AUTONOMOUS CARS ON INDIAN ROADS

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***Abstract*—** **Humanerrorandnegligence is the main reason for the risein the number of accidents that happeneveryyear.Totacklethisproblem,aself-driving vehicle can be designed andbuilt.Theself-drivingvehiclecanbedriven without human intervention. Thevehicle can detect the vehicles travellingalongsideit,peoplecrossingtheroad,trafficsignals,andmanyotherthingsthat are encountered while travelling viaroad.Thevehiclecansenseitssurroundingsusing sensorsandacamera. The prototype to be developedwillmakeuseofvariouscomputerapplications like computer vision, imageprocessing,andreal-timesensorstotravel, thereby giving the user a smoothride.Theintelligentdecision-makingprocess will play a major role in trafficrulesbeingfollowed.Likeamachinelearning process, the input data will becollectedandthedecision-makingwillbebasedonboththeinputandthepossibleoutcome.**

Keywords*— *ComputerVision,ImageProcessing,Sensors

I. Introduction

Oneofthegreatestdevelopmentsinthehistory oftheworld'stechnologicaladvancement is the introduction of automationin on-road vehicles. The boom in research andawarenessaboutthefieldofartificialintelligencehasgreatlycontributedtothishithertounprecedentedgrowth.This automation aims at enabling a vehicle to beabletomoveonitsown,withoutbeingcontrolled by a human driver. Top companiesthat are dominating the field, like Ford, Audi,BMW, and Tesla aim to spread their reach bylaunchingtheirlineofautomatedvehiclessoon. In India, almost 87 per cent of passengertraffic and 60 per cent of freight traffic areaccounted for by roads. Roads and highwaysareconsideredtobethemajorsectorininfrastructureandeconomicdevelopment.Indiahas thesecondlargestroadnetworkinthe world at 58.98 lakh km. Around 1.4 lakhkmareNationalHighways.Significantly,NationalHighwaysconstitutearound2%ofthe total road network in the country but carryabout 40% of the road traffic. The density ofIndia'shighwaynetwork142.7kmofroadspersquarekilometreofland–islikethatofthe United States (65) and much greater thanChina's (42.8) or Brazil's (18.6). One of thebiggestproblemsbeingfacedonIndianroadsis the condition of the roads themselves. Manyroadnetworksacrossthecountryfindthemselvesfullofpotholes,disregardfortraffic rules, encroachment of the sidewalks byvendors, and so on. Due to the occupancy ofvendors on the sidewalks, people are forced towalk on the road, which can cause accidents.The lack of traffic signs on some roads and thelackofawarenessregardingtheaforementionedsignsisaleadingreasonforthe disregard for traffic rules. Some measuresthat can be taken here is to recondition theroads. This is essential because smoother roadsensureafasterandsafermeansoftransportation.Propertrafficsignsmustbeinstalledonstateandnationalhighways.

Awareness about traffic signs must be spread.Written exams can be conducted alongside thedriver's license test. Stricter enforcement mustbebroughtaboutregardingtrafficrules.Higherfinerates,thepossibilityofimprisonment, cancelling the driver's license,andsoonmaydissuaderulebreakers.

II. AUTONOMOUSCARS

Anautonomousvehiclecanoperatewithoutthe need for any human control and can sensetheenvironment.Anautonomouscarissometimescalledself–adrivingcar,ordriverlesscar.Itusesacombinationofsensors,actuators,machinelearningsystems, andcomplex and powerful algorithms to executesoftwareandtravelsbetweendestinations withoutahumanoperator.Thesensorsarepresenttogatherreal-timedatafromtheenvironment.Thesedatacanincludethelocation, speed, direction in which the vehicleis travelling, the obstacles present in its path,and so on. The location of the vehicle can befoundbytheGlobalPositioningSystem,which makes use of satellite communications.An accelerometer can be used to detect thespeed at which it travels. Proximity sensorscan be used to detect the obstacles that may bepresentinfront.Popularproximitysensorsused infrared rays that will be transmitted andreflectedtodetectthepresenceofobjects.

TheNationalHighwayTrafficSafetyAdministrationhasdeclaredsixlevelsofvehicle automation. These levels are classifiedbased on how much a human is involved indriving. The various levels of driver assistanceareasfollows:

Level0:Noautomation–Alltasksareperformedbythedriver.

