INTELLIGENT CAR

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Abstract. INTELLIGENT CAR (ICAR) is a car, developed on eye-tracking software using a camera. The ICAR is the first Intelligent car that works with eye control and automatic driving. You can ride a car and move around where ever you want. The car drives Right, left, forward and stop using your eyes with the help of camera and coding. You need to sit facing the camera to control it. The main advantage is the car drives without any hassle in the roadways because of sensors i.e without any accidents/hitting any objects. It requires some hardware along with software along with a camera. Roads are easy and cost-effective for travelling through vehicles and walking people. Physically challenged people can also travel easily by I-Car, they need not call any person for help on the roads or depend on anyone to move from one place to another.

Keywords: Digital processing, Sonar, IR sensor, Arduino UNO, Automation

1. Introduction
This paper is proposed mainly for physically challenged people. The physically challenged people are depended on somebody whenever they need to travel. This car makes travelling easier for them by driving on their own. Several autonomous cars are available in the existing system [1], which are not affordable by everyone. The car operates in automatic and manual modes. The main features are lane detection, understanding the curves and turns in the road using Python OpenCV. Whenever a person sits inside the car, their face is captured and sent to the database, to examine whether the user is a new or registered user of the car[2]. Once it recognizes the registered user, the car in the manual mode detects the eyeball of the person to start the car. Once the I-car starts it moves according to the movement of the eyeball. This process is done by image processing. Several sensors are integrated with this car to make it an accident-free vehicle. One of the important features of this car is the usage of LDR sensors where the car beam is turned on automatically if it moves to a dark space. While the car is moving, the light in the car gets lowered, if a strong beam of light of the other vehicles on the opposite direction falls on it. Human eyes will not get affected because of the high emission of radiation. In accident periods, the car will sense a force because of sensors present in the I-car from the vehicle that has hit the car. The person travelling get injured,
the heartbeat sensor and motion detection are there for help. These might help the doctors in treating the affected person. The car will also detect if a person driving the car is sleeping or not.

2. Block Diagram
The intelligent car (I-CAR) is explained with several modules like face recognition[3], lane detection, car detection, sleep detection, circuit control, motion recognition, and Eye control.

2.1. Face Recognition
Face recognition is the initial stage of the car, the camera that is placed in front of the driver seat captures the face of the driver and saves as a record. Then the captured image is compared with the available database and verified whether the user is the owner[4] or registered person of the vehicle. The system after verifying the drivers/captured image authentication, it starts the car for the movement. If the captured image is not recognised with database or a new user then the car will never switch on and request for the authentication for start[5].

2.2. Lane Detection
Lane detection [6] is done by the camera that is kept outside the car, this camera captures the image specifically using the Region of Interest (ROI). The captured image is converted to greyscale and identifies the major transformation of black to white along the region of interest this process is called Edge Detection. After identifying the edge, a mask is made in green colour on the threshold colour to find boundaries of the lane. The difference between the boundaries is analyzed to find the middle of the road for movement of the vehicle. In this lane detection python, OpenCV is used. Lane detection's objective is to keep the I-car to the centre of the road. The captured image is sent to the system for processing, where the decision is made and then the decision is given back to the car controller board.

2.3. Car Detection
The detection of other vehicles is done to maintain the hassle-free movement of the car. The camera installed outside the car will focus always on the other vehicles movement to calculate the distance and maintain the speed of the I-CAR. This is done with Scaling method and object detection[7] using python OpenCV. In the movement, if a vehicle comes closer to our I-car the image captured is sent for analyzing the vehicle for its width for object detection. The below formula eq(1) is for calculating distance with the focus of the camera, pixels, and width:

\[ F = \frac{(P \times D)}{W} \]  

The distance can be determined from the focus of the camera. This will detect the distance of the vehicles that are moving in the image from frame to frame. The movement of the car is handled by H-bridge, that controls the motion of the motors. This is used to detect and move the I-car safely using python, OpenCV.

