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Modelling and Simulation of Semi-Autonomous Cars Undercarriage Cleaning Mobile Robot

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Abstract: This paper introduces and explains about precise planning and guiding methods for a car's undercarriage cleaning mobile robot. The proposed semi-autonomous mobile robot makes use of Mecanum wheels, ESP-32, and IR sensors to effectively clean the entire undercarriage of the car. The mobile robot travels in horizontal and vertical directions and is controlled throughout the process. The robot guidance incorporates line follower algorithms as well as programmed motion commands. Line follower algorithm has been implemented via IR sensors. Modeling of the mobile robot is presented through the SolidWorks environment. The path planning is validated using MATLAB Simulink, V-REP and MATLAB as an API. We observed that the size factor hinders the process of adapting car cleaning to household purposes. We worked in that area and created a compact robot for cleaning. This job would serve as a cost-efficient yet time-saving solution to the present circumstances.
Keywords: mobile robot, omni directional, mecanum wheel, ESP32, SOLIDWORKS, ANSYS, MATLAB, simulink, V-REP.

I. INTRODUCTION

The field of robotics is rapidly evolving, and robots are gradually becoming an integral part of humanity's daily lives. These days, robots are being used for a variety of residential purposes in addition to manufacturing facilities. Even small robots are employed on a large scale. They're employed in a wide range of sectors, including the office works, defense, medical field, sports, farming, and more. The robots that move from one location to another to perform certain task while taking up least amount of space are called mobile robots. They are primarily utilized for tedious and repetitive tasks [7]. Traditional car washing, on the other hand, is a time-consuming and labor-intensive process. In traditional car washing, chemicals like hydro fluoric acid are employed, are toxic to the human body and can cause numerous skin conditions. We attempted to resolve this issue using an autonomous mobility robot. We proposed a model that explains how a robotic system can be used to clean the undercarriage of a car in a domestic setting. This undercarriage washer is a high-pressure mechanical spraying robot that removes loose paint, mold, filth, dust, mud, and dirt from the car's bottom surface. The rise in demand for cost-cutting services led to the development of specialized service robots. A good example is a mobile robot that cleans the undercarriage of a car for domestic use. The majority of contemporary vehicle washes are guided by human operators. Due to rising maintenance costs, staffing costs, and the hazardous effects of chemicals used in car washing, this cleaning activity may be performed autonomously in the future. Almost majority of autonomous robots that have been built aid human operators in vast, fixed areas with well-defined structures. Only a few methods are capable of completing a task without prior knowledge of the environment's architecture, geometry, or complexity. There still exist many problems in intelligent navigation and path planning [3]. Identification of the cleaning area, obstacle detection, and accurate path tracking are only a few of them. This paper describes the modelling and simulation of a path-following undercarriage cleaning robot. Our primary focus is cleaning the vehicle's undercarriage. Our primary goal is to produce a compact, easily accessible robot for domestic use and to save time and money for human being. Consequently, our effort strives to bridge the gap between autonomy and compactness while remaining light weight and efficient system. Based on the line following algorithm, the robot travels either horizontally or vertically at a certain time. Line-follower robots almost universally make use of black lines or white lines on a white or light-colored backdrop. This is due to the ease with which a robot may be programmed to distinguish two colors with significantly differing intensity. Line follower robots are rare, due to difficulty in recognizing colors in a light changing environment. The IR sensor aids the entire procedure. Infra-red sensors are radiation-sensitive optometric components that are frequently seen in motion detectors. The mobile robot's direction is controlled by nine infrared sensors. Robots of various geometric sizes, shapes, and agility are required for various cleaning situations. As a result, a planning system must be capable of generating cleaning paths for robots with varying geometry and kinematic capabilities. The cleaning area is identified first, and then the planning system begins. The nozzle's spread directly affects the size of the cleaning area. Several types of nozzles are offered for diverse applications. Some nozzles produce a triangular water jet (fan pattern), while others produce a narrow, spiraling jet of water (cone pattern). By utilizing nozzles with a higher flow rate, a lower output pressure can be achieved.

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It is attached at the top end and sprays water on the undercarriage, which cleans it of dust and debris. SolidWorks is utilized for designing, whereas V-REP and MATLAB as an API, as well as MATLAB Simulink, are used for simulations.
The structure of the paper is as follows: The 2^{nd} Section provides an Overview of the Mobile Robot. The 3^{th} Section explains the robot motion simulation and is followed by the Selection of nozzle in the 4^{th} Section. The 5^{th} section went over the Electronic Circuit arrangement. Finally, the 6^{th} section and 7^{th} section concludes the paper and provides future scope.

II. OVERVIEW OF THE MOBILE ROBOT

The components that make up the proposed undercarriage cleaning robot include an ESP 32, an infrared sensor, an aluminum chassis, an L298 Driver IC, a side shaft motor, a transformer, and a nozzle. The robot uses a path planning algorithm to run beneath the car either horizontally or vertically. The nozzle is mounted on the top of the robot and sprays water to clean the undercarriage effectively. The robot is also equipped with an IR sensor, which guides it along the correct path. Both Fig. 1 and Fig. 2 depict the robot.

