Mechanism of Decision-Making Ability in Prototype Vehicle using Artificial Intelligence

Jagrati Rajput
Dept. of CSE
FET Agra College
Agra, UP, India

R.K. Sharma
Dept. of CSE
FET Agra College
Agra, UP, India

ABSTRACT
Modern days vehicle technology is based on decision making ability in a short time with a high accuracy. So, this research article is based on driver assistance system using artificial intelligence. The number of passenger vehicles is increasing day by day which brings ease in daily life, along with the comfort there are certain negative effects of the growing number of on-road cars, such as congestion, pollution, and accidents, which eventually have an impact on human's social, economic, and environmental elements of life that must be overcome. Road accident is a common problem in the Indian road traffic environment, among which 40% of road accidents happen because of sleep-deprived drivers. The number of accidents due to the sleepiness of drivers can be hypothetically reduced by new technology in vehicles which attempts to improve safe driving. The technology is called advanced driver assistance systems (ADAS). This technology is based on three important parameters such a driver monitoring system (DMS) which monitors the driver's attention, position, and movement of eyes, a driver drowsiness detection (DDD) which warns the driver of sleepiness or other distraction, and an automatic parking system (APS) which park the car in the leftmost lane of the road. These segmets will play a vital role to guard against risky driving where the driver is not doing any action.The simulation and physical model study has been done for a vehicle in three different phases like: to detect and avoid the obstacles in the path of the vehicle to conduct safe parking, to monitor the driver's action and his motion while driving, and to alert the driver when the system detects the driver's sleepiness.

Keywords
Four-wheel vehicle, driver assistance system, Control algorithm using artificial intelligence.

1. INTRODUCTION
The paper discusses about vehicle technology and development a high performance during run-time and also increasing attention for having distinctive features as efficiency is high, low emission, pollution free, cost effective technology [1]. Vehicles have always been a part of human life. The number of passenger vehicles is increasing day by day which brings ease in daily life, along gain with the comfort there are certain negative effects of the growing number of on-road cars, such as congestion, pollution, and accidents, which eventually have an impact on human's social, economic, and environmental elements of life that must be overcome. Incidents in driving can occur on a daily basis with uncertain causes that the driver was sleep deprived. One form of accident causes the driver to sleep while driving, and it can lead to severe damage to the vehicle and it could be life-threatening for the driver [2-3].The ADAS system can cure these kinds of incidents. In India, on average among all accidents, there are 40% of accidents happen because of sleep-deprived drivers. Decision-Making ability in a car using artificial intelligence is an active safety system created to eliminate human errors while driving a car [4]. This system uses cutting-edge technology to aid the driver while they are driving and so enhance their performance. It makes use of a variety of sensors to collect the environmental data surrounding a car and in necessary situations, either inform the driver or take action itself. Through automated systems and early warning mechanisms, this system improves safety and response times to hazards. Some of these systems are standard on vehicles, while others can later be customized for the driver with features or even whole systems. Road accidents are increasingly being recognized as a growing public health problem. According to statistics 1, 37, 000 people were killed in road accidents in 2013 and more than 16 children die every day in India because of road accidents. There is one death every four minutes due to a road accident in India. Road accidents are an indispensable loss to our community [5-6]. According to the research, one of the major causes of road accidents is Sleep/Drink driving. A Sleep/Drunk driver is a person who lacks their focus on the road, and it can be due to they are too tired and feeling sleepy. Scientists are trying to develop several systems to prevent different types of accidents using alcohol sensors, automatic braking system and IR eye blink sensor. In this experiment, tried to develop a system which can get rid of these types of accidents to a great extent. With this alert system several distractions of the drivers can get rid which may cause for road accident [7-8].

1.1 Reduce the number of traffic accidents: The system should help drivers to identify dangerous situations and take corrective action to prevent accidents. It should provide warning signals when the driver is driving too fast, approaching a challenging situation or collision, or losing control of the vehicle.