2.4. Eye Control
This mode is controlling the car with the eyeball using a software known as processing (c++ and RoI). This software will work only if the two eyeballs are detected, then it will see in what direction the eyeballs are pointing and accordingly the car moves. Eye control will help the handicap people to get an experience for driving a car. The special feature is when the driver turns away from the camera the car follows the previous command for 5sec and then slows down. If we wink our eye the car will slow down gradually.

2.5. Sleep Detection
This is a safety precaution of an I-Car, it identifies whether the driver is sleepy when he is riding in a manual mode. Enormous drivers are driving the vehicles on the highways during the day and night. The drivers travelling long-distance will suffer from lack of sleep. To prevent them from the accidents due to sleep, a method has been formed to alert the driver using Python open CV. While the driver travels a long distance in the manual mode and feels sleepy, the camera in the I-Car detects the eyes winking style and compares to the sleeping position of a person. If the driver is sleepy[8] then the car will alert the driver along with slowing down the car. The driver should wake up and make him steady. If the driver is not responding, then the I-Car will automatically switch to automatic mode to avoid any accidents. The process of switching to automatic mode is the image of the person is sent to the system for processing. The image is converted into black and white, Then the RoI is used for eyeball detection and the movement of the eyelash. When the eyelash goes smaller after every blink then the sleep alert is triggered. The convention of feed from colour to greyscale is done by "BGR2GRAY". The code is made into infinity loop so that it detects regularly, with the movement of the car for the driver and other people inside the I-Car. This is called the Sleep detection module in this Intelligent car.

2.6. Circuit Control
The main controller[9] Arduino UNO is connected to the H-bridge and get commands from the system and sensor to control the movement of the vehicle. The circuit consists of the integration of multiple sensors. The manual working has several sensors associated with the controller, the ultrasonic sensor is used for the detection of objects or vehicles around it so that I-Car does not race into another vehicle. This will prevent accidents and help people to be safe in the car. IR Sensor is placed at the front to detect the speed breakers and bumps on the road to retard automatically. LDR is connected with LED to control[10] the intensity of the light. This helps in
reducing the bright light falling on the eye of the driver and vision breach to him. The force sensor, GPS[11], heartbeat sensor, and ESP8266 WiFi module are used for safety assistances. The force sensor is used to detect the accident. The force experienced by the people inside the car is calculated by the force sensor, once the force is above the threshold then the location and heartbeat are sent to the cloud as an alert message. The alert message will be displayed on the mobile to the parental user. ESP8266 is used to send data to the cloud and it can be viewed from anywhere.

**Figure 1. Circuit Block Diagram, How the components are connected to the Arduino**

2.7. *Motion Detection*

The motion detection is kept for safety measures in the car. Once the force sensor reaches a threshold this module will be turned on for detection of life in it. The regular movements inside the car are measured and updated. This is made with Python OpenCV[12] programming. This module compares the existing frames inside the car with the previous frame to examine the movement of the person. If there is a movement, the alert message will be sent to mobile to the parental control and also this message is sent to the cloud using Esp8266.
3. Working

The working of the car is made in such a way that the car is safe to ride in both automatic[13] and manual driving. The complete working of the car is shown below with each stage it has in both the mode. The safety [14] mode for each mode is common. Each step works for a purpose. In the beginning, the Arduino Uno is conned to the H-bridge that is to the digital pins of 4,5,6,7,8,9,10 for h-bridge En1, In1, In2, En2, In3, In4 for movement the car.

![Flowchart](image)
When the car is switched on, the face is captured and verified with the registered database. Then the main feature of the manual mode is eye control, using processing software. This is made with C++ language, it also works on the principle of detection of the eyeball. Depending on the eye pupil movement, the car will move accordingly direction. This is a manual mode, that comes across errors like falling asleep on driving, sudden stopping emergence like an accident, etc, for these only reasons only the circuit control is made.

![Figure 3. processing software, Eye control and face reorganization](image)

The motors are fixed on the chassis of the car and the wheels are connected to the H-bridge. The H-bridge is powered with an external power of 12v, 5v from Arduino and GND to Arduino. The processing software will be running in a pc for the instruction for the Arduino for manual mode. In this manual mode we humans make mistakes, to reduce that we are giving a solution to manage errors in the circuit shown below for safety[15], sleep detection, and motion detection. First, the circuit control will maintain the distance from the objects and other obstacles.