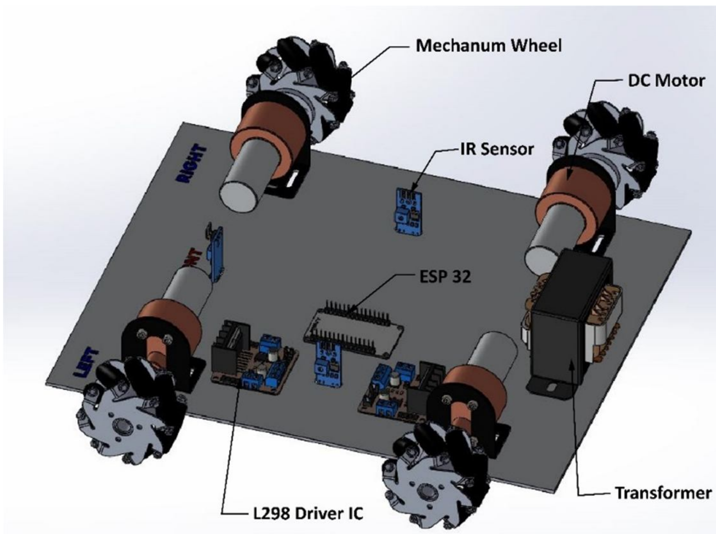

Fig. 1 Base Plate of Mobile Robot with Electronics components

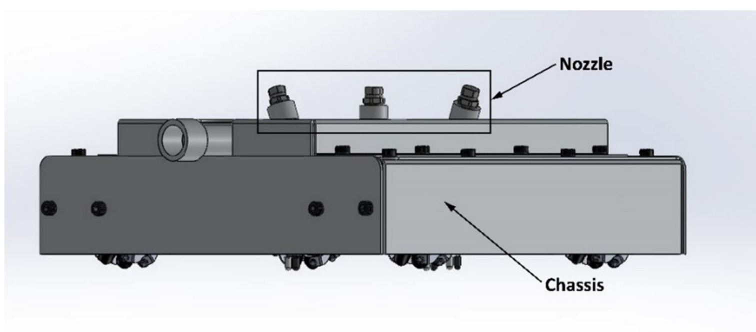

Fig. 2 Isomentric View

I) Mecanum wheel: Each of the four mecanum wheels is connected to a motor so that they can be controlled independently. The four wheels on the robot allow it to go forward, backward, and spin like any other vehicle. The axis of the rollers in Mecanum wheels is at a 45-degree angle to the axis of the active wheel base. By adjusting the clockwise and counterclockwise angular velocities of each wheel, a robot can move in Horizontal direction, Vertical direction and can also able to rotate [4]. We divide the force into two vectors, one in the forward/reverse direction and the other in the right/left direction. When the wheels on one side are spun in different directions, the forward and reverse vectors cancel each other out, however the sideways vectors accumulate. When you do the same thing with the other two wheels, you get four more sideways vectors. We're employing four Mecanum wheels with a load capacity of 16 kg and a diameter of 60 mm. II) ESP-32: The ESP32 serves as our microcontroller. The ESP32 is a series of low-cost, low power microcontroller. Its standard feature includes Wi-Fi and Bluetooth.

The ESP32 can operate at temperatures between -40 ^{o}C to +125^{o}C, making it suitable for use in a variety of commercial and industrial settings. It can dynamically erase defects of external circuit and adapt to changing external environment, due to improved calibration circuitries. ESP32 achieves ultra-low power consumption by combining multiple proprietary software types. These characteristics will help us progress with our project's development. III) IR sensor: By emitting or detecting infrared radiation, the IR (infrared) sensor identifies particular properties in the environment. Infrared radiation is emitted by IR. Infrared rays are reflected and picked up by photodiodes when they strike a white surface, creating voltage changes. An IR detection system consists of 5 primary components: IR source, transmitting channel, optical component, IR receivers or detectors, and signal processor. IR sources include infrared LEDs and infrared lasers with specified wavelengths.

We are using nine infrared sensors. Three sensors [8] on each side (Front, Left, Right) side in order to implement the Line Follower Algorithm on an omnidirectional robot. IV) Chassis: Aluminum is a soft metal; it is usually mixed with other metals in an alloy. Aluminum 6061 T6, which is 97 percent aluminum with iron, copper, titanium, and a few other metals mixed in for strength, is one of the most used alloys. Because aluminum is one of the lightest metals, it is a preferred choice for many robotic chassis. This reduces the overall weight of your robot.

The chassis is built of 6061-T6 aluminum that is 2mm thick. Some chassis parts are welded together, while others are secured with M6 Allen bolts. Aluminum has a moderate to high tensile strength, excellent corrosion resistance, and excellent machinability and weldability. V)L298 Driver IC Because the voltage and current requirements of a motor differ from those of the controlling device, it usually necessitates the employment of a driver circuit. The Driver IC in connected between motor and controller unit. The main purpose of the Drive IC is to run motor with low current single by converting it into high current signal. The L298 Driver IC is what we're using. This L298 Driver IC is mostly used to drive DC motor and Stepper motor. It can drive up to 4 DC motor or 2 DC motor with directional and speed control. The L298 IC contains four distinct power amplifiers, two of which may be combined to produce H-bridge A, while the other two types of amplifiers can be combined to form H-bridge B. One H Bridge is used to control the motor direction by switching the polarity, whereas a bipolar stepper motor is controlled by a pair of H bridges.VI) Side Shaft Motor: Side Shaft Motor is most suitable for medium weight robot running on average voltage. We are utilizing Johnson Side Shaft Geared Motors of the B Grade, which operate at a speed of 150 RPM at 12 V DC. Our requirements have been met by the motor, which has a rated torque of 4.7 kg/cm. Excellent for line tracking robotic application. VII) Transformer: Transformer is used in the transmission of electrical energy. The input to the transformer is Alternating Current. The main application of transformer is to increase or decrease the voltage supply without changing the frequency of AC. It works on the principles of electromagnetic induction and mutual induction. It is basically a voltage control device. Our mobile robot is powered by a transformer. A 12V step-down transformer is being used (0-12 configuration) which lower the 240V supply to 12V and provide it to the input of the power supply unit. The power supply unit is composed of a full-way rectifier that converts AC to DC.VIII) Nozzle: The undercarriage of the vehicle is cleaned with nozzles. For this, we use high-impact flat fan nozzles. They produce droplets that are smaller and less likely to drift. They are effective up to a spray angle of 60 degrees. They apply uniform spray across the entire width of the nozzle's spray pattern. Bandwidth can be regulated through nozzle release height of the nozzle and spray angle of the nozzle. Cleaning is accomplished using three flat-faced nozzles. For effective cleaning, the three nozzles are angled at 90°, 80°, and 100°, respectively.