1.2 Enhance driving performance: The system should support drivers to improve their driving performance by monitoring and analyzing their behavior on the road. It should provide real-time feedback on driving behavior, such as speed, acceleration, and braking, to encourage the driver to modify their driving style and drive more safely.

1.4 Increase situational awareness: The system should help drivers to remain attentive and aware of their surroundings, reducing the risk of distractions and fatigue-related accidents. It should provide information on road conditions, weather, traffic congestion, and other relevant factors that could interfere with safe driving [9].

1.5 Enhance convenience: The system should provide drivers with a range of useful features, such as route guidance, parking assistance, and traffic updates. These features should be easy to access and use, both in the vehicle and on mobile devices. During earlier innovation in electric vehicle technology, there are several techniques has been developed for automatic and smart vehicles. Overall, the objective of the advanced driving assistance system is to use technology to make driving safer, smoother, and more efficient, providing drivers with the tools and information they need to be responsible and conscientious on the road [10-11].

2. CONTROL TECHNIQUES FOR A VEHICLE

Control strategy of a vehicle is discussed here in detail. The vehicle braking force distribution, vehicle steering in systematic way using control techniques, and PID controller are foremost section of planned system arrangement, which has been a important role in this section. The main system is subdivided into smaller subsystems which are mentioned as follows:

2.1 AI-based driver face expression recognition system: This system continuously tracks the facial expression of the driver and based on the AI-based trained modal it recognizes whether the driver is actively driving the car or there is some kind of illness with the driver if so then a kind of signal is sent to the controller which activates the advanced driving assistance system (ADAS).

2.2 AI-based lane detection and obstacle detection Algorithm: Once it is detected that the driver is not actively driving the car this system takes control which is the lane detection algorithm started to track the lane and tries to park the vehicle on the safer side without any crash with the help of obstacle detection algorithm.

These subsystems are then interfaced with a main controller board having a microcontroller that takes a decision to various actions like slowing down a vehicle, turning the vehicle, applying brakes, etc. in such a way as to safely park the vehicle at the leftmost lane of the road without any crash or damage.

One more system is discussed above that is called the alert system which alerts the driver whenever there is any unwanted movement or facial expression is observed then an immediate alert warning helps the driver to wake up and concentrate on driving.

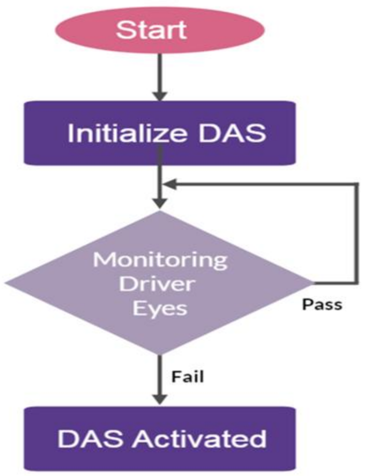

Fig1: Flowchart of ADAS working

The algorithm for obstacle avoidance can be grouped into the three following classes:
(a) Hypothesize and test
(b) Penalty test
(c) Explicit free space

The first approach hypothesizes and test method was the earliest proposal technique for the Autonomous vehicle avoiding the obstacles. The basic method consists of three steps: first, hypothesize a candidate path between the initial and final destination of Autonomous vehicle manipulator, second test a selected set of the path for possible collisions, third if a possible collision is found, propose an avoidance motion by examining the obstacles that would cause the collision. The entire process would be repeated for the modified motion. The main advantage of this approach is its simplicity.

The second class of algorithms for obstacle avoidance is based on defining a penalty function on manipulator configurations that encodes the presence of objects in its path. In general, the penalty is infinite for configurations that cause collisions and drops off sharply with distance obstacles. The total penalty function is computes by adding the penalties from individual obstacles and possibly, adding a penalty term for deviations from the shortest path. The key drawback of using penalty functions to plan safe paths is the strictly local information that they provide for path searching. Penalty functions are more suitable for applications that require only small modifications to a known path.

