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Watch Your Driving: A Driver Health Monitoring System Using Raspberry Pi

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ABSTRACT: *Road accidents continues to be a major issue in India and it ranks first in the number of road accidents deaths across 199 countries. It is important to monitor the driver health condition before driving. We propose a model that can monitor the driver health condition based on intelligent monitoring, analysis and predict whether the driver is fit to dive or not using accurate decision-making algorithms and based on the prediction the Car Ignition system is locked or unlocked. "Watch Your Driving: A Driver Health Monitoring System" is designed to continuously track and monitor driver's vital health parameters such as (BLOOD PRESSURE, BODY TEMPERATURE, SLEEP ACTIVITY, HEART BEAT AND ALCOHOL LEVEL).This system can monitor the state or condition of the driver which is the major reason for road accidents. In this system the analysis of vital health parameters is done before driving so that this information is used to alert the centralized controller installed inside the vehicle that controls the car ignition system. This project aims at reducing the reckless driving situations which leads to major accidents and to develop a reliable and cost-efficient system to avoid accidents and to safeguard human life.*

KEYWORDS: *Internet of Things; Centralized system; Decision tree algorithm; health monitoring; Alcohol detection*

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I. INTRODUCTION

As per the accident reports, a total of 4,49,002 accidents took place in the country during year 2019. Accidents not only occur due to poor road condition, speed or driver fault they fail to understand the health condition of driver. This driver health monitoring system provides the solution for the above problem by tracking and monitoring the driver health condition before driving. This system keeps track of driver's vital status such as sleep, heart rate, blood pressure, body temperature and alcohol content in the body.There will be a centralized controller along with alcohol sensor fixed inside the car which controls the car ignition system. Once the driver enters the car the drivers smart phone gets connected to the centralizedcontroller which has access to the data that is tracked and monitored for the last24hours that is stored and processed in the application.The centralized controller checks all the vital health parameters, if found normal then the controller checks the alcohol level of the driver, if in permissible range then the car ignition system is unlocked.

II. RELATED WORK

Accident and Alcohol detection in Bluetooth enabled Smart Helmets for motorbikes (2018) et al [1] has proposed a mechanism that can detect if a person is wearing helmet, it also detects accidents and also detects the alcohol level in the body. This can help in preventing accidents by detection process by gathering data to provide an accuracy. Alcohol detection for car locking system (2018) et al [2] they made an attempt to develop locking system for cars and it will not unlock the car without checking alcohol level. Alcohol sensor is used for prediction. The main aim is to prevent the accidents by system developments.Safe Drive: An automatic engine locking system to prevent drunken driving (2018) et al [3] has proposed a model using Internet of things to avoid reckless driving. This system uses MQ3 sensor, location tracking, sobriety test and so on. Based on result obtained by alcohol detection, system determine whether driver is drunk or not before driver starts the car.Drunken driving detection and prevention models using Internet of things (2017) et al [4] has proposed a model based on IoT for drunk detection and drowsiness especially at night. This model includes analysis of alcohol concentration, eye blinking rate and for drunken or drowsy state detection it analyses the rate at which car is made to turn. This includes speed reduction, triggering, alarm, informing traffic control. Portable alcohol detection system for Driver Monitoring (2019) et al [5] has proposed a portable alcohol detection based on exhaled breath analysis. This system uses breath sensor unit, smartphone and data cloud system. It can monitor driver status from a remote location. Breath sensor contains four separate sensors first is water vapor other are semiconductor gas sensor to detect ethanol, acetaldehyde and hydrogen level it checks the result and send it to cloud and future detection is made.Drunk Driving and Drowsiness Detection (2016) et al [6] has proposed a mechanism for detection of driver's drowsiness using visual features along with this the drunk detection using alcohol sensor is done. Drowsiness detection is done using HAAR-Cascade classifier for face and eye, for yawing detection – template matching in the mouth region is done. Finally, alcohol detection is done.