III. PATH PLANNING

A. Generalized Path Model: MATLAB Simulink

Simulations are required for the creation and validation of a generalized path. Predominantly, MATLAB Simulink was utilized for the simulations. Simulink is a graphical extension of MATLAB that offers an interactive and effective graphical user interface for, simulation, modelling and analysis of dynamic systems. It comprises a pre-defined block needed to develop a system's graphical model. MathWorks Corporation designed the Simulink solver to facilitate the modelling of various systems. This program contains a wide range of libraries of solvers, which calculates the time for the next step of simulation and implement numerical methods to perform mathematical operation with various objects (vectors, matrices, numbers) and also solve the sets of ODEs which describe the model. The solver will also satisfy user specified requirements for solving the initial value problem. In addition, Simulink library contains an extensive collection of models with mathematical descriptions and documentation.

We must complete a few prerequisites before we begin the simulation. Initially, we must add the "Mobile Robotic Simulation Toolbox" MATLAB Simulink add-on [9]. This toolkit is used for the construction and visualization of algorithms. It comes with a wide range of pre-defined models that may be used at any level of simulation. The mathematical model primarily (Fig. 3) of two blocks.

1) Generalized Path
2) Omni Directional Robot (4 Mecanum wheel kinematic model)

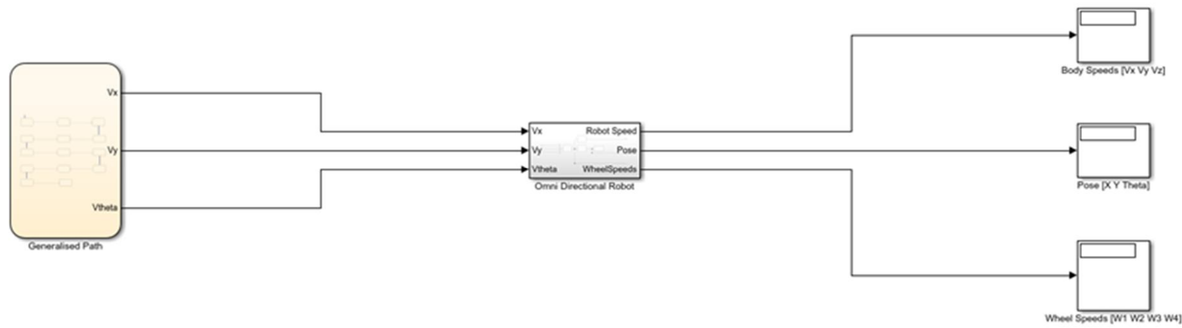

Fig. 3 Simulink Model of Mobile Robot

a) Generalized Path: This block was developed with the help of a state flow chart. A state flow chart is a visual representation of finite state. It includes transitions, data and states. This simulink block contains the mobile robot's Generalized Path Algorithm for navigation. The algorithm will feed the Omnidirectional Robot Block with the mobile robot's horizontal velocity, vertical velocity, and orientation at regular intervals. The linear velocity and time required to travel a specific distance have been estimated using the relationship between linear velocity, time, and displacement. Initial assumptions are made regarding the car's wheelbase and track width. In Table I, the calculated parameters are presented. The state's flowchart is depicted in Fig. 4.

TABLE I
PATH PLANNING PARAMETERS

Wheel Base of the Car	2600 mm
Track width of the Car	1700 mm
Horizontal Distance travelled by the Mobile Robot	1300 mm
Vertical Distance travelled by the Mobile Robot	350 mm
Linear Velocity of the Mobile Robot	0.56 m/s
Time required for the mobile robot to travel in Horizontal Direction	23 sec
Time required for the mobile robot to travel in Vertical Direction	6 sec

