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ADVANCED DRIVING ASSISTANCE WITH TRACKING AND ACCIDENT AVOIDANCE SYSTEM

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Abstract— **Assisted vehicles are the smart vehicle that detects the obstacles, prevents any major accidents by tackling obstacles, and alerts nearby hospitals in case of an accident. This research introduces a low-cost prototype of a miniature assisted vehicle model, utilizing readily accessible and straightforward technologies, which has the capability to be a hallmark of the forthcoming technological revolution. Motive is to avoid accidents due to frequent mistakes made by the driver. This prototype leverages the Jetson Nano controller and H-bridge drives for controlling the two DC motors, resulting in a highly functional vehicle. The implementation of cutting-edge technologies such as GPS for location determination, ultrasonic sensors for obstacle detection and avoidance, computer vision for pedestrian detection and image processing for intelligent systems, enhances its capabilities. In the event of an accident, the accelerometer gets activated and an alert message is rapidly sent with the live location to the registered mobile number and nearby hospital via GPS and GSM. These vehicles are seen as a solution to urban transportation challenges, offering safe and timely transportation, and could have potential applications in military scenarios.**

Keywords— **Jetson Nano, CNN Algorithm, SSD Detector, Mobile Net, Emergency Alert**

I. INTRODUCTION

Proposed area of implementation is advanced assistance driving or semi-autonomous driving methodology. An advanced assistance driving approach promises to significantly reduce road accidents and minimize serious injuries by continuously monitoring the surroundings and proactively avoiding potential hazards in real-time. Researchers are putting forth new concepts to develop advanced assistance systems aimed at fostering safe transportation. Major companies such as Uber, Google, and Tesla are at the forefront of the global drive for innovation and design in the field of driving system advancements. [1]. Along with autonomous driving area, implementation of image processing, electronic sensors and power devices contribute significantly in our proposed model. It has been observed that advanced driving assistance can help to reduce the number of road crashes. Government data has pointed the driver behavior or error as a factor in 94 percent

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of crashes, and driver assistance systems can help reduce the driver error. Higher levels of assistance have the potential to reduce the dangerous and risky driver indulged accidents. The greatest promise may be reducing the disruption due to impaired driving, speeding and distraction. As per a recent survey, the autonomy levels of self-driving technology were categorized as follows [2]

Level 0: encompasses vehicles that possess no autonomous technology, only offering automated alerts or automated secondary features such as headlights or windshield wipers.

Level 1: The vehicle controls one or more safety-critical functions, but each function operates independently. The driver still maintains control.

Level 2: In the survey combines the technologies from Level 1, working in unison, yet the driver retains overall control of the vehicle.

Level 3: Features limited self-driving capabilities, allowing the driver to hand control of all safety-critical functions to the vehicle, with only occasional intervention required.

Level 4: On the other hand, represents a fully autonomous vehicle, capable of controlling all safety-critical functions for the entire journey without any driver input.

According to the Mass Rapid Transit System (MRT), a staggering 74% of road accidents are caused by driver error or human involvement in driving. This highlights the pressing need to tackle this issue through the development of advanced driving assistance systems, aiming to eliminate human error on the roads for new advance assistance driving systems. Our idea is to build an advance assistance driving system car. A raspberry pi V2 camera is used to do the object detection and obstacle avoiding using object detection algorithms and automatic tackling of obstacles to move in either left, right, backward direction. The main controller used is the Jetson Nano 2GB version that is capable of high speed data analyzing and processing. An innovative solution for preventing road accidents is proposed through the use of an ultrasonic sensor and an accident alert system. The ultrasonic sensor serves as a backup in case the camera fails to detect an incoming obstacle, accurately detecting it instead. The accident alert system sends out crucial information about the accident to emergency hospitals in the vicinity, enabling swift rescue operations and potentially saving lives. [3]. A tracking system, as discussed by Y. Zein [4], utilizes GPS data to accurately determine the vehicle's location through the use of coordinate-based estimations. And accident is alerted with the help of accelerometer sensors and GPS/GSM for location tracking and sending alert messages. The motor wheels are powered with a 12V DC adapter power given to the L293D motor driver IC. A system aimed at detecting accidents in vehicles is being proposed. It uses GPS to track the location of the vehicle and determine if it has been involved in a crash. In the event of a fall, an alert message is sent to the nearest hospital, providing crucial information for a prompt rescue operation [5].

