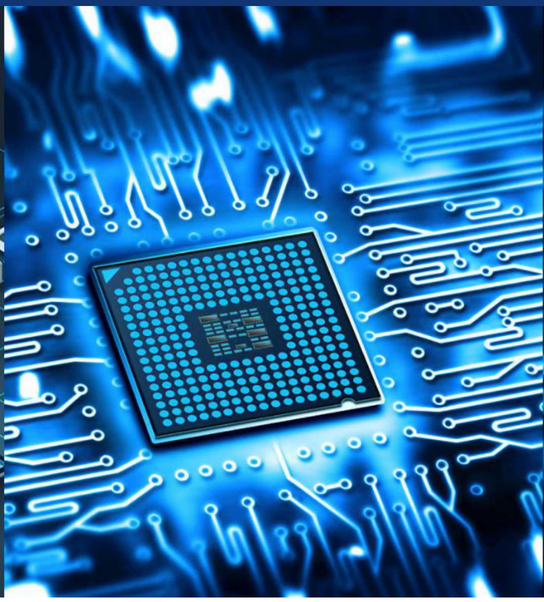
ISSN(O): 2320-9801
ISSN(P): 2320-9798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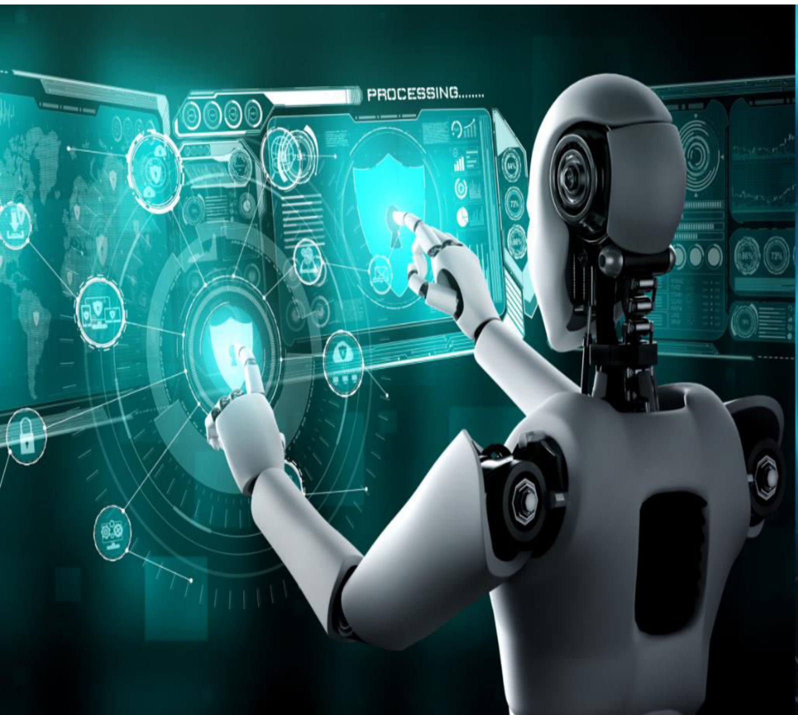