III. PROPOSED SYSTEM

We propose a complete health tracking and monitoring system along with prevention technique so that we can reduce possibility of being in accidental situations due to variations in health conditions. Driver's vital health parameters such as (blood pressure, body temperature, sleep activity, heart beat and alcohol level) can be the main contributing factors to tell how fit a person is, so variations in these parameters may cause fatality. There will be a centralized controller (Raspberry Pi) along with alcohol sensor installed inside the car which controls the car ignition system. Then the driver's vital health parameters have to be recorded with the help of On-Body sensors or wearable device like smartwatch. The health parameters are recorded and sent to web application installed in the driver's smartphone. The sensor data is tracked, monitored and processed in the application. When the driver enters the car thedriver's smartphone gets connected to the centralized controller and gets activated. Controller hasaccesstotheprocesseddata,iftherearenoabnormalitiesthenthecontrollerfinallychecks the driver's alcohol level, if in permissible range then the car ignition system is unlocked and then the driver can start thevehicle.

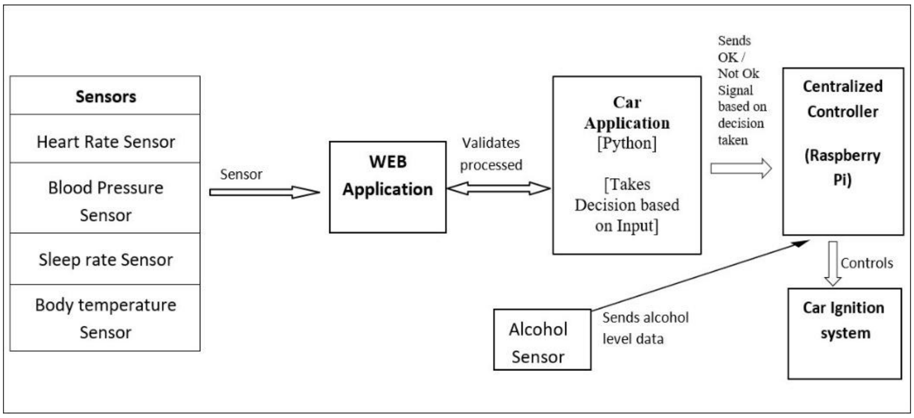

Fig 1: Basic Block diagram

A. Sensors [Data collection]

Inthismodule,varioussensordatasuchasheartrate,bloodpressure,bodytemperature and sleep activity are continuously sensed from on-body sensors such as smartwatch. These health parameters determine the driver's health condition hence need to be transmitted to web application.

Health parameter & Sensor Name	Normal Range	Permissible Range	Non-Permissible Range
Heart Rate Optical Heart Rate Sensor	80-120 bpm	≥ 50 and ≤140 bpm	< 50 and >140 bpm
BloodPressure Pulseoximetry	80/120 mmHg	(80 – 89) / (130 – 139) mmHg	>90 / > 140 mmHg
Body Temperature Temperature Sensor ICs	97 F to 99 F	≥ 97 F to ≤ 99 F	< 97 F to >99 F
Sleep Rate / Activity Bioimpedance Sensor	8 to 10 hrs	≥ 4 hrs to ≤ 12 hrs	< 4 hrs to > 12 hrs
Alcohol LevelMQ3Alcohol sensor	0.03% per 100ml	≤ 0.03% per 100ml	≥ 0.03% per 100ml

Table 1: Permissible and non-permissible range of all sensors

B. Web Application

In this module, the web application receives the sensor data from sensors. This data is stored dynamically and this data is continuously tracked and monitored for any variations in anyone of the vital health parameters. These health parameters determine the driver's health condition hence need to be continuously monitored for any slight variations. The web application produces a processed data file from the recently obtained data, when requested from centralized controller.

C. Car Application [Python]

This module is installed in the Car Console as a software which is triggered when the driver wants to start the car. This feature allows the Driver a smooth interface where the driver can trigger the start car functionality, upon clicking a decision will be taken bytheprocessingunitandthenasuitableactionwillbetakeni.e.,Locking/Unlocking the Car Ignition System if all vitals are normal else displays an error message on the screen.