II. LITERATURE REVIEW

From the Self-Driving Car Model using Raspberry Pi paper [1] we got the reference on manual based vehicle driving model. This paper had the limitations of automatically controlling the vehicle. With reference to the Autonomous car driving model using raspberry pi paper [6]we got the idea of different sensors interfacing and sensor based decision driving. The urgency for an autonomous system to sense and monitor human impact was realized upon learning about the devastating consequences of accidents, as reported in various articles. The need for such a system became apparent as a means to mitigate the number of fatalities caused by road accidents. Self driving RC car using behavioral driving paper [7] taught us about the design of the sensing parameter of the driving vehicle which was helpful for both physical and wireless communication. Development of driverless RC car showed the methods to develop a system that will continuously measure the parameters and provide monitoring and tracking using GPS/GSM over computer/android platforms. In a study [8], a concept of using a camera to detect and categorize objects was presented. The detecting algorithms were implemented by extracting the features of the object's image through the use of Convolutional Neural Networks (CNN). Frame differencing was utilized to capture frames from the camera at fixed intervals and calculate the difference between successive frames. And to filter noise, operation of filters like fpsFilt initialization takes place to filter out the unwanted blur or noise in the detection. A python program was utilized to implement the SSD algorithm in OpenCV. Classifiers were used for object counting and image classification[9]. A study [YOLO reference] showcased the effectiveness of utilizing YOLO along with a Gaussian Mixture Model (GMM) in deep learning for feature extraction, resulting in remarkable accuracy.[10]For smart cities to achieve intelligent green transportation autonomous with connected cars together have been considered as a promising solution[11]. Sensors play a vital role in autonomous driving, providing accurate information on the vehicle's altitude and driving direction. The car navigation system uses DR and RPR, updating the DR through road profile recognition. In order to ensure high accuracy, the synchronization error between the mapped and measured data must be constantly estimated. The simulations showed promising results, with positioning errors lower than 10m (standard deviation) over a distance of 150. Using Navstar an introduced navigation method is ideal to complete the commercial navigation systems [12].

Road accidents are a major concern globally, with devastating consequences for both individuals and communities. According to the World Health Organization (WHO) [13], road accidents cause over 1.25 million deaths and 20-50 million injuries every year. India, in particular, has a high number of road accidents and fatalities, with 78% of accidents being caused by human error in driving. This highlights the need for technology-driven solutions in the form of 'Assisted Semi-Autonomous Vehicles' to mitigate the impact of human error on road safety. For example, Lee and Abdel-Aty [14] found drivers to be at fault in 80% of pedestrian crashes at the roadside intersections. The main objective of the experiment is to design system that detects the conveyance or any other impediment in front of it and to design genuine time conveyance this can be operated remotely via mobile/computer. Also to develop an accident avoidance system this detects the collision of the vehicle. Also, various traffic sign detection and image recognition algorithms were discussed as an advanced solution to generic methodology that makes the implementation of Raspberry pi for processing the image data [15] . It also includes the references about cameras and sensors that help the driver to get avoid the roadside obstacles. A vehicle monitoring and tracking methodology has been developed by Y.B. Mane and P.A. Shinde using wireless communication technologies [16]. And it makes driver aware upon choosing an unknown path with the help of mobile devices. Also for vehicle's safety the system utilizes gas sensors and temperature sensor. In [17], for smart strategies of parking in urban areas fuzzy-PID control based vehicle idea was generalized. A design methodology was suggested by MA Khan to warn and detect the user in case of over speed, and traffic signals. For further action the system has been efficiently programmed to send the speed limit crossover message to the officials. A verified limit value of speed was defined to carry out these functions. And the similar information is sent to the desired administrators if the vehicle doesn't follow the limit. Digital Image Processing technologies are utilized for license plate detection of the expeditious conveyances to eschew the accidents and pay for the required fine by the driver. The system has used a novel methodology for obstacle detection with image processing.