Level 1: Driver Assistance – Stand-alonevehiclecomponentssuchasElectronicStabilityProgram(E.S.P)orAutomaticBrakingarepresent.

Level2:PartialAutomation–combinedautomatedfeaturessuchassteering/acceleration,i.e.,lane-keepingandadaptive cruise control are present. However, the drivermustalwaysbeinvolvedinthedrivingandhe/shemustmonitortheenvironment.

Level3:ConditionalAutomation-Thedriver can fully cease control of some of theimportant functions of the vehicle in certainconditions, but he/she must remain ready totake control of the vehicle at all times withadvancenotice.

Level4:HighAutomation–Thevehiclecanexecuteallthedrivingfunctions.Theoptiontocontrol the vehicle may or may not be therewiththedriver.

Level 5: Full Automation – The vehicle canperform all functions related to driving, underallsituationsandconditions.

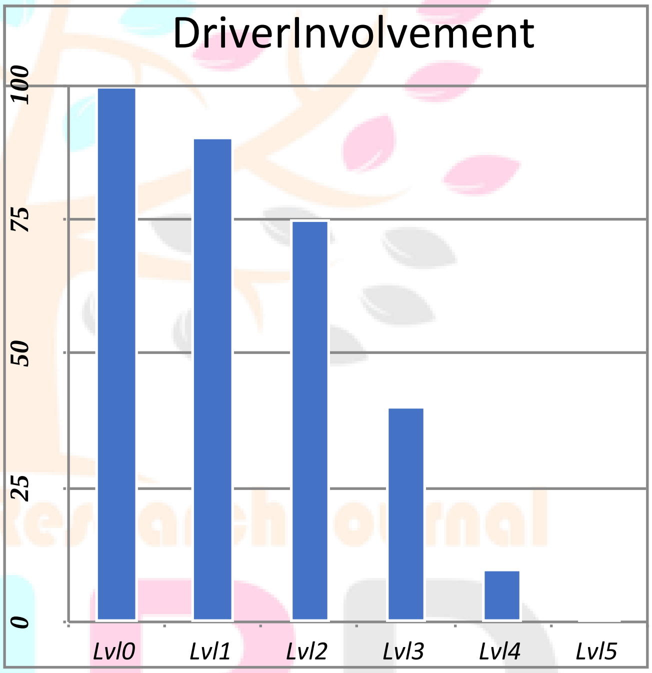

Fig1:Levelsof Automation

III. INITIALPROTOTYPE

The prototype is a model car that was builtusing components such as DC motors, ArduinoUNO,servomotor,motordriver,andanultrasonic sensor. It operates on the techniqueofobstacledetection.TheDCmotorsareattached with wheels of appropriate size thatallowstheprototypetomovearound.Theoperating of DC motors is controlled by theArduinoUNO,bymeansofthemotordriver.

Inadditiontothis,aservomotorandanultrasonicsensorarealsoconnectedtotheArduinoUNO.The ultrasonicsensorisadevice that can be used to detect objects thatarepresentinfrontofit,byemittingultrasonicsoundwaves.Theultrasonicsensoremitssound waves and receives the reflected wavesback when the sound waves strike any objectpresentinthepathoftheemittedwaves.The

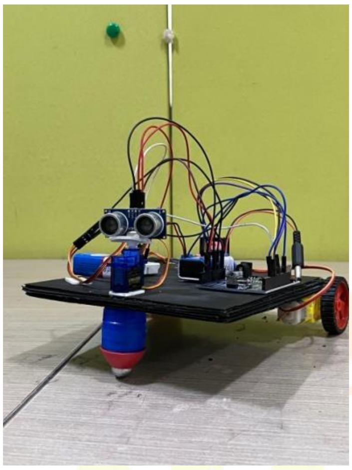

Fig2:Prototype

working of the ultrasonic sensor is enabled byboth the Arduino UNO and the servo motor.The Arduino UNO is initially connected to arequired power supply, usually a 9V battery.This in turn, switches on the motor driver andtheultrasonicsensor.Theultrasonicsensorcheckswhethertherearеanyobjectspresentinfront of it. When there are no such objects, themotor driver controls the DC motors and themodel moves forward. This continues until thesensor detects an obstacle, causing the modelto stop in its position. Using the servo motoron top of which it is placed, the sensor swirlsaroundtocheckthepresenceofobstacles.Whennoobstaclesareencounteredinthe

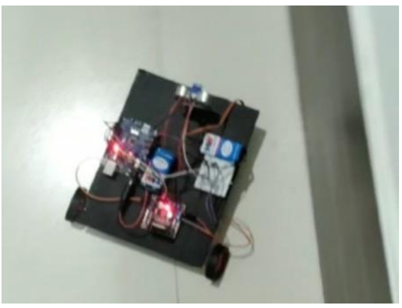

Fig3:PrototypeWorking

directioninwhichthesensorswirled,themodel resumes movement. In this manner, themodelmovesarounditsenvironment,untilitis disconnectedfromitspowersupply.