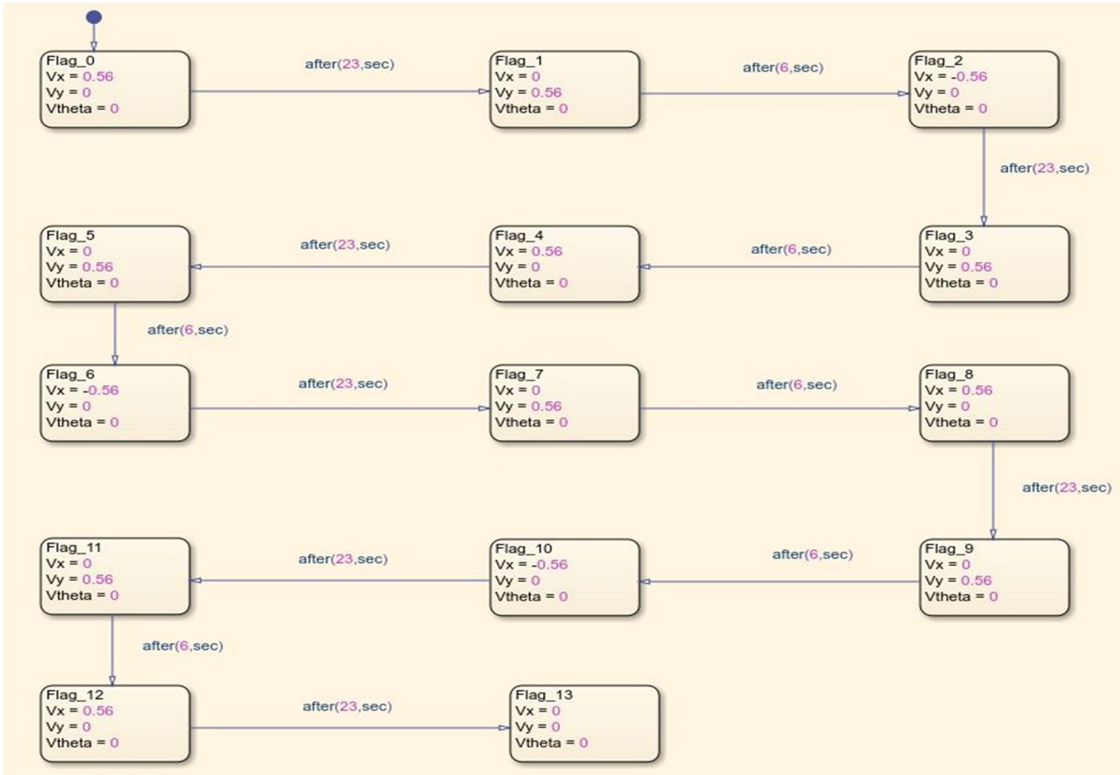

Fig. 4 Algorithm in State flow chart

b) Omni Directional Robot: The initial stage in the simulation was to develop the Four-Mecanum Wheel Kinematic Model using the pre-defined block from the toolkit that met all mechanical constraints. The toolkit comes with a number of pre-defined blocks that can be used at various points in the simulation process. Omni Directional Robot Model was created with the aid of the toolkit's Four-Wheel Mecanum Inverse Kinematics Block, Four-Wheel Mecanum Forward Kinematics Block, Four-Wheel Mecanum Simulation Block, and Robot Visualizer Block [9]. As inputs for this model, the State flowchart will assign velocity in the horizontal direction, velocity in the vertical direction, and orientation. Using Inverse Kinematics, the Four Wheel Mecanum inverse kinematic block translates input into the angular velocity of each wheel. The simulation block transforms the angular velocity of the wheel into the location and orientation of the robot and then sends that information to the visualizer block. The Visualizer block depicts the path followed by the mobile robot in graph form.

Fig. 5 illustrates the omnidirectional block. Fig. 6 shows the generalized path of the mobile robot by taking the distance travelled by the robot in horizontal and vertical directions as X and Y respectively.

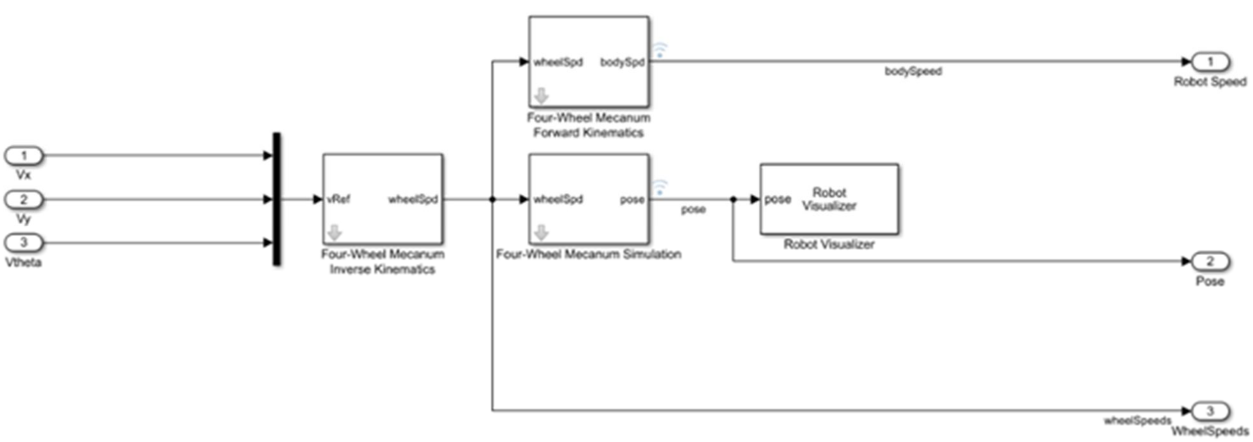

Fig.5 Omni Directional Robot Block

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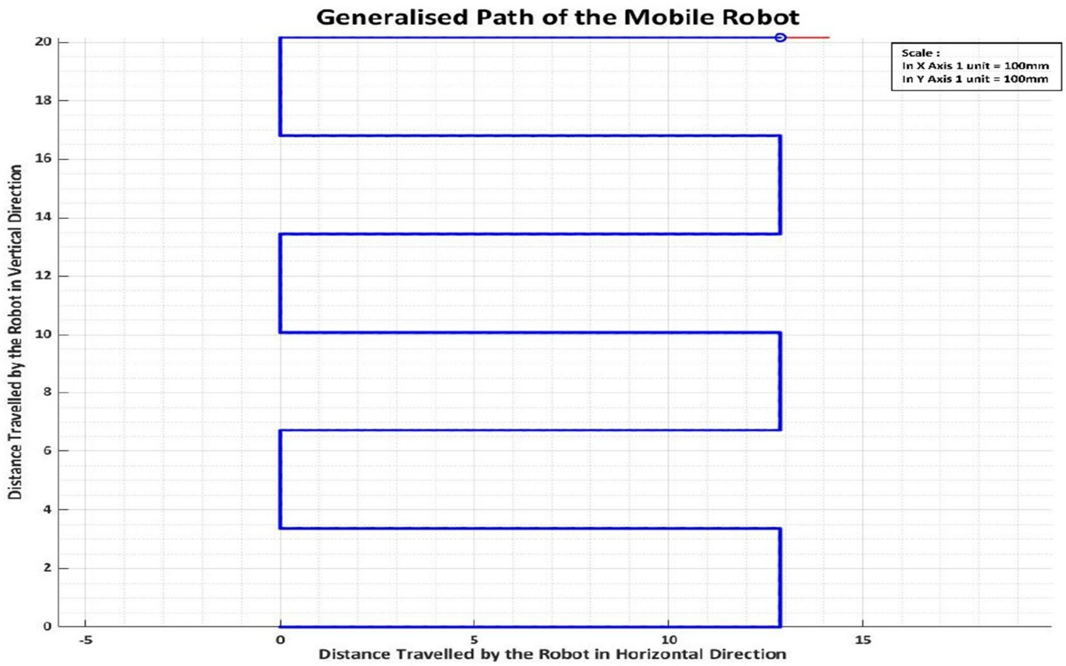