The third class of obstacle avoidance algorithm builds explicit representations of subsets of Autonomous vehicle configurations that are free from collisions, the free space. Obstacle avoidance is then the problem of finding a path, within these subsets, that connects the initial and final configurations. The advantage of free space methods is that their use of an explicit characterization of free space allows them to define search free space. Moreover, it is feasible to search for short paths, rather than simply finding the first path that is safe. However, in relatively cluttered spaces other methods will either fail or expend an undue amount of effort in path searching.

Here the method used the concept of a state to make Autonomous vehicle have an idea what it is doing at any given time. Autonomous vehicle turn defines different states:

enumsate_t{ stateStopped, stateMoving, stateTurning };

The “stopped” sate will be for when AUTONOMOUS VEHICLE is not moving at all. The “moving” state will be for when AUTONOMOUS VEHICLE is moving forward. Finally, the “turning” state will be used while AUTONOMOUS VEHICLE turning.

The algorithm for obstacle avoidance is discussed above in Figure 4.10. AUTONOMOUS VEHICLE that here going to use in the run () method of my turn enabled firmware will be as follows:

In the above diagram diamond shapes represent decisions and boxes represent processes or state changes.
AUTONOMOUS VEHICLE will begin in state_Moving state and will run for a limited amount of time, after which will

change to the state_Stopped state. The first two decisions in the flowchart address that part of the logic.

If AUTONOMOUS VEHICLE is in statemoving it will check for obstacles, and if one is found it will turn, which changes the state to stateTurning. If there is no obstacles are found then it will not change its state.

If AV is in state_Turning it will check if it is turned, at which point it will change back to state_Moving. If the turn is not complete then it will remain in the same state.

Recall that this is going to be inside the run () method, so as soon as this algorithm completes a pass the method will be called again, so this algorithm will run repeatedly.

