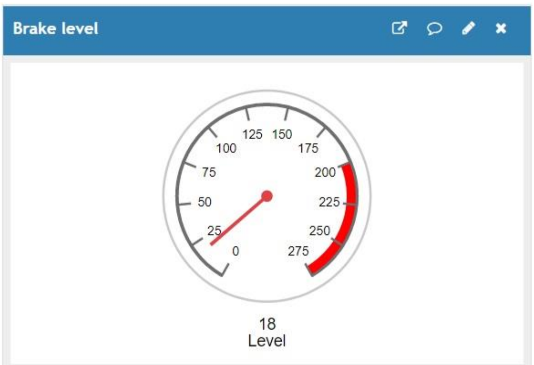
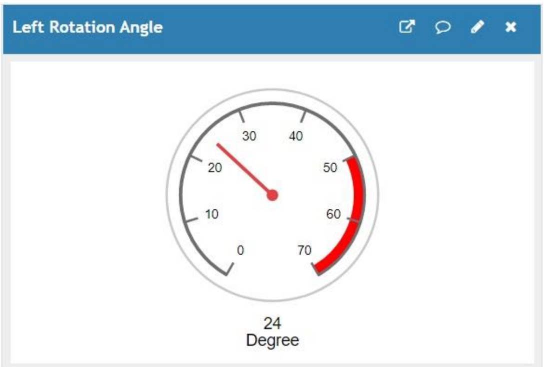


Fig.7 Acceleration Level **Fig.8 Brake Level**

The Level at which the accelartion and brakes are applied can be seen in the dashboard like the one above it has 255 instantaneous values.



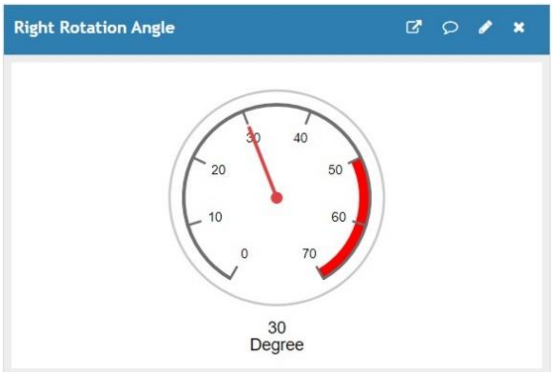


Fig.9 Left Rotation angle **Fig.10 Right Rotation angle**

The angle in which the steering is steered towards the left and right side are depicted here , It is availbe for the user to see at the IoT dashboard.

Fig.11. Honk Indicator **Fig.12. Head Light Indicator**

Fig.13 Wiper Indicator **Fig.14 Turn Indicator**

Above are the snap shots of the dashboard of IoT platform which depicts the status of Honking, Headlight, wiper and Turn Indicator whenever the event happens the corresponding light glows telling the user that the particular event is happening right now.

Conclusion And Future Work

Automation of vehicle especially with IoT has made a great revolution in the automobile industry and also in the autonomous vehicle, though the vehicle has not fully automated in this work the benefits of semi automation is fully reaped, with the advancement in the communication technology like wifi and 4g, the data transaction between the vehicle and the base station is done very fast. Since this work involves the transmission of video information, Usage of 5g enhances the work better, data redundancy reduction in while transmitting the video reduces the bandwidth, improves the bandwidth utilization and reduces the overall latency which is the critical parameter in this work.

References

[1] Laura-Bianca Bilius, Radu-Daniel Vatavu. (2021) A multistudy investigation of drivers and passengers' gesture and voice input preferences for in-vehicle interactions. *Journal of Intelligent Transportation Systems* 25:2, pages 197-220.

[2] Eric Petersen, Matthias Sweet. (2021) Navigating a fad or the future? Opportunities and limitations in integrating carshare membership and automated vehicle propensity in travel demand forecasting. *Transportation Planning and Technology* 44:3, pages 223-245.

[3] Zhao, D. and Peng, H., "From the Lab to the Street: Solving the Challenge of Accelerating Automated Vehicle Testing", <i>arXiv e-prints</i>, 2017.

[4] Data Redundancy Reduction in IoT Weather Station , Praveen K , Rajalakshmi K, M.Malathi ,Dhanagopal R International Journal of Control and Automation Vol. 13, No. 2, (2020), pp. 534 – 545

[5] Dr.Janarthanan1 , Dr.Suresh Kumar V , Praveen K ,Ramesh R Automatic Electronic Secure Payment in Toll Plaza Using NFC Technology Automatic Electronic Secure Payment in Toll Plaza Using NFC Technology

[6] Praveen K, Malathi M, Rajalakshimi , Abirami S , Nirupama B , Priyadharshini S An Efficient Data reduction Technique in IoT Health Care System International Journal of Future Generation Communication and Networking Vol. 13, No. 1, (2020), pp. 1307-1319

[7] Malathi.M,Rathika kannan,Praveen,Thandapani T, An Efficient Steganography for Data Hiding Using DWT and IWT International Journal of Grid and Distributed Computing Vol. 13, No. 1, (2020), pp. 524-531

[8] F. Ekman, M. Johansson and J. Sochor, "Creating Appropriate Trust in Automated Vehicle Systems: A Framework for HMI Design," in *IEEE Transactions on Human-Machine Systems*, vol. 48, no. 1, pp. 95-101, Feb. 2018, doi: 10.1109/THMS.2017.2776209.

[9] Baiba Pudāne, Eric J.E. Molin, Theo A. Arentze, Yousef Maknoon, Caspar G. Chorus, A Time-use Model for the Automated Vehicle-era, Transportation Research Part C: Emerging Technologies, Volume 93, 2018, Pages 102-114, ISSN 0968-090X, https://doi.org/10.1016/j.trc.2018.05.022. (https://www.sciencedirect.com/science/article/pii/S0968090X18307277)

[10] Adu-Gyamfi YO, Asare SK, Sharma A, Titus T. Automated Vehicle Recognition with Deep Convolutional Neural Networks. Transportation Research Record. 2017;2645(1):113-122. doi:10.3141/2645-13