![Figure 4. circuitconnection](image)

This is done to detect the car using the ultrasonic sensor. It will detect the range and distance of the obstacles. If the distance reduces to min value then our car will reduce the speed.
The ultrasonic sensor will transmit waves at echo and receives by trig pin. To give an echo wave it needs a power supply and GND connection. The IR sensor is used to detect the speed breakers and slow down automatically and the data is given to the Arduino and slows the car. LDR is used with the LED to detect the light around the car. The light will turn on only if the light intensity is less. If the car that comes in front is having a high intense headlight turned on if that light falls in LDR and the LED will pause for a while till the car in front cross it. So that high-intensity light will not fall on the driver of the opposite car. This system has a safety circuit that will be active in case of an accident. The location is sent to the mobile using the GPS[16] module and the heartbeat of the person is checked regularly. Then the front camera will start a motion detection program for safety detection. --This safe mode is started when the force sensor shows a high-level force on it. The location and heartbeat rate are sent to the cloud using ESP8266. Then it is viewed on the mobile. In this motion detection, the process will compare the previous frame to the previous frame. This will help to find the movement of any person in that car after the accident[17].

![Figure 5. Motion detection](image)

That red mark is made comparing it with the previous frames and it will show that a person who is alive is stuck. It will be checked until the machine is reset. The person sleepy or not is detected by this above photo.

![Figure 6. Sleep Detection](image)

The person might have chosen the manual mode and car travel[18] need to be safe. The eye is taken as a controller, this formula is used to detect the weather the person is sleeping or not.

\[
E_{AR} = \frac{||A_2 - A_6|| + ||A_3 - A_5||}{2||A_1 - A_4||}
\]  

(2)
The formula used is for the Eye Aspect Ratio (EAR) eq(2) and is calculated depending on whether the person is sleeping or not. The automatic mode has two modules lane detection and car detection. The lane detection is done by taking the RoI of the image.

Figure 7. Computer vision and RoI from the I-Car view

When the road is detected the car will see the original image in a live feed and the red Parallelogram indicates the Region of Interest that the car must detect the lane. Then after this, the Parallelogram is used for lane detection. The red Parallelogram is converted into a rectangle for detection. Then the edge detecting takes place. The lane is classified using the white line on the road setup.

Figure 8. Edge detection

Then the centre of the road is calculated by the pixel difference between the two green lines. The green line is a mask of white colour on the road this is how the lane is detected and calculated. Then at last the car detection is done by Python[19] OpenCV template matching. The car image is given inside to detect the car that moves in the front with that template. Then the boundary box is framed on the detected car. using the focus of the camera the distance is calculated eq (3) & (4). Car that has width W, particular distance D from camerapixels Pfocal length F:

\[ F = \frac{(D \times P)}{W} \]  \hspace{1cm} (3)

Assume piece of paperhorizontally: \( W = 11 \) D = 24 inches from object to camera and take a pictureperceived W of the paper is P = 248 pix.

\begin{align*}
F &= \frac{(24 \times 248)}{11} = 543.45 \\
D' &= \frac{(W \times F)}{P} \hspace{1cm} (4) \\
D' &= \frac{(11 \text{ in} \times 543.45)}{170} = 35\text{ in}
\end{align*}
which is 3 feet.

4. Results

5. Future Scope
Presently available autonomous cars are not affordable by everyone but this car is made with the use of simple components and more software, so it will be cost-efficient. The I-CAR could be made available for everyone. This car would be more comfortable and easier to use once 5G comes to existence. Elevation of the zebra crossing could be made while the signal goes red so that the car stops behind with the help of the ultrasonic sensor thereby people will not violate the traffic rules and there will be very fewer accidents. The GPS in the car can send a message automatically to the hospital if it meets with an accident so that the ambulance can arrive at the place without anyone calling for it.
6. Conclusion
The car can understand what is happening in the surroundings and decide whether to Go or Stop. Thus, driving is made easier for everyone. The physically challenged people will be happier to have a car ride experience and move around. We will know the list of people using the car since all the data gets stored in a database. Car Theft can be controlled.

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