Presently, the 2-point navigation mechanism is implemented for AUTONOMOUS VEHICLE. The positional information in terms of Latitude & Longitude of the Destination Point/ Target point is prefer to AUTONOMOUS VEHICLE and the information about the current position of AUTONOMOUS VEHICLE is acquired through the onboard GPS/ Local mapping. An imaginary Reference Trajectory (RT) is drawn at the start of the autonomous mode and the angle of this line (Reference Angle) with reference to the north is stored. This angle along with angle of current heading (obtained through GPS) is used to generate the Hdgerr. The perpendicular distance of AUTONOMOUS VEHICLE from the RT is termed as cross-track error (yerr). This cross-track error is also converted in to equivalent heading error and summed up to Hdgerr. The total heading error is restricted between –1800 and 1800 by passing through short angle computation. The scheme requires only GPS measurements. Depending on the sign of heading error, either left or right turn of steering is commanded, leading to left or right turns. The development for GPS based AUTONOMOUS VEHICLE is started with commercially available very low cost BL2120 SBC. The steering of that system was such that it was taking steering command for maximum only. We were not able to issue any intermediate steering command. As well as, the motor employed for turning got burned several times during testing. These all issues forced us to get AUTONOMOUS VEHICLE where intermediate steering control could be employed through good quality servo, resulting in current system. However, this motor is controlled through PWM so we had migrated from BL2120 SBC to Arduino ATMega328 board a cost-effective solution. As there were two PWMs needed one for speed control and another for steering control and the Arduino was able to produce 6 PWMs it becomes inherent choice. The servo and the motor engaged for turning and speed is tested for its PWM frequencies and duty cycle. Then AUTONOMOUS VEHICLE is driven through PWMs generated through Arduino SBC for various duty cycle and frequencies. Since there was no appreciable change in performance of the motor and servo for frequencies between 30 to 90 Hz, 50 Hz is taken as the operating frequency for servo and motor. The program is developed for guiding the AUTONOMOUS VEHICLE autonomously based on the local map data and limited lab testing has been carried out. Next test is performed while the autonomous vehicle was allowed to run on ground. Latitude and longitude of point inside the FET is preferred to the Arduino along with the program as Destination Point/ Target. The max value of duty cycle of motor is made lower and release of steering command after 200 ms is made in program to avoid these things and the tests were conducted again. The holding of turn command is also increased for 400 ms and the tests were carried out with modified hardware. However, the autonomous vehicle was found to be working as per the expectation. The three sensors for guiding the autonomous vehicle autonomously are found to be incapable up to this point of testing. It is felt strongly that either we should employ the sensor with higher frequency of update rate or magnetic compass. It is also felt that if the autonomous vehicle has to move the long distance, then finally its steering got stabilized. The program code for obstacle avoidance which is implemented in the Arduino board for the local mapping with all functionality,

```
% Start point of AUTONOMOUS VEHICLE
Theta = atan2((y-q(2)),(x-q(1))) - q(3);
Check the target point
r = sqrt((x - q(1))^2 + (y - q(2))^2);
% fctx = (fct*(cos(theta));
% fcty = (fct*(sin(theta));
fctx = fct*((x - q(1))/r);
fcty = fct*((y - q(2))/r);
Turning angle of AUTONOMOUS VEHICLEdue to obstacles in path
% angle = [ pi/6 pi/ pi/2 (2/3)*pi (5/6)*pi pi (7/6)*pi (4/3)*pi (3/2)*pi  (5/3)*pi, (11/6)*pi 2*pi ];
for n=1:11,
m0(1,n) = tan(ang(1,n) + q(3));
m = 1;
c = 100;
c0(1,n) = q(2) - m0(1,n)*q(1);
% End points of the Obstacle
xm(1,n) = (c - c0(1,n))/(m0(1,n) - m);
ym(1,n) = (m0(1,n)*c - m*c0(1,n))/(m0(1,n) - m);
if ((xm(1,n)<x2) && (xm(1,n)>x1))
dsqr(1,n) = ((xm(1,n) - q(1))^2 + (ym(1,n) - q(2))^2);
p = fcr/dsqr(1,n)/sqrt(dsqr(1,n));
fcrx(1,n) = p*((xm(1,n)) - q(1));
fcry(1,n) = p*((ym(1,n)) - q(2));
else
dsqr(1,n) = 0;
fcrx(1,n) = 0;
fcry(1,n) = 0;
end
end
xm
ym
Fx = fctx -
(fcrx(1,1)+fcrx(1,2)+fcrx(1,3)+fcrx(1,4)+fcrx(1,5)+fcrx(1,6)+
fcrx(1,7)+fcrx(1,8)+fcrx(1,9)+fcrx(1,10)+fcrx(1,11));
%Fxa = fctx - sum(fcrx');
Fy = fcty -
(fcry(1,1)+fcry(1,2)+fcry(1,3)+fcry(1,4)+fcry(1,5)+fcry(1,6)+
fcry(1,7)+fcry(1,8)+fcry(1,9)+fcry(1,10)+fcry(1,11));
Find the target location
beta = (atan2(Fy,Fx)) ;
v = k1*sqrt(Fx^2 + Fy^2);
qd(1,1) = v*cos(q(3));
qd(2,1) = v*sin(q(3));
qd(3,1) = k2*(beta - q(3));
%end function
```

The behaviour of autonomous vehicle and the plan can be experienced if it can get the route of the trail, when subjected to a given place of circumstances. The path representation of autonomous vehicle is developed in MATLAB-12 and the plan is tough for Autonomous vehicle to arrive at unlike purpose point in every four dissimilar quadrants. The MATLAB-12 curriculum has been built-in which explain the constants k1 and k2. Specified a worldwide orientation equation flat surface in which the early location and direction of autonomous vehicle is given by (q1, q2, q3) with deference to the position scheme. Autonomous vehicle is to create from a point (x, y) and has to attain a specified spot with esteem to the limited position plane. Since, this position flat surface position change constantly with high opinion to the stage location vehicle, the initial or starting location from the derivation of the autonomous vehicle is given by