III. BACKGROUND

Road accidents have become a global epidemic, leading to the loss of countless lives and causing long-lasting physical and emotional harm to survivors. The statistics are staggering, with approximately 1.25 million people dying in road accidents annually and millions more suffering from injuries and disabilities. Despite advances in vehicle technology, human error remains a major contributor to road accidents, making it imperative for society to find innovative solutions to reduce the number of incidents. With the increasing use of assisted semi-autonomous vehicles, there is hope that technology can be harnessed to minimize human error and create safer roads for everyone. The challenge remains to find a balance between the benefits of technology and the need for human interaction, and to create a safer world for all road users. It is therefore necessary to design and develop accident avoidance system that is capable for precisely avoiding the collision and responds to collision if it happens unfavorably by tracking the location of the collided vehicle at the time of collision. Many times the message of the accident taken place is sent to the victims' family members, but it is better to prioritize messaging the nearby hospitals where the accident took place as this can reduce the time delay for the victim's treatment. And provide a low cost solution than the advanced security car systems to avoid the vehicle accident [18] GPS and GSM based systems. The wide availability of GPS has transformed many industries, including transportation, agriculture, and emergency services, among others. With its growing importance and widespread use, it is clear that GPS will continue to play a vital role in our world for many years to come. The system became fully operational in 1994 by overcoming the limitations of previous systems. Each satellite is responsible for continually transmitting the message that consists of the 1. The message transmission time 2. Position of satellite at the time of transmission of message. The GPS receiver's ability to determine its position is based on the speed of light and the transit time of messages received from satellites. A sphere is defined as each of satellites locations and their distances. Some inbuilt navigation equations are used to compute the location of the receiver in terms of space co-ordinates. This sophisticated process is what makes GPS a valuable tool for navigation, mapping, and many other applications.

Also, several GPS modules show the direction and speed information which could be calculated from position differences[18].Tracking information can also be possible by using three satellites instead of four in special cases if one of the parameter is already known, then a receiver can find its position by using only three satellites. For example- an aircraft may already have known elevation, so using some known assumptions like last recorded altitude, dead reckoning, or using information from the vehicle server, to give a position with fewer satellites can be possible.

IV. METHODOLOGY

To detect any obstacle ultrasonic sensors along with motor driver are attached with parallel computing processor Jetson Nano. Also the obstacles images will be detected through an USB camera that precisely recognizes the type of object. Accelerometer sensors play a crucial role in preventing road accidents by alerting the driver or the vehicle's system in case of an accident occurrence. These sensors are mounted on the top of the vehicle to detect any tilts on the horizontal x-axis and provide real-time data to the vehicle's control system. Real time object detection is developed using SSD Mobile-net functions and Jetson Utils library in python. To control the motion the vehicles, motors along with the driver IC's come into play. The vehicle will move in the desired direction based on the control signals assigned by the controller. GPS/GSM modules are taken into consideration for location tracking and alerting to nearby hospitals by sending accident occurrence messages. The positioning devices mainly uses three to four satellites that helps to record the day to day, monthly and yearly location activities . The positioning systems relies on a network of satellites orbiting the Earth to determine the exact location of a device equipped with a GPS receiver. To gain the positioning activity precisely the usability of GPS is taken into consideration and for the alert message GSM comes into play.

GSM and GPS based system will provide real time vehicle location, reporting and mapping the co-ordinates with quality level of service. Even storage and download of GPS data is possible to a computer at a base station that can further be utilized for analysis. For the prototype of the new model, the location information is received using Blynk IOT application where controlling of the sensors, GPS/GSM is done through Arduino Uno and Node-MCU for establishing the wifi-connectivity. A list of stages consisting a list of weak learners is provided to the cascade classifier in the obstacle detection using Raspberry pi camera.

The algorithm involves moving a window of a specified size over the image and analyzing the content of each region defined by the current window location. Object is found if the label is positive and object is not found if the label is negative. The window moves to next location if the labeling results as negative. For positive, the region moves to the next classification stage. A final result of positive is evaluated when all the stages generate a result that an object is found in the image. For the true positive, the algorithm reports a true result if a particular target is searched in the video. The classifier fails to capture the actual object within the video in the false positive and in true negative a non-target is correctly classified as not the original target. To work in a normal manner, each cascade stage must ensure a minimum false negative rate else the classification of the branch stops if actual object is recognized as a non-object [19].