IV. LANEDETECTION

The lane in which the model car is to travelisidentifiedbymakinguseofthecameraspla ced on the model. The camera captures themovement in front of the model as a videowhich is used to decode the lane. The video isbroken down into frames which are subjectedtoCannyedgedetectionalgorithm.The CannyEdgedetectionalgorithmfirstconvertsthei mage to grayscale, to which Gaussian blur isapplied to blur the grayscale image. The edgesare identified by the algorithm and is extractedas the region of interest. The region of interestis a trapezoidal mask. Hough transformation isapplied on the region of interest. The detectedlanes are the overlapped on the original videoframe. The processed frames are returned as avideo containing the identified lanes. As thecapturedvideoruns,theregionofinterestfocusesonlyontheregionwherethelanelinesarepresent.

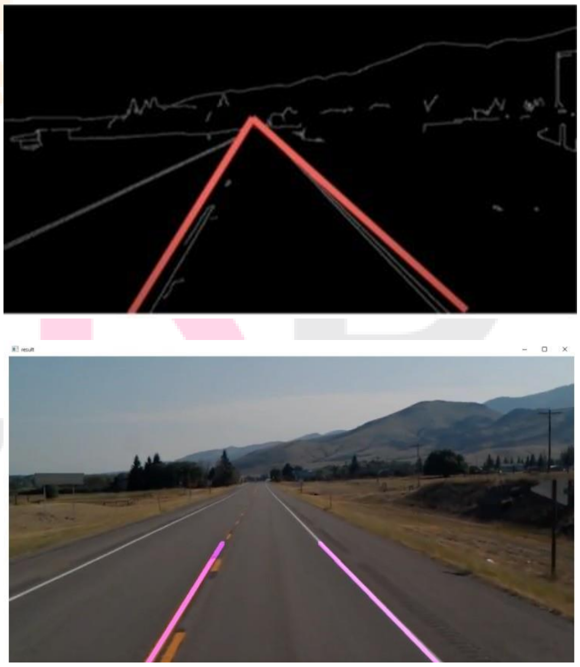

Fig4:LanedetectionusingCaneEdge

Cannyedgealgorithmisveryhelpfulincase of the model travelling on straight roads.Abird’seyeviewperspectivecanbeimple mented in order to find out the curvatureoncurvedroads.Thecameraiscalibrate dinitially, by processing various images of thesame object from different views. The camerathen undistorts the images to learn what theobjectis.Thebird’seyeviewisthemi m p l e m e n t e d b y u s i n g O p e n C V ’ swarpPerspective()function.Basedonthesource and destination points taken from thetrapezoidmaskoftheregionofinterest,apersp ective matrix is constructed. This matrixisfedtothewarpPerspective()functiontoc onvert the feed into bird’s eye view. Lane isdetectedinthisview.Theinverseoftheperspecti vematrixisusedtoconvertthebird’seye view back to normal view. This allows thecamera to see a little further and look whetherthe road bends or not.Based on the curvatureof the road, the curvature radius of the lanewillbeobtained.

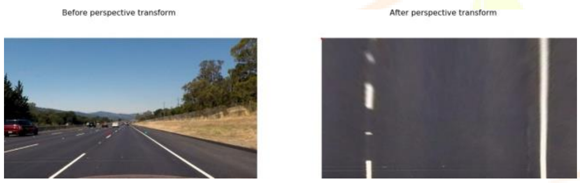

Fig5:Howperspectivec hangeworks

The offset of the car from the centre of thelane will also be obtained. Offset tells how farthe model is from the centre of the identifiedlane. It is obtained as a positive value if themodel is to the right of the centre of the lane,andasanegativevalueifitistotheleft.