D. Centralised controller [raspberry Pi]

In this module, when the driver enters the vehicle, his smartphone connects to the Centralized controller in order to activate the controller. After that the controller requests the web application for the recently processed data file. Further validates the data file for any abnormalities in health parameters. If all OK, then the controller unlocks the Car ignition system else it won't unlock.

E. Car ignition system

In this module, the car ignition system controls the car ignition process, i.e., controls the on/off of a vehicle. After only successful validation and OK signal from the centralizedcontrollerthisunitwillbeunlockedandallowthedrivertostartthevehicle.

IV. SYSTEM ARCHITECTURE

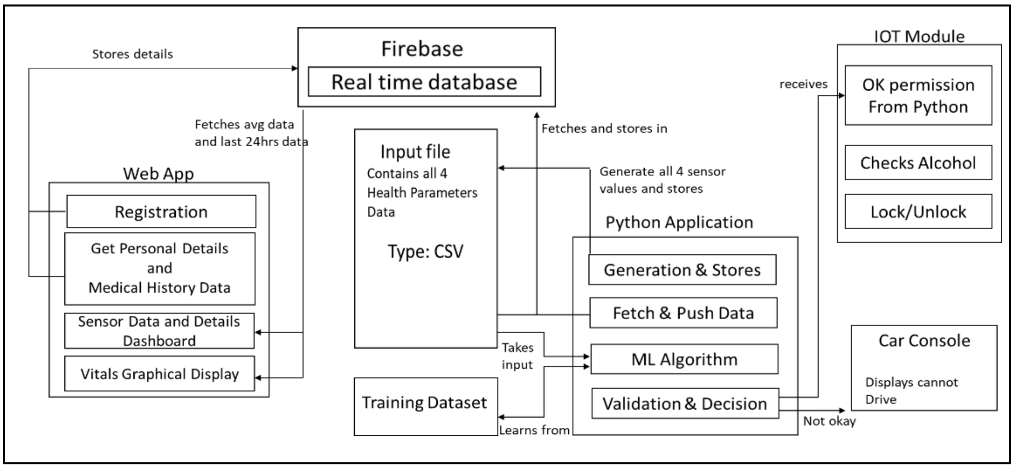

Fig 2: System Architecture

A system architecture is the conceptual model that defines the structure, behaviour, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviours of the system

A. Web Application

It contains four sub – modules:Registration:This page provides the driver to Sign Up to our Product by providing email id and password and the credentials will be verified by email verification module. Get Personnel details and Medical History Data: This page provides the driver to enter their personnel details upon successful User verification through Sign Up andto provide details about their present and past medicalconditions.Sensor Data and Details Dashboard:This page provides the user a complete information about their vitals of various health parameters with a Dashboard view. It also contains details about the sensors used and displays the users Avg value of each parameter which is calculated dynamically based on the last 24 hrs. data that is collected and stored by thesensors.Graphical Display of Vitals:Graph provides a quick and easy understanding of variations.Toprovidetheuserwitheasyunderstandingofthevariationsintheirhealth parameterthisfeatureisimplementedsothatitshowsagraphviewforeachindividual parameter and individual sensor and displays the variations from current time to previous 24 hrs.

B. Firebase server

This Server contains various databases for different purposes and in our project, we have utilized two kinds of databases. One for storing user login credentials for authenticationandotheristheRealtimedatabaseforstoringsensorvaluesandother user details. It performs storing and data sending and retrieval tasks.

C. Input file

It contains all the 4 sensors dynamic data i.e., in each column individual sensor data keeps getting updated every 5 secs and this input data is then pushed to the Firebase server for the Web application to access data fordisplaying. The data of individual sensor will in accordance to its standard data type and will be generateddynamically.ThegenerateddatawillbesenttoProcessinguniti.e.,Python application for further data processing, validation and decision taking based on the inputgenerated.

D. Training dataset

It contains a sample dataset where the data of all 4 sensors are populated randomly and the data is then classified as valid input or not by assigning a Boolean value at the end of each row consisting of all the 4 sensorvalues.In this dataset, all kinds of possible variations and circumstances are drafted and for each possibility a valid value is assigned to make the ML algorithm learn based on thesevariations.