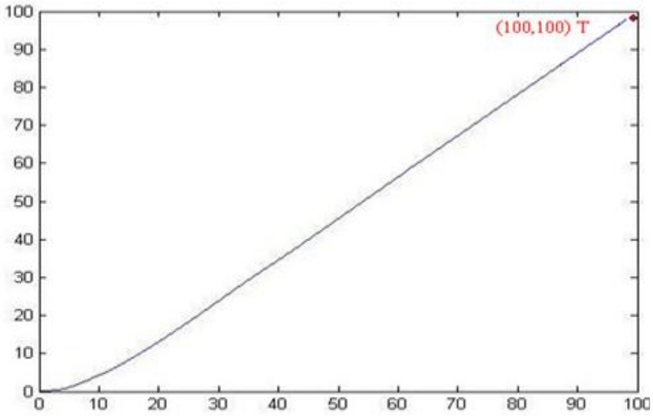

Fig 2: The route of Autonomous Vehicle when no obstacle in path

In Figure 2, Autonomous vehicle is starting from the source. There is no obstacle in the route, therefore Autonomous vehicle move below a stable striking force from the origin to the objective. Hence the route of Autonomous vehicle is a straight line.

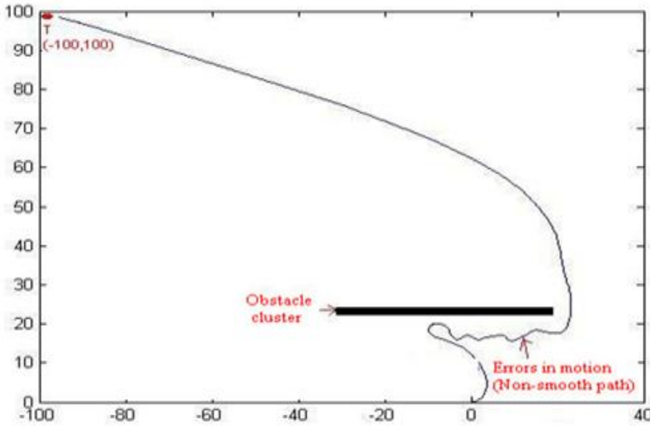

Fig 3: Simulates path of Autonomous Vehicle reaching the target, which comes in second quadrant

The goal is in the 2nd quadrant at (-100,100). But as quickly as the ultrasonic sensor map the blockage come together, the revolting forces start performing shown in Figure 3. Thus, Autonomous vehicle at hen calculate the resulting of the striking and the revolting energy force and traverse in the way of the resulting force. The rate of movement depends on the extent of the resulting force F. The observation of the wind which is shown in Figure 4. This is a blunder, which can be rectify by adjust the principles of the parameter k_1 and k_2.