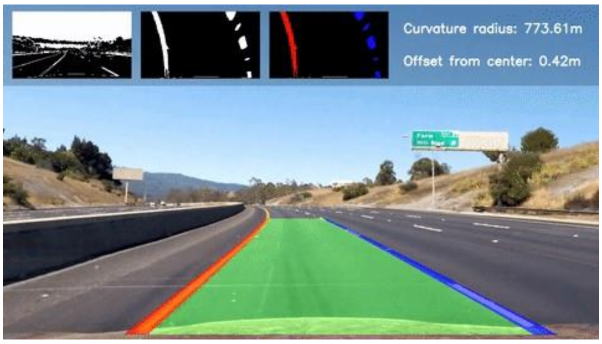

Fig6:LaneDetectionw ithperspectivechange

V. VEHICLEIDENTIFICATION

Thepresenceofvehiclesinthefieldviewofthec amerasattachedonthemodelisperformed by making use of object detection.Objectdetectioncanbedonebyusingth eYOLO algorithm. YOLO accepts an image asinputandcomputestheboundingboxcoordin atesandclassprobabilities.Forvehicleidentificat ion,YOLOispreferredasitcanperformmultiobje ctclassificationonthesameimageatanefficientsp eed.Thevideotakenbythe camera is broken down into video frameswhicharesubjectedtoobjectdetection.Ifth ereareanyvehiclesidentifiedintheframe,

Fig7:VehicleI dentification

theyareannotatedbytheuseofboundingboxes. This helps the model understand thatthesevehiclesareobstacles.Theannotatedvid eoframesareputbacktogether,togenerateanoutp ut.

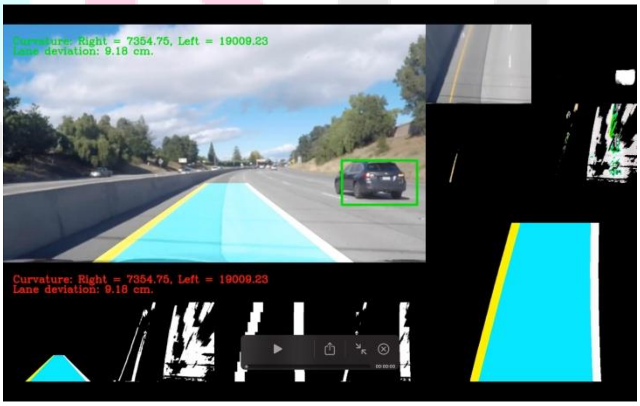

Fig8:VehicleIdentificationwithL aneDetection

Thisfeedisthenintegratedwiththeobtained lane detection video feed, where theobstacles detected and path for the model totravel are shown.In the resultant video, whenthe lane in which the model is moving is clear,the colour of the path is shown to be green.Whenanyobjectispresentinfrontofthemodel, or tries to cut into the lane, the colourof the path immediately turns red, indicatingthepresenceofobject.

VI. TECHNOLOGYUSED

- OpenCV
- Python
- RaspberryPi
- PiCamera
- RaspberryOS
- GPSSystem
- UltrasonicSensor
- Gyroscope
- DCMotors

VII. CONCLUSIONANDFUTURE SCOPE

Bytheuseofvariouscomputervisiontechniquessuchasperspectivetransform,houghtransform, objectdetection,detectionoflanesandvehicleidentificationhavebeenperformed. Traffic signs and signals can beidentified by the model to ensure traffic rulesareproperlyfollowed.Basedonthemovementofthenearbyvehicles,theirpathscanbepredicted and adjust the speed of the modelaccordingly.Localisedmappingcanbedonetobuildamapofthemodel'senvironment,leadingtobetterroadnavigation.Fullyautonomous vehicles are still in developmentand may not be financially feasible for people.Usingsuchtechnologies,themodelcanbe implementedinacost-effectivemanner.