E. Car Application [python]

This is the main component which carries out the processing task for the entire project. This is installed on the Car console assoftware.WhentheDriverpresstheStartbuttonthenthisapplicationfetchesthedatafromthe input file i.e., the last 24 hrs. data and then refers the training dataset to learn and based on these two files a decision is taken by the ML algorithm running in the application and further the result is indicated to the IoT module and also an appropriate message is displayed for the Driversunderstanding. The ML algorithm used is decision tree based ID3 algorithm which takes the input and learns from the drafted training dataset and takes adecision. The other functionalities of python application are to push the last 24hrs data to the firebase server and since this is Computer Science projected the hardware task of generating sensor values is also carried out by this application. It randomly generates the values for all 4 sensors according to the individual health parameter permissible range and keeps in mind the type of data that needs to be generated for individualsensor.

F. IOT module

Inthismoduleitwaitsfortheprocessingunittosendthedecisionbasedontheinput. The decision sent by the Processing unit is a Boolean value 0 or 1, if it is 0 then it indicates that there is some variation observed in the driver's health parameters and the driver is not fit to drive. Based on this decision the IoT module does not further check for the alcohol level and does not unlock the Car ignitionsystem.If the value is 1 then the IoT module further checks for the Drivers alcohol content in the body using alcohol sensor integrated on the Centralized controller installedin the car. If the alcohol level is also in the permissible range, then it further Unlocks the Car ignition system indicating that the driver is fit to drive.

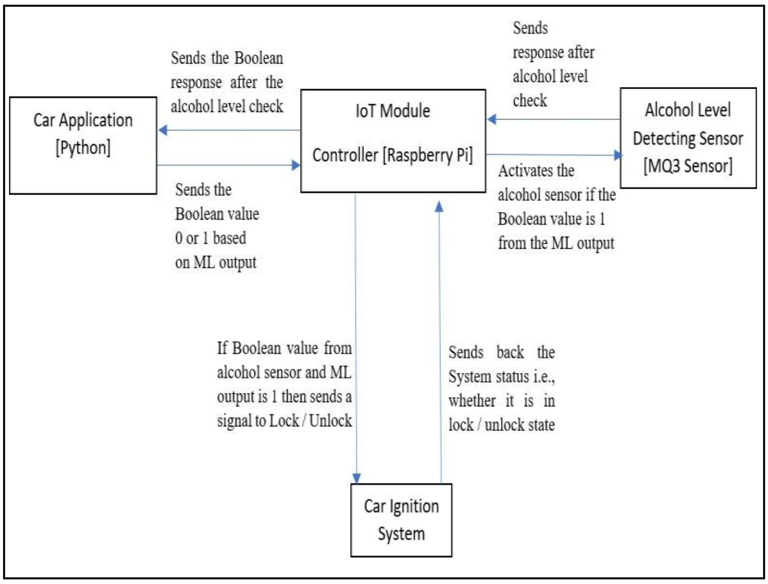

Fig 3: IOT Module

G. Car console

It is basically a GUI [Graphical User Interface] which provides an interface for the driver to Start the vehicle and also displays appropriate message after processing.Ifthedriverisfittodrivethenitdisplays"WelcometoYourJourneyHasstarted Keep Calm and have a SafeTravel". If the driver is not fit to drive then it displays "Sorry You cannotDrive" This software is installed in the Carconsole.