Fig. 6 Generalized Path of Mobile Robot

B. Line Follower Path Model: V-REP and MATLAB as API

A simulation environment was used to verify the mathematical model and to view the path of the mobile robot. The majority of simulations were conducted in V-REP with MATLAB serving as the API [10]. V-REP is the Virtual Robot Experimentation Platform, which is utilized to generate 3D models that may be used to stimulate any robot. MATLAB can be easily connected with this, and it has a wide range of potential applications. MATLAB is an interactive platform for performing a variety of numerical analyses and computations. Instead of using V-REP's conventional programming language Lua, we are planned to use MATLAB to develop control algorithms for our mobile robot, MATLAB servers as remote API. Regardless of the programming language, remote APIs offer us to implement four distinct modes of operation suited for distinct objectives (Fig.7). The First mode is called as blocking function call, which forces an API client to wait for simulator response. The second mode is called non-blocking function call, which can only use to send data to simulator and it does not wait for server response. The third mode is called data streaming, in which a client sends a message once and server sends response periodically. The last mode is called synchronous operation which synchronize each step of the simulation with API. In synchronous operation mode, the server delays the execution of each simulation step until a trigger is received from the client. As a result, this mode of communication is typically the slowest [6].

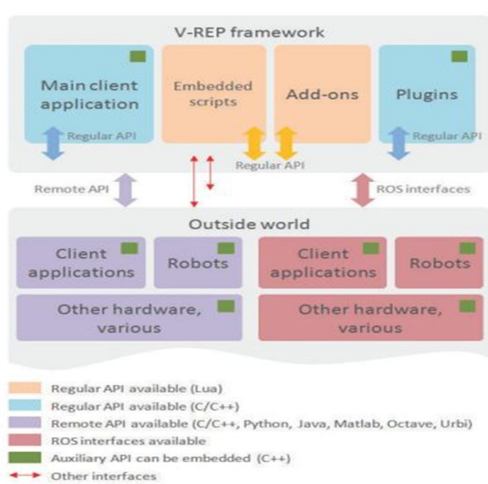

Fig. 7 V-rep and MATLAB as API

In the process of simulation, the first step is to construct a properly defined mobile robot model in V-REP Coppeliasim. The robot model should satisfy all structural, kinematics and mechanical constraints and can be simulated in a manner that mimics actual operation. For the verification of the path planning algorithm, we used a default omnidirectional robot model (KUKA Youbot) that is accessible in Coppeliasim for simulation purposes. According to our requirements, we have customized the KUKA Youbot to some extent. We have removed the six-degrees-of-freedom (DOF) arm and other unnecessary components that are beyond our field of interest. To develop a line follower algorithm with great precision, we have added 9 orthographic IR sensors (3 for the front, 3 for the right, and 3 for the left) (Fig. 10).

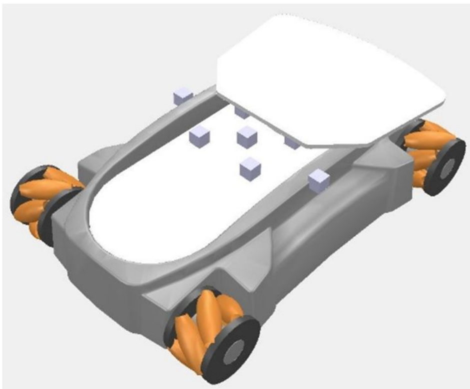

Fig. 8 Isometric View

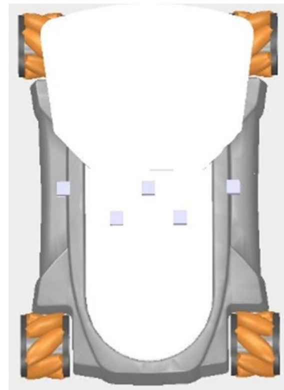

Fig. 9 Top View

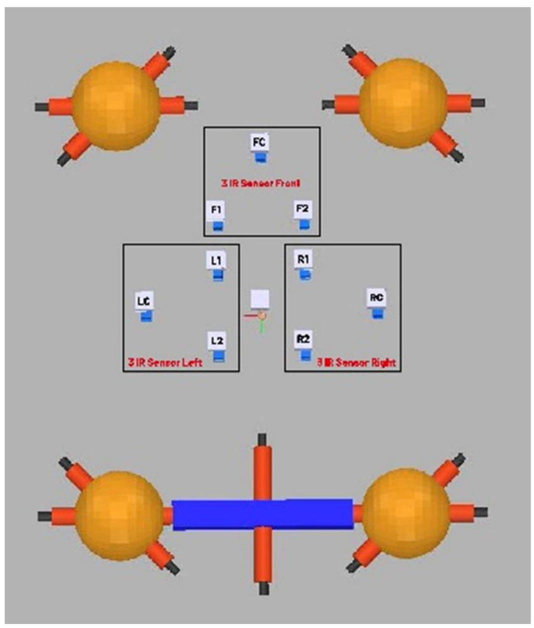

Fig. 10 Sensor alignment

The mobile robot model was constructed with dynamic and visually enabled bodies to boost calculation performance. Segmented paths were used in order to enhance the simulation's visual appeal. This arrangement has proven to be the most reliable for numerous simulated instances. MATLAB was linked to the modified V-REP robot model through remote API connection. The link permits simulations to be run directly in MATLAB, with data being transferred simultaneously between both MATLAB and V-REP. The mathematical model developed in MATLAB is used to evaluate the trajectories and velocity control modules of the mobile robot model in V-REP by controlling the angular velocity of individual wheels. Fig. 11 depicts the starting position of the mobile robot in the V-Rep environment. Initially, we simulated the mobile robot on the path depicted in the graph (Fig. 6). Next, the robot's motion was evaluated for several paths, including a path created for top commercial vehicles (Maruti Suzuki Alto, Tata Indica, and Maruti Suzuki Celerio).