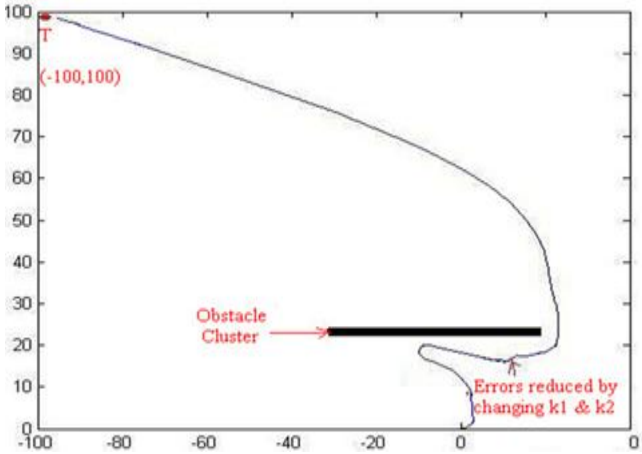

Fig 4: The route of Autonomous Vehicle among k_1=7 and k_2=5

The most favorable standards of the parameter k_1 and k_2, in figure 5 are known as,
k_1= Onward speed
k_2= Pointed deflection of the wheel
Geometric modeling of Autonomous vehicle considers immediately single obstacle huddle. Yet, a figure of obstacle cluster can be measured by modify the programing code. With the purpose of, allowing for two obstruction group expressions. Obstacle of every form and dimension can be describing with the help of suitable equations. Autonomous vehicle is moving smoothly avoiding the obstacle like static or dynamic which are coming in his path. The results are showing the response according to the situation. Here in figure 5 shown below is that Autonomous vehicle is moving from starting point to target point after avoiding the obstacles in his path.

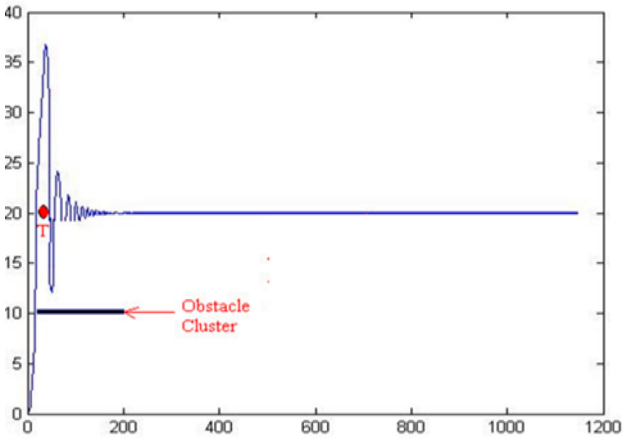

Fig 5: Autonomous Vehicle responses after reaching the target

3. RESULTS

3.1 Final test results of the system

Simulation of the controller and decesion making system is shown below in figure 5. The variables of every system mechanism are located as describe over. The simulation of the system are shown on computer screen in scope facial graphics of a driver, vehicle moving straight on a road, parking left on the road. The output results are display for three sets of signal which is specified to the controller circuit [15-16].

Successfully trace the iris movements and facial expression for identifying the condition of a driver is shown in figure 5

Fig6:Results of Face expression recognition

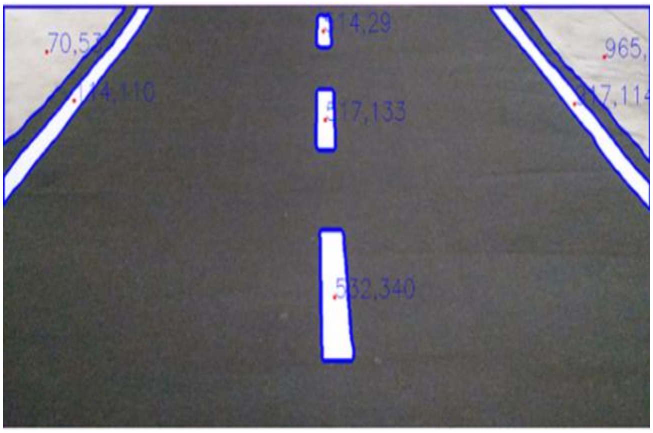

Fig 7:Results of Lane detection algorithm

The figure 6, shows the road lane detection which helps to track the position of a vehicle and assist the vehicle to run inside the lane.Final test of the vehicle parking on leftmost of the road which was tested succesfully at the indoor test of prototype with advance driving assistance system (ADAS) and other Sub systems. The figure 7 shown below.