VIII. REFERENCES

1. Autonomous cars: Recent developments,challenges, and possible solutions, 2021IOP Conference Series: Material ScienceandEngineering,SehajbirSinghandBaljitSingh
2. Self-DrivingRC-Car,IJARSEVol6,Issue10,Oct2017,DokeAkshayM,Shinde Vishal R, Kumbhar Mangesh RRaiNishant, Prof S. B. Bhosale
3. ArtificialIntelligenceinSelf-DrivingCarsResearchandInnovation:AScientometricandBibliometricAnalysis,GianlucaBiggiandJackStilgoe,ResearchGate,Apr2021
4. AutonomousVehicles:Levels,Technologies,Impacts,andConcerns
5. Nallathiga,Ramakrishna.(2019).HighwaysandRoadDevelopmentinIndia:ProgressandProspects.II.13-17.
6. Mohan,Dinesh&Tsimhoni,Omer&Sivak,M.&Flannagan,M..(2009).RoadSafetyinIndia:ChallengesandOpportunities.UMTRi-2009-1.
7. M.V.RajasekharandA.K.Jaswal,"Autonomousvehicles:Thefutureofautomobiles," 2015IEEEInternationalTransportationElectrificationConference(ITEC),Chennai, India,2015,pp.1-6,doi:10.1109/ITEC-India.2015.7386874.
8. M.Weber,"Whereto?AHistoryofAutonomous Vehicles," 2014. [Online].Available: http://www.computerhistory.org/atchm/where-to-a-history-of-autonomous-vehicles/
9. Bimbraw, Keshav. (2015). AutonomousCars:Past,PresentandFuture-AReview of the Developments in the LastCentury,thePresentScenarioandtheExpected Future of Autonomous VehicleTechnology.ICINCO2015-12thInternational Conference on InformaticsinControl,AutomationandRobotics,

Proceedings.1.191-198 .10.5220/0005540501910198.

10. UzmaKazi,DrSharmilaS.Gaikwad,Richa Koli,SamikshaMhadeshwar,2020,Model ofAutonomousCar,INTERNATIONAL JOURNALOFENGINEERINGRESEARCH&TECHNOLOGY(IJERT)Volume09,Issue05 (May 2020)
11. Mr Nihal A Shetty, Mr Mohan K, MrKaushikK,2019,AutonomousSelf-Driving Car using Raspberry Pi Model,INTERNATIONAL JOURNALOFENGINEERINGRESEARCH&TECHNOLOGY(IJERT)RTESIT–2019(VOLUME7 – ISSUE08)
12. Sulaimon, Kolapo & Onibonoje, Moses&Akinola,Solomon&Michael Adegoke,Ogunlade&Mmonyi,Anthony&Ayamolowo,Oladimeji&Dada, Samuel. (2018). Development ofanArduino-basedobstacleavoidancerobotic system for an unmanned vehicle.ARPNJournalofEngineeringand AppliedSciences. 13. 886.
13. Jun Jie Wee, Connie Tee and MichaelKahOngGoh.ForwardCollision WarningforAutonomousDriving.JournalofLogistics,InformaticsandServiceScienceVol.9(2022)No.3,pp.208-225DOI:10.33168/LISS.2022.0315
14. Bodhe, Ketan & Taiwade, Himanshu &Ingle, Janhvi. (2021). Image Processing& M.L Based Driverless Car with ImageDetectionSystem. IJARCCE. 10.164-169. 10.17148/IJARCCE.2021.10426.
15. Assidiq, A.A.M. & Khalifa, Othman &Islam, Md & Khan, Sheroz. (2008). Realtime lane detection for autonomousvehicles.82-88.10.1109/ICCCE.2008.4580573.
16. AbdulJunaidA,RoshanDanielS,Sadath Nabeel R , Manjunath G Asuti.(2020).LaneDetectionforSelf-Driving CarusingDeepNeuralNetworksandRaspberryPi.*InternationalJournalofAdvancedScienceandTechnology*,*29*(10s),4039-4048.Retrieved from http://sersc.org/journals/index.php/IJAST/article/view/21067
17. Zhang, Shiwen. “Traffic Sign Detectionfor Vision-based Driver ’ s Assistance inLand-basedVehicles.”(2016).
18. Bhupathi,Keerti&Ferdowsi,Hasan.(2020). An Augmented Sliding WindowTechniquetoImproveDetectionofCurved Lanes in Autonomous Vehicles.522-527. 10.1109/EIT48999.2020.9208278.
19. Shah,SyedHadiHussain&Hussain,Arif& Shah,Raza&Abro,Safdar.(2019).MiniRover-ObjectDetectingGroundVehicle(UGV).
20. S. S. Kalyan, V. Pratyusha, N. Nishithaand T. K. Ramesh, "Vehicle DetectionUsingImageProcessing,"2020IEEEInternational Conference for InnovationinTechnology(INOCON),Bangluru,India,2020,pp.1-5,doi:10.1109/INOCON50539.2020.9298188.