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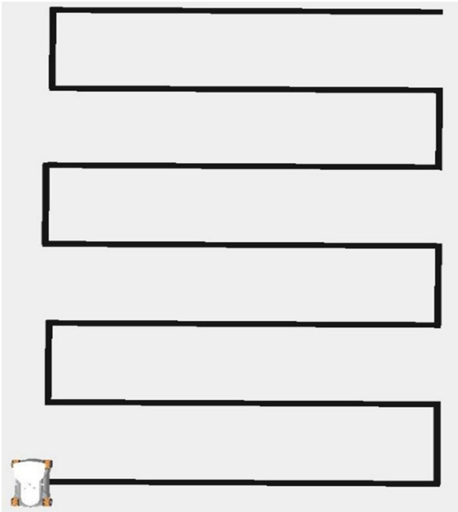

Fig. 11 Path of Mobile Robot

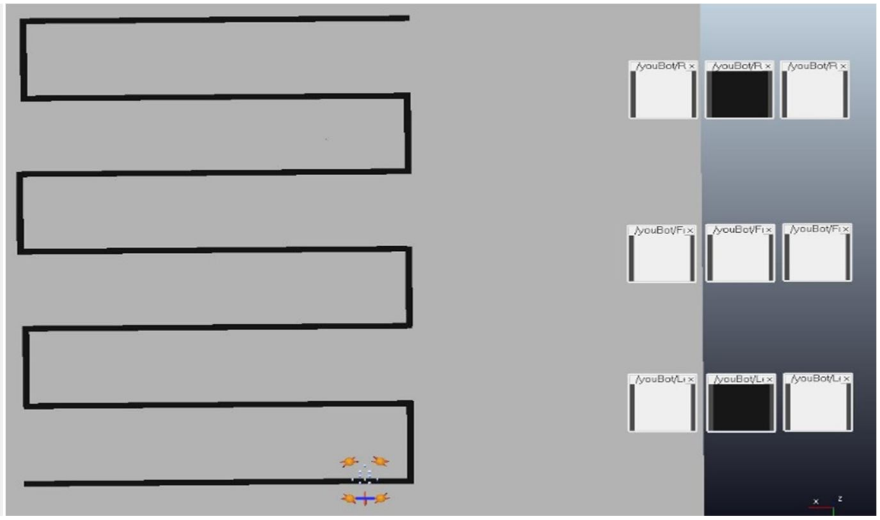

Fig. 12 Simulation of Mobile Robot in V-rep Environment

The V-REP and MATLAB simulation software proved to be very effective tools for testing and simulation of the mobile robot models. This allowed us for the further improvement and optimization of the Line follower Algorithm as well as the construction of a control system for the robot prototype.

IV. SELECTION OF NOZZLE

One of the most crucial considerations we must make in related to our applications is nozzle selection. Not only the kind of nozzle effect the volume of spray to a certain area, but it also influences the efficiency of the spray, coverage, drift on sprayed surface. There are 4 basics functions of nozzle. They are Atomizing liquid droplets, Dispersing the droplets in a pattern, Meters liquid in specific flow rate, needs to develop hydraulic momentum. Main criteria for selecting nozzles are Impact, Spray angle, Spraying behavior, Distribution of liquid, Droplet sizes, Material, Wear [11].

The major factors for evaluating spray pressure and spray impact are the effectiveness in cleaning of a spray nozzle and impact, or overall spray force that impacts the car. Impact per square inch is the ultimate measure of cleaning efficiency. We can maximize the cleaning impact by increasing the flow rate and droplet size. High pressure creates smaller droplets with lower mass and velocity, which have a lower cleaning effect. Increasing flow rate is more efficient than increasing pressure. Spray distance has a significant effect on impact, and 6 to 8 inch is the perfect distance for optimal spray nozzle performance. Increasing the nozzle distance from the car's surface by just 6 inches (15.25 cm) reduces impact by 50%. Because the spray pattern is substantially larger and the droplet velocity is lowered because of air's frictional drag. Impact pressure is reduced when same impact force is applied over a large area. Spray angle is defined as the width or dispersion of spray when it leaves the aperture. Spray angles can broaden dramatically under high pressure, as a result the spray spreads out towards the edges causing low-impact. High cleaning force can be achieved by narrowing the spray angle, but also peel molds, and imperfect paint jobs. Table II shows the relationship between spray angle and distance.

TABLE II
THEORETICAL SPRAY COVERAGE

Spray Angle in degree	At various distances form nozzle orifice (cm)					
	15	20	25	30	40	50
15	4.0	5.3	6.6	7.9	10.5	13.2
25	6.7	8.9	11.1	13.3	17.7	22.2
40	10.9	14.6	18.2	21.8	29.1	36.4
65	19.1	25.5	31.9	38.2	51.0	63.7
80	25.2	33.6	42.0	50.4	67.1	83.9
110	42.9	57.1	71.4	85.7	114	143

The Table II represents ideal spray nozzle characteristic for cars under carriage cleaning [11]. The flat fan nozzle sequence has efficient line of spray. When compared to full or hollow cone spray nozzle patterns the impact of spray is high, but not as high as solid stream nozzle. We are using 3 Flat fan nozzle each inclined at certain angle along with an external pump for effective cleaning. For effective spray the pressure needs to be low and flow rate needs to be high with optimum impact angle

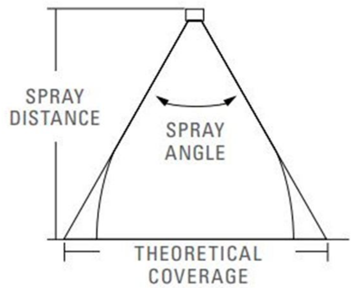

Fig. 13 Spray Angle Vs Spray Distance

A. Hydraulic Pressure Calculation

Power = $(Q_{Flow} \text{ x } P_{Water})/1715$

Where, Q_{Flow}= Water Flow rate (Gallons per minute)

P_{Water}= Water Pressure (psi)

The pump has the flow rate of 4.5 lpm

The pump has 1hp power.