To start with the object detection algorithm we need to return the floating numbers expressed in seconds. Initialize the filter window along with the neural network. Window resolution has to be set with flipping of windows set to be zero. Capture the video from USB and set the proper window size. Read the camera frame continuously in loop unless and until the wait key is not pressed to stop the detection. Release the cam function and destroy all the windows that capture the video to stop the object detection.

Algorithm 1: Algorithm to detect the objects

```
input: set the height, width parameters for
 window resolution
output: display the labelled objects detected
 along with their images
return time: as a floating point number
expressed in seconds
initialize: filter fps,  fpsFilt=0
initialize: the Neural Network
set display window resolution: dispW=640,

dispH=480
set default flip to zero: flip=0
set font: HERSHEY_SIMPLEX
capture video from USB camera and set
display window size
while true:  #start detecting objects if no release
and exit of windows are enabled
    | #read camera frame
    | _,img= cam.read()
    | height=img.shape[0]
    | statement
    | statement
    | frame= jetson.utils.cudaFromNumpy(frame)
    | detections= net.Detect(frame,width,height)
    |
    | for detect in Detections:
    |     | ID= detect.ClassID
    |     | top= detect.Top
    |     | statement
    |     | item = net.GetClassDesc(ID)
    |     | print(item, top, left, bottom, right)
```

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```
        dt = time.time() - timeStamp
        timestamp = time.time()
        fps = 1/dt
        fpsFilt = .9 * fpsFilt + .1 *fps
        # label the detected objects
        # show the image of detected objects

        if cv2.waitKey(1)==ord('q'): break
cam.release()
Exit all windows
```

The vehicle motion is controlled with the Jetson Nano controller where ultrasonic sensors come into play for emergency stopping of vehicle if the obstacle is too near to the vehicle and with a chance of collision. These sensors work by transmitting short bursts of sound waves, also known as ultrasonic pulses, from a transmitter. The sound waves then bounce off the target object and are received by a receiver. The time difference between the transmission and reception of the ultrasonic waves is then calculated to determine the distance between the source and the target object. There are different pins of the ultrasonic sensor as some of the common pins include the power pins, which provide the electrical power needed to operate the sensor, and the trigger pin, which sends a signal to the sensor to initiate a measurement.

Algorithm 2: Algorithm to control motion of motor and measure the obstacle distance

```
1   input: enter a number to move vehicle
    forward,
2   backward,left,right
    output: distance of the obstacle is
    displayed
    and vehicle moves towards a
    particular
    direction based on input and stops
    automatically if distance of obstacle is
    very
     less.
3   assign: the jetson nano GPIO pin
    numbers
     for each motor terminals
4   assign: pin numbers to echo and
    trigger pins
     of ultrasonic sensor
5   initialize: output pins of motor as zero
    or false
6   setup: trigger pin by making it high
    for 10
    micro sec and then turn off
7   echo pin: goes high once the wave is
    returned
     after getting reflected by any object.
8   compute: the pulse duration and the
    distance
    pulse_duration = pulse_end –
    pulse_start
-   distance = pulse_duration * 17150
9   display: the value of distance
10  if distance <= 2 :
        #stop the vehicle
        GPIO.output(12,GPIO.LOW)
        GPIO.output(13,GPIO.LOW)
        GPIO.output(7,GPIO.LOW)
        GPIO.output(11,GPIO.LOW)