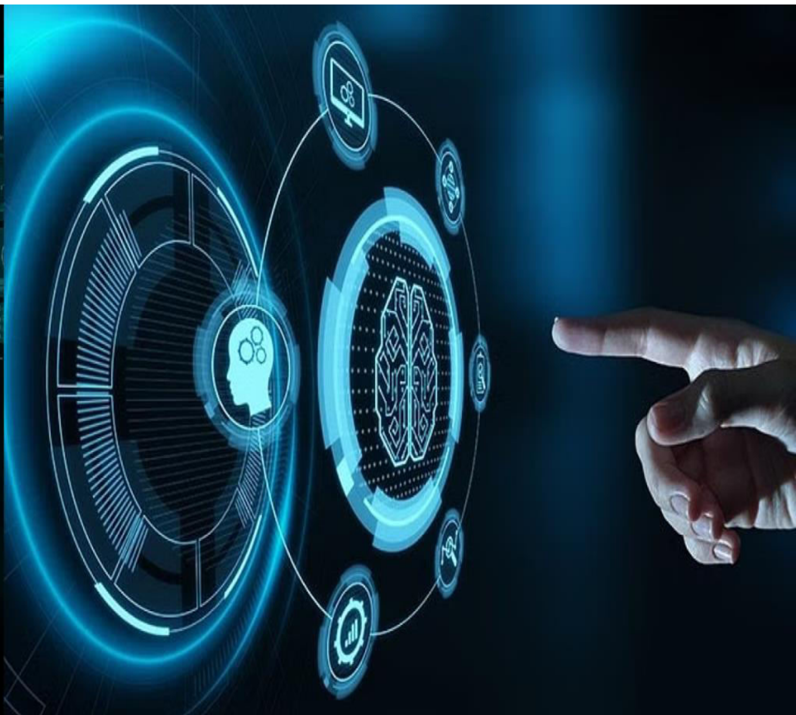

Impact Factor: 8.771

Volume 14, Issue 4, April 2026

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International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Sensor Based AGV System

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ABSTRACT: In recent years, robotics has seen significant advancements in automation and artificial intelligence, leading to the development of various autonomous and semi- autonomous robotic vehicles. This project presents the design and development of an autonomous mobile robot IR sensor-based Automated Guided Vehicle (AGV) prototype for efficient and autonomous material handling. The AGV is designed to navigate through multiple stations using IR sensors, eliminating the need for manual intervention. The system uses a set of IR sensors for path following, station detection, and object verification, combined with an Arduino Mega controller and a relay-driven motor system. The solution offers a low-cost, reliable, and scalable automation system suitable for small-scale industrial applications. This project aims to design and fabricate a mobile robot that can follow the path with the help of IR Sensors. Path following proves to be very useful in today's modern technology and it is still considered an important field of robotics. The main aim of this project is to make an Arduino-based efficient self-directed path-following robot.

KEYWORD: Autonomous Mobile Robot, Arduino, Path Follower Robot, IR Sensor, Automated guided vehicle.

I. INTRODUCTION

In recent years, robotics has seen significant advancements in automation and artificial intelligence, leading to the development of various autonomous and semi- autonomous robots. One such category is object-following robots, which have applications in industrial automation, logistics, and personal assistance. These robots use sensors and control systems to detect, track, and follow objects without human intervention. The objective of this project is to design and implement an object- following robot capable of detecting and following a moving object using sensor-based feedback mechanisms line follower is an intelligent robot which detects a visual line embedded on the floor and follows it. The path is predefined and can be either visible like a black line on a white surface with a high contrasted color or the path can be a complex such as magnetic markers or laser guide markers. In order to detect these lines various sensors can be employed. Generally, infrared Sensors are used to detect the line which the robot has to follow. The robot movement is automatic and can be used for long distance application. Line follower can be modified by giving obstacle detection capability to it. If any object is placed on the path, then a normal line follower will try to push the obstacle and hence it gets damaged. By using ultrasonic sensor, the line follower can detect an obstacle and can stop till the obstacle is removed. This type of robots can perform lot of tasks in industries, like material handling. These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts. They also have domestic application and one of the interesting applications of this line follower robot is in health care management. As this smart line follower robot. This project integrates multiple hardware and software components to achieve real-time object detection and tracking. The primary hardware components include an Arduino Uno, a motor driver shield, ultrasonic and infrared sensors, a servo motor, and DC motors. The Arduino IDE is used for programming and controlling the robot's behaviour. The robot processes sensor data to adjust its motion dynamically, allowing it to maintain a set distance from the detected object.