$1 = (1.18877 \text{ x } P_{Water})/1715$ (1 liter per minute = 0.264172 gallon per minute)

P_{Water} = 1442.67 psi (1 psi = 0.0689476 bar)

P_{Water} = 99.4 bar

The pump can develop maximum pressure of about 100 bar (approximate)

B. Calculation For Jet Velocity

$Q_{Pump} = A_{Pipe} \text{ x } V_{Pipe}$

Where, Q_{Pump} = Discharge of the pump (m^3/sec)

A_{Pipe} = Area of Pipe (m^2)

V_{Pipe} = Velocity of water in the pipe (m/sec)

Now,

d = Diameter of Nozzle = 1 mm.

a = Area of Nozzle = $7.853 \text{ x } 10^{-7}$ m^2

Pump Discharge = 4.5 lpm = $7.5 \text{ x } 10^{-5}$ m^3/sec

a_1, a_2, a_3 and v_1, v_2, v_3 are Area and Velocity of water from 3 nozzles respectively

From theory of continuity, we know that, $A_{Pipe} \text{ x } V_{Pipe} = a_1v_1+a_2v_2+a_3v_3$

$a_1=a_2=a_3=7.853 \text{ x } 10^7$ and $v_1 = v_2 = v_3$

Therefore, $Q_{Pump} = 3av$

$v = Q_{Pump} / (3 \text{ x } a)$

$v = 7.5 \text{ x } 10^{-5} / (3 \text{ x } 7.853 \text{ x } 10^{-7})$

v= 31.83 m/sec

The optimal pressure range for washing your car with a pressure washer is 1200 to 1900 psi [1]. This pressure may be achieved with most pressure washers. Using a 4.5lpm flow rate from the pump, we were able to achieve a pressure of 1442.66psi. As a result, the system can effectively remove dirt from the vehicle.

V. ELECTRIC CIRCUIT: BLOCK DIAGRAM

A block diagram is a visual representation of the relationship between the input and output of a system in a concise and pictorial form. For our convenience, we may represent any intricate system and its properties in a simple block diagram, or we can use block diagram representation to express a comprehensive process. They're constructed up of designated blocks with arrows connecting them. The arrows show the flow direction as well as the inputs and outputs of the blocks. Our circuit's block diagram is shown in Fig. 14, and the following is an explanation of the block diagram follows: Power Cord, 12V Step Down Transformer, and Full Way Rectifier make up the Power Supply unit. The power supply device is connected to a regular 230-240V domestic power source through the power cord. The voltage is reduced to 12V using a Step-down transformer of configuration 0 – 12. A bridge rectifier (Full wave) has been employed convert the AC supply (Input) to DC supply (Output). The Bridge rectifier's output voltages are 12V and 5V, respectively. The ESP32 is powered by a 5V source, whereas Motor Controller 1 and Motor Controller 2 are powered by a 12V supply. L298 Driver IC is used as Motor Controller. The motor is regulated by the Driver IC, which is powered by a 12 V supply. It is coupled to the ESP32. The motor controller is wired to the motor and has the ability to regulate up to two motors. The ESP32 is grounded and powered by a 5V input source. There are nine IR Sensors in the IR Sensor Block. The Line Follower Algorithm is implemented using nine infrared sensors. Three IR sensors follow the line, while the remaining six are used to optimize the movements. Three IR sensor is placed on each side (Front, Left, Right). The mobile robot's movement is governed by the signals from the infrared sensors. The signal from the infrared sensor is received by the ESP 32, which then processes it. The ESP 32 sends a signal to the motor controller, which controls the motors, based on the signal.

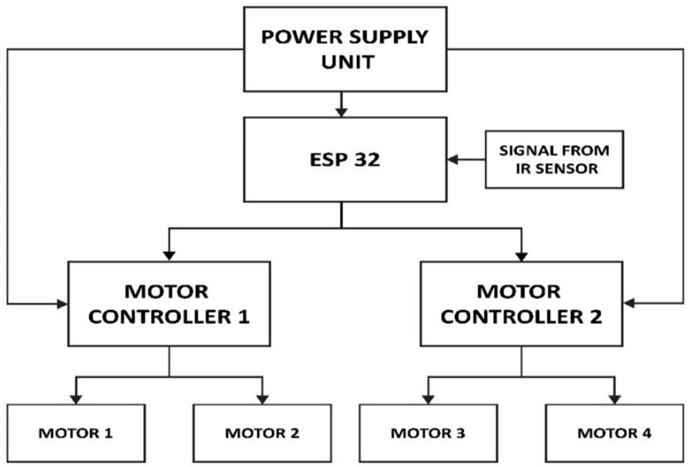

Fig. 14 Block Diagram of Electric Circuit

VI. CONCLUSION

This paper proposes and implement a novel procedure for implementing mobile robots for automotive undercarriage cleaning. This work presents the design, analysis, mathematical modelling, and simulation of a mobile robot for cleaning the undercarriage of an automobile. Simulation is performed using V-REP simulation software with MATLAB as API and MATLAB Simulink, the computational tool, proved to be highly effective for evaluating the kinematic model and operation of a four-Mecanum-wheeled mobile robot. This four-mecanum wheel allows the robot to move in both horizontal and vertical directions independently. With the aid of nine infrared sensors, this robot can precisely follow the path. The proposed method will significantly minimize the time and labor required to clean cars. At present situation, people can't spend their time in washing their cars because of their busy schedules. In that case, the proposed model will serve that purpose. This will serve as the foundation for the complete automation of car washing.

VII. FUTURE SCOPE

The proposed model is an appropriate system for semi-automatic undercarriage cleaning. We can also include oil and engine coolant leak detection sensors. Additionally, the robot's size could be lowered much further than the model proposed. So that it can be sufficiently compact for residential use. Future work will focus on developing obstacle avoidance strategy. This algorithm needs to be different form typical obstacle avoidance algorithm, because it should not detect components of the car.