V. FLOW CHART

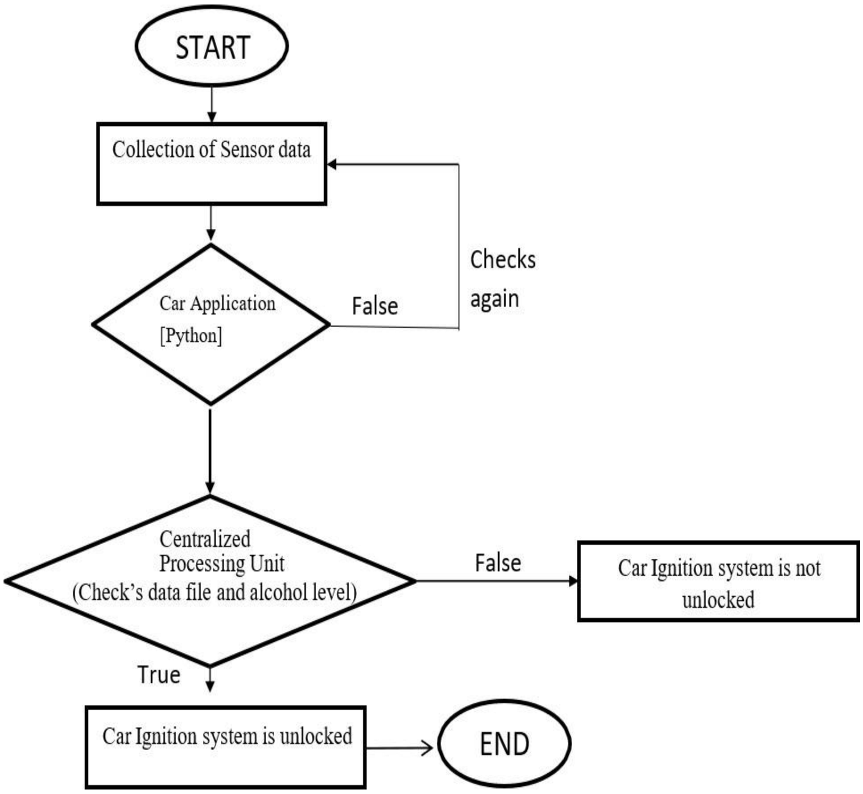

Fig 4: Flow chart

Aflowchartcouldbeakindofdiagramthatrepresentsaadvancementor method.Aflow chartmayalsobeoutlinedasadiagrammaticalillustrationofassociatedegreerule,astepwise approach to finding a task. The flow chart shows the steps as boxes of varied types, and their order by connecting the boxes with arrows.

VI. ALGORITHM

A. Decision tree Algorithm

Decision tree algorithm is a supervised machine learning algorithm used to build classification and regression model to form tree structure.The node in the tree represents the feature, the branch in the tree represent decision made by the algorithm and the leaf which represent final outcome of the algorithm.There are many algorithms which uses decision tree algorithm. Among those algorithms we use ID3 algorithm.ID3 Algorithm means Iterative Dichotomiser 3 algorithm. ID3 algorithm is a classification algorithm which follows greedy approach (it always makes the choice that seems to be best at that moment) by selecting best attribute that yields maximum information gain or minimum entropy.

Step 1: Begin the tree with the root node which contain dataset

Step 2: Find best attribute in dataset using Attribute selection method

Step3:Divide root node into subsets that contain possible value for the best attribute

Step 4: Generate decision tree node which contain the best attribute

Step 5:Recursively make new decision trees using subset of dataset created in step3.Continue process until a stage is reached where it cannot further classify the nodes and called final node as a leaf node.

VII. EXPERIMENTATION AND RESULT

A. Sensor module in web application

Thismoduleisimplementedwithhelpofchart.jspackagewhichrequiresdataasinputandneed tospecifytheXaxisandYaxisvaluesandrangeandalsowritethefunctioncall backstogoand locatethefirebaseremotedatabaseandthenfetchthevaluesfromthedatabaseandusethesame fetched data for displaying.ProvidestheUserwithasensordashboardconsistingofinformationabouteachsensor and can also know the average value of each individualsensor.Provides a Graphical representation of the sensor data of all health parameters and help the users to quickly understand the variations and changing trends in the health parameters.Thedataisdynamicandresponsivelycomingfromtheservereverytimethe data gets updated.