11  a = (provide input)
12  if a==1:
        #drive the motor forwards
        #statement
13  elif a==2:
        #drive the motor backwards
        #statement
14  elif a==3:
        #drive the motor towards left
        #statement
15  elif a==4:
        #drive the motor towards right
        #statement
16  elif a==5:
        #stop the motor
        #statement
17  else:
        print( wrong input entered)
18  end
```

The total pulse duration need to calculate in order to decide the distance of the object so pulse duration is given by-
pulse_duration = pulse_end – pulse_start.
The total distance is calculated as
Distance = pulse_duration * 17150

Where Distance is range of ultrasonic sensor. The Timestamp is used for real time object detection,dt = time.time() –timestamp is used to read various real time objects. For filtering of detected object
fpsFilt = .9 * fpsFilt + 0.1 *fps this is used.

Algorithm 3 : Algorithm to send emergency message and location

1. Declaration: set up the authorization key from blynk application
2. initialize: ssid
3. initialize: password for your wifi
4. declare: void setup function
start serial communication
assign baud rate as 9600
initialize mpu6050
connect with blynk application using ssid, key, and password
while
(!mpu.begin(MPU6050_SCALE_2000DPS, MPU6050_RANGE_2G))
check the availability of mpu sensor and print if sensor is not responding
give some delay to fetch the mpu sensor data without any noise and error

5 declare: void loop function
if (Serial.available() > 0)
# read the serial data and store it in a variable

#Read normalized values
Vector normAccel =
mpu.readNormalizeAccel();

# Calculate Pitch & Roll
int pitch = -(atan2(normAccel.XAxis, sqrt(normAccel.YAxis * normAccel.YAxis + normAccel.ZAxis * normAccel.ZAxis)) * 180.0) / M_PI;
int roll = (atan2(normAccel.YAxis, normAccel.ZAxis) * 180.0) / M_PI;

split the data string into different indexes of variables
assign these string values for calculating latitude, longitude, pitch
print the value of pitch, latitude, longitude

if (pitch >10)
# store the latitude, pitch values in a string variable and print the data along with the message as accident is detected.

V. FLOWCHART

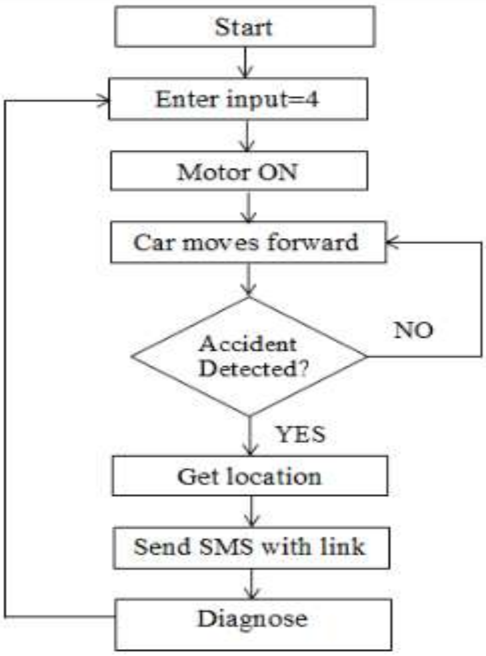

Fig. Accident alert system

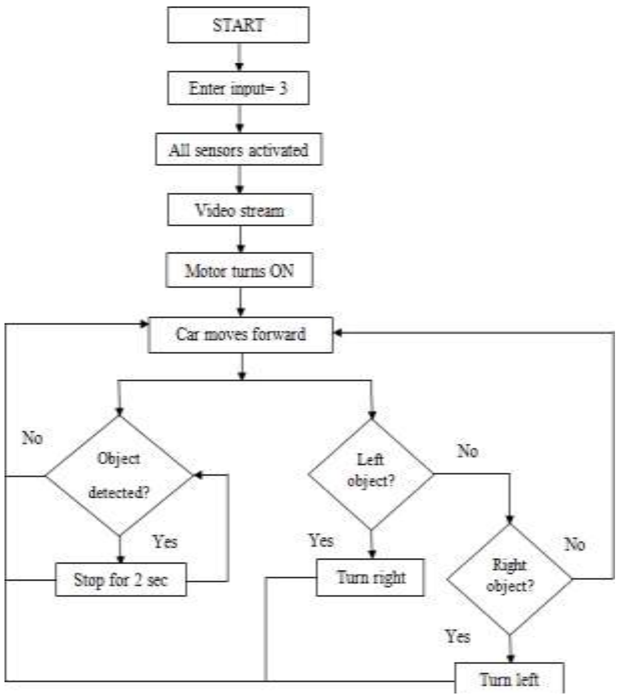

Fig.Realtime object detection

After giving necessary input motors turn on and car will start moving forward. By integrating the accelerometer with GPS and GSM technology, the precise location of the car can be determined in real-time. This information can then be used to send an emergency message, alerting authorities to the accident and allowing them to diagnose and address the problem as quickly as possible.

VI. RESULTS AND DISCUSSIONS

A prototype of the advanced assisted vehicle with object tracking and accident avoidance system car is developed. In the event of an accident, the accelerometer can detect the tilt in the X-axis and immediately send an alert message to a designated emergency contact, such as a hospital. As soon as the jetson Nano gets on along with the LCD screen, the video streaming gets started and the motor starts to move based on the input given to it. If the obstacle comes too close in front of the vehicle then ultrasonic sensor detects the object and the vehicle stops. Again upon providing the input the vehicle further moves to the desired direction either left, right, forward, backward. A code was written in python by using Single Shot Detector algorithm and executed using OpenCV [20]. In image processing, the size and complexity of the original images can pose a challenge in terms of storage and computational requirements. To mitigate these issues, the images are often transformed into a pixel representation, which reduces their size and simplifies the data for processing. For performing approach was used. The filter implementation is performed in each channel, where a