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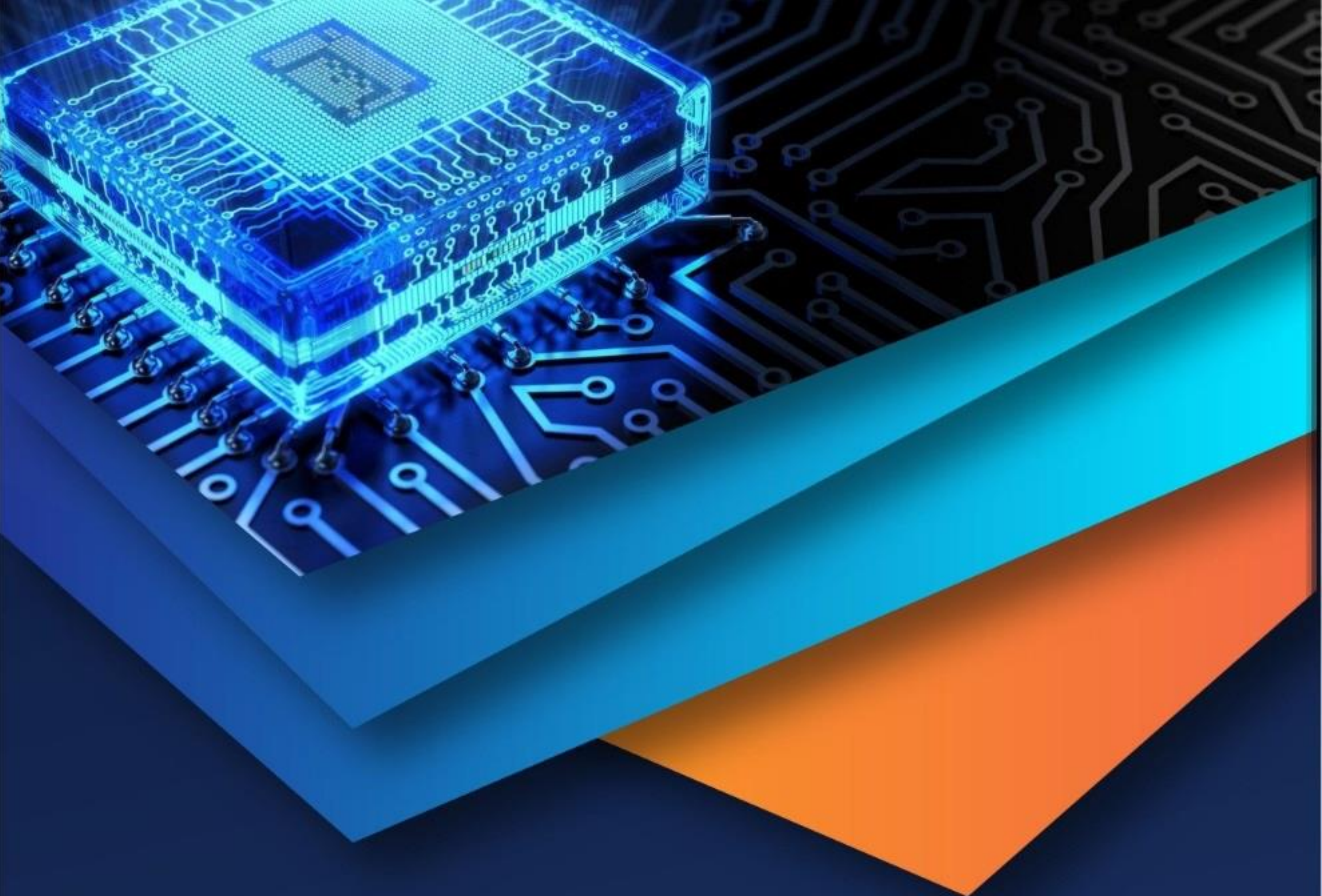
With the upgrade to the microcontroller, we planned to use Raspberry Pie. This will give us more freedom and more options, let the robot find its own path for each vehicle, and free us from having to use the line follower algorithm. With the current advancements in the fields of machine learning and IoT in mind, future advances must include how well the proposed robot is employed automatically to clean the entire automobile without human interaction. This project serves as starting point for further advancement in using mobile robots for cleaning.

REFERENCES

[1] Amber Naik et al., (2015) 'Design, analysis & fabrication of portable car wash trolley' International Journal of Advanced Technology in Engineering and Science Volume No 03, Special Issue No. 01, March 2015
[2] Taheri et al., (2015) 'Kinematic model of a four mecanum wheeled mobile robot' International journal of computer applications, 113(3), pp.6-9.
[3] Hofner, C. and Schmidt, G (1995) 'Path planning and guidance techniques for an autonomous mobile cleaning robot' Robotics and autonomous systems, 14(2-3), pp.199-212.
[4] Shabalina et al., (2018) 'Comparative analysis of mobile robot wheels design' In 2018 11th International Conference on Developments in havard systems Engineering (dese) (pp. 175-179). IEEE.
[5] Viraj, M.A et al., (2020) 'Design and Control of a Wall Cleaning Robot with Adhesion-Awareness' Symmetry, 12, pp.1-18.
[6] Ciszewski, M et al., (2017) 'Modeling and simulation of a tracked mobile inspection robot in MATLAB and V-REP software' Journal of Automation Mobile Robotics and Intelligent Systems, 11(2), pp.5-11.
[7] Francis, N.R. and Sudheer, A.P., (2018) 'Design, modelling and fabrication of railway track cleaning bot' Procedia computer science, 133, pp.526-536.
[8] Oltean, S.E et al., (2019) 'Mobile robot platform with Arduino uno and raspberry pi for autonomous navigation' Procedia Manufacturing, 32, pp.572-577.
[9] Mobile Robotics Simulation Toolbox [online] https://in.mathworks.com/matlabcentral/fileexchange/66586-mobile-robotics-simulation-toolbox
[10] Remote API functions (MATLAB) [online] https://www.coppeliarobotics.com/helpFiles/en/remoteApiFunctionsMatlab.htm
[11] Spraying System Co - Car Wash Spray Product [online] https://www.spray.com/en-in/industries/other-industries/car-washes-and-pressure-washing



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