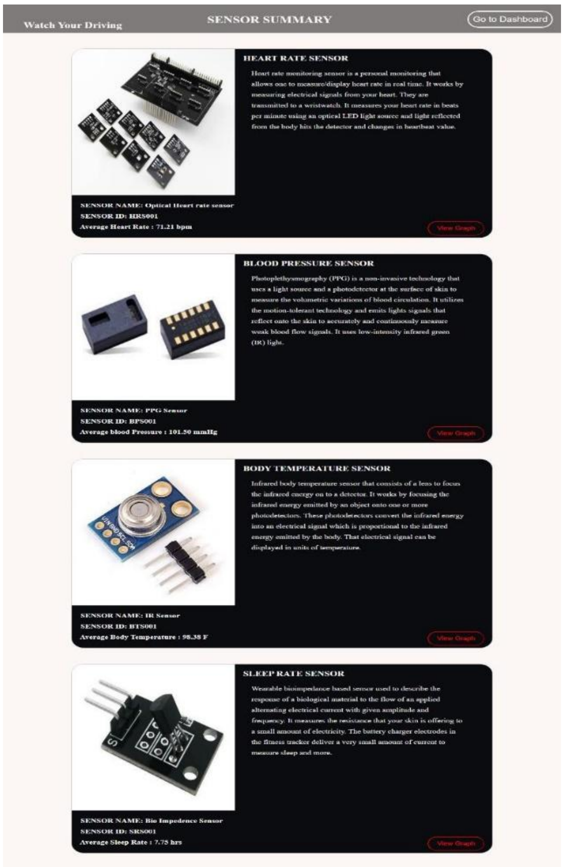

Fig 5: Sensor details with average value display

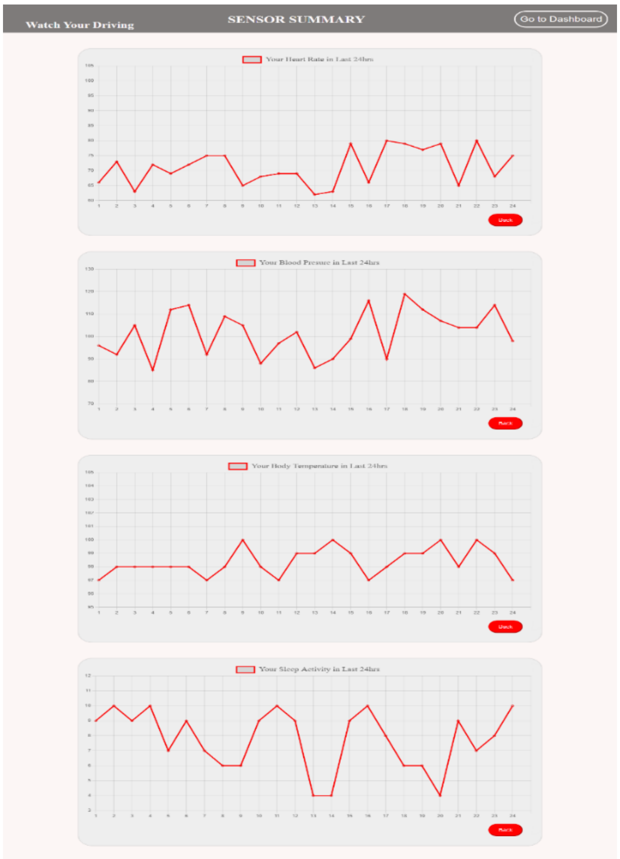

Fig 6: Graphical representation of sensor data

B. Algorithm model

Inourprojectwhenhealth.csvisgiventotheID3algorithmitcalculatestheentropyofhealth.csv and entropy of each attribute in health.csv and it calculates information gain. Algorithm makes decision on information gain it chooses the highest information gain attribute and assign that attribute as a node under the root node, again root node make decision either it terminate node or it will analyse the next highest information gain attribute and assign that as next node. This process continues until final node is reached where there is no other attribute for classification. Based on leaf node the algorithm make decision by allowing user to continue with python application or alert user by a message "Sorry you can't drive because your health condition is not under limit". If the Boolean value is 0 then without the consent or without waiting for response from the IoT module the Python application takes the decision that the driver is not fit to drive because Boolean value 0 indicates that there is a variation in the 4 vital health parameters and these values cannot be accepted to drive. The Boolean value 0 is sent to the IoT module indicating to lockthecarignitionsystem.AccordingtotheoutputthePythonapplicationdisplaysappropriate message in the carconsole. If the driver is fit to drive then it displays “Welcome to Your Journey Has started Keep Calm and have a Safe Travel”If the driver is not fit to drive then it displays “Sorry You cannot Drive”