threshold is applied to select only those image pixels that belong to the target object. This helps to eliminate background noise and focus on the relevant parts of the image. Additionally, the fps (frames per second) filter is utilized to smooth out smaller, noisy areas of the image and produce a more coherent representation of the target object. [21]. The program is implemented in Linux OS. Total 17 targets were trained in this object detection system. Detection of objects like controllers, bus, train, PCB board, animal, with confidence levels of 99.69%, 96.77%, 98.65%, 96.99% respectively.

Our prototype is designed using Jetson Nano which The microcontroller is a crucial component in the design of advanced vehicle systems. It serves as the central unit for interfacing with various hardware peripherals and controlling the motion of the vehicle. The microcontroller is responsible for receiving input from sensors and interpreting that data to make decisions about the vehicle's movements. This includes the detection of obstacles and the implementation of avoidance strategies to ensure safe operation. The vehicle is equipped with GPS and GSM that provide precise tracking and positioning, essential for efficient fleet management. The prototype design for a vehicle emergency response system utilizes an embedded application based on an Arduino microcontroller. The system is designed to report the location of the moving vehicle in case of an accident emergency. The Arduino is interfaced serially to a GPS receiver and a GSM module to facilitate the communication and transmission of data. In the event of an emergency, the GSM module sends an alert message to designated hospitals, providing them with the necessary information to respond quickly and effectively. The GPS receiver is used to gives the position of the vehicle, the latitude and longitude from a remote location. he GPS data collected by the vehicle's tracking system is made available to authorized users through a cloud-based mobile application powered by Blynk. This allows users to access the vehicle's location information in real-time, providing greater visibility and control over the vehicle's movements. The serial communication between the GPS module and the Jetson Nano utilizes the RS-232 protocol, which provides a robust and reliable means of transmitting data.

The combination of GPS, Blynk, and RS-232 technology provides a complete solution for vehicle tracking and monitoring, enabling users to stay informed and respond quickly in case of an emergency or other event.

VII. CONCLUSION

An advanced assistance car model has been developed as an economical prototype, showcasing the capabilities of the latest technologies in the field. The design and development of this prototype demonstrate a commitment to innovation and cost-effectiveness, delivering a range of advanced features and functionalities at an affordable price point. The successful demonstration of these functionalities highlights the potential of the prototype to serve as a model for future car designs, offering a glimpse into a safer and more convenient future for drivers and passengers alike. The car is able to be controlled manually as well as automatically by using image processing, ultrasonic sensors and made capable of position tracking using GPS/GSM with raspberry pi camera for object detection. The advanced car model is equipped with a cutting-edge object detection system that enables it to distinguish real-time objects and navigate around obstacles with precision. In the event of an accident, the vehicle triggers an alert mechanism which sends an emergency message to the nearest hospital, ensuring prompt medical attention. This advanced vehicle technology represents a significant improvement in driver and passenger safety, delivering a new level of control and peace of mind on the road.

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