Fig 8:Results of vehicle parking on leftmost of the road

4. CONCLUSIONS

The future of driver assistance system technology is bright, with continued development and innovation expected in the upcoming years. Some of the research focus for future ADAS systems include: More advanced autonomous driving capabilities: while many ADAS systems are designed to assist the driver, future systems will likely offer even more autonomous driving capabilities, such as fully self-driving vehicles. Connectivity and shared intelligence, ADAS systems will increasingly be connected and share information with other vehicles, as well as with infrastructure and pedestrians, to help prevent accidents and optimize traffic flow. Personalization, future driver assistance systems will be more personalized, adapting to the individual preferences and driving styles of each driver to enhance safety and comfort. More sensors and improved perception: ADAS systems will rely on more advanced sensors and perception technologies to better detect and respond to the environment, such as using lidar, radar, and advanced camera systems. Enhanced cybersecurity such as ADAS systems become more connected and integrated, cybersecurity will become an increasingly important consideration to prevent hacking and other cyberattacks. Overall, the future of ADAS systems promises to offer even greater levels of safety, convenience, andefficiency for drivers and passengers alike.

5. REFERENCES

[1] Awad. F and Shamroukh.R , " Electric Vehicle Detection by Intelligent Machine Urban Search and Rescue Using Image Processing and Neural Networks" International Journal of Intelligent Science , pp.4 39-53, 2022

[2] Gold.J and Koren.K, "Hybrid vehicle with Obstacle Avoidance with Ultrasonic Sensors". IEEE Journal of Robotics and Automation, vol. RA-4, No.2, pp. 213-218, 2023.

[3] Hook.A, and Koren. K, "The vector field histogram-fast obstacle avoidance for electric vehicle, IEEE Trans. on Robotics and Automation, pp.501-518, 2022.

[4] Harrol. J and Latombe .J.C, "Hybrid Machine motion planning: a distributed representation Approach", International Journal of Robotics Research, vol.10 no.6, pp. 628-649, 2018.

[5] Mongin.A.K , Chatterji.B.N , Ray A.K . "Design of a real-time tracking system for fast-moving objects with Solar EV" IETE J. Res 43, pp.359-369, 2022.

[6] Nick.D and Forsyth.A, "Finding and tracking people from the autonous electric machine", in Proceeding of Computer Vision and Pattern Recognition (CVPR), Madison Wisconnin , June 2019.

[7] Nian, X. Peng, F. and Zhang, H. "Regenerative braking system of electric vehicle driven by brushless DC motor," IEEE Trans. Ind. Electron., vol. 61, no. 10, pp. 5798–5808, Jan. 2023.

[8] Prassler, E. Bank, D. Kluge, B. and Hagek, H. "Key technologies in robot assistants: Motion co-ordination between a human and a mobile robot," proc. 30thint .sym. Robotics, 2001, pp. 410-415, Mar. 2020.

[9] Schulz, W. Burgard, D. and Fox, "People tracking with mobile robots using Sample-based joint probilistic data association filters", International Journal of Robotics Research pp.99-116, Sept. 2023.

[10] Urzelai, J. and Ezkerra, J, M. "Fuzzy controller for wall-following with a non- holonomous mobile robot" FUZZY-IEEE / IFES, BARCELONA, July, 2021.

[11] Yadav, A. Chaturvedi, D, K. "Design and development of safe intelligent moving machine". International Journal of Electrical Machines & Drives(IJEMD). vol.2, pp 16-21, Feb. 2016.

[12] Yadav, A. Chaturvedi, D, K. "Mathematical Model for Ground Electric Vehicle Using Matlab-Simulink". International Journal of Automatic Control System (IJACS). Vol. 2, pp 26-34, April 2019.

[13] Yadav, A. Yadav, N. Chaturvedi, D, K. "An Intelligent Electric Vehicle (IEV)Using LabVIEW". IEEE 2nd International Conference on Communication, Control and Intelligent Systems (CCIS) vol.2, ISSN 978-5090 Nov. 2016.

[14] Yadav, A. Chaturvedi, D, K. "An Autonomous Ground Electric Vehicle using LabVIEW". National Systems Conference on Super Intelligent Man and Machines sponsored by IEEE (NSC-17), DEI, Agra, Dec. 2017.