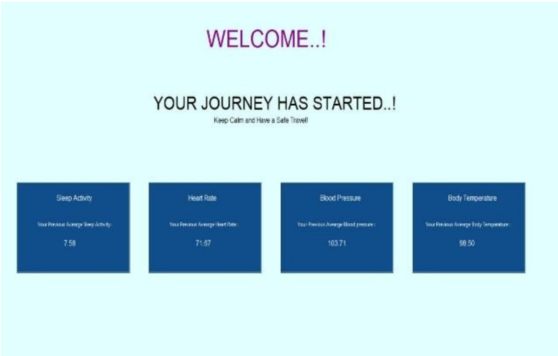

Fig 7: Allowing user to drive

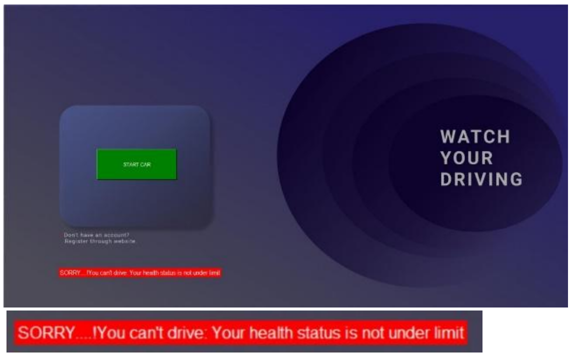

Fig 8: Alerting user

C. IOT Module

Car application sends a Boolean signal 0 or 1 based on the MLoutput. Based on the Boolean value obtained the controller i.e.; Raspberry Pi decides which step to proceedfurther. IftheBooleanvalueis1fromtheMLoutput,thenthecontrolleractivatestheAlcohol detectingsensorandchecksthealcohollevelinthedriver'sbodyandsendstheresponse back to the controller indicating the alcohol level value andstatus. IftheBooleanvaluefromalcoholsensoris1thenthecontrollerindicatesthecarignition system to unlock else it indicates to lock it.If the Boolean value is 0 then the controller indicates the car ignition system to lock and asks back the system status of car ignitionsystem.The status sent by the car ignition system is then sent back to the Python application to display appropriate message in the carconsole.

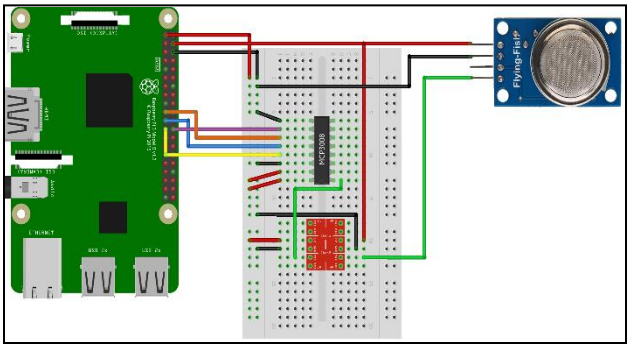

Fig 9: MQ3 Alcohol Sensor connection with Raspberry Pi

Fig 10: Raspberry Pi

VIII. CONCLUSION AND FUTURE ENHANCEMENTS

The main objective of the project is to ensure safety in driving and to avoid accidents by developing a reliable and a cost-effective system to safe guard human life.The system will help the drivers to a much larger extent. It is a real time model that can monitor and track the status of driver's health and automatically unlock the car ignition system.ID3 algorithm used because of Understandable prediction rules are created from trainingdata.It builds a short tree in relatively smalltime.This system can be used by automobiles manufactures by integrating it in the manufacturing process of vehicles. It can be concluded that this driver health monitoring system using Raspberry Pi is a cost effective, reliable and feasible solution for prevention of accidents.This systems efficiency can be further improved by considering more health parameters and the data generated will be more so that the prediction can improve vastly.It can be further extended to Transport services such as Ola and other transport service-oriented companies to get drivers information and health details before boarding.It can also be extended to Automatic Traffic fine management system by taking driver license and other vehicles details and can automatically send the fines through the portal.

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