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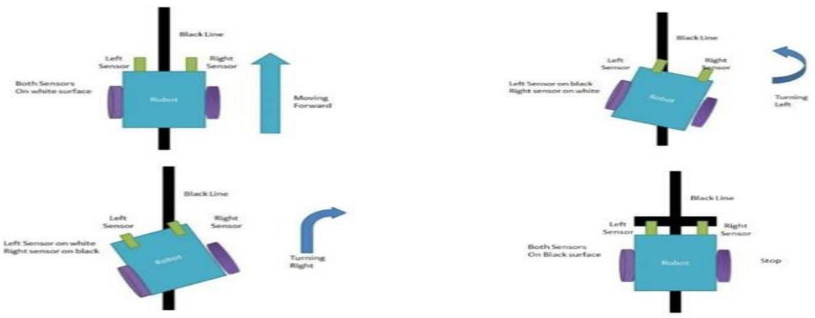

Fig- 1: Path Following Robot

II. LITERATURE REVIEW

Based on the used techniques for image features extraction, all methods for vision- based on-board obstacle detection can be divided into two main groups: methods based on traditional CV and methods based on AI. The first group has methods which use well-established CV techniques for both image segmentation (e.g., edge detection, corner detection or threshold segmentation), and for object recognition based on the extraction of so-called "hand-crafted" features. "Hand-crafted" features refer to properties extracted from an image (e.g., edges, corners, and shape descriptors of segmented image regions) using various methods that exploit the information present in the image itself. The AI- based methods in the second group are based on Machine Learning (ML) and in particular on Deep Learning (DL). In Experimental results are also provided to validate the effectiveness of the robot.

Samira Badrlo [2] This paper reviews various image-based obstacle detection techniques used in unmanned vehicles. The reviewed techniques are divided into monocular and stereo methods based on whether a single or multiple synchronized cameras are used for obstacle detection. The paper provides detailed descriptions of each technique, including their advantages and limitations. The experimental results of each technique are also provided to validate their effectiveness in obstacle detection. Overall, these research papers provide valuable insights into the design and implementation of line follower robots with advanced capabilities for obstacle detection and avoidance. The proposed algorithms and techniques can be used to develop more sophisticated robots with improved capabilities, and can also be applied to other areas such as autonomous vehicles and drones.

Arkin and Murphy, Rooks, and Vis have compiled general literature reviews describing the state-of research on navigation and docking. Arkin and Murphy [9] described some of the earliest research methods that were proposed for achieving mobility of autonomous vehicles in the workplace. They presented an overview of the autonomous robot architecture, which was designed to facilitate intelligent mobility/navigation. They also described the changes needed to adapt AuRA to new domains for flexible manufacturing systems. The changes included the new types of knowledge and the new motor behaviours required for this domain. Finally, they discussed the results of both simulations of, and real experiments of, navigational planning and reactive/reflexive motor schema-based navigation in that domain.

In 2001, Rooks [10] described different uses of AGVs across a range of industries and applications. For example, he described how at one manufacturing facility, AGVs were used as tugs to tow trailers delivering components to production lines, while at another, they carry both part kits and finished engines to and from assembly dressing lines. At yet another facility, they handled heavy paper rolls and served coating machines. These applications use traditional embedded wire navigation technology. Other guidance techniques were also described, including laser scanners which are being applied in a Belgian fruit and vegetable market to transport pre-packed products to dispatch lines. Specific to docking, Rooks details an automatic docking system and a standard pallet truck that is available as a complete automated package with laser guidance.

Vis [11] discussed literature related to the design and control of AGV systems in four different applications: manufacturing, distribution, trans-shipment, and transportation. The author concluded that new analytical and simulation models were needed for large AGV systems to overcome large computation times, NP (nondeterministic polynomial)-completeness, congestion, deadlocks, and delays in the system and finite planning horizons. The author

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concluded that more specific research is needed in the design and control of large AGV systems in the application areas of distribution, trans-shipment, and transportation.

Vehicle control is a major research topic for both navigation and docking. The earliest form of AGV navigation was based on following electrical wires buried in the floor, or reflecting lines painted on it; some vehicles still operate using this mode. This made adaptation to changes in production or warehousing processes elaborate and costly because changes in vehicle paths required changes in factory infrastructure to modify the guidance paths. Some newer AGV systems use beacons, which make changes easier, but these systems are typically not yet capable of avoiding obstacles. Very recently, computers have become a common navigation component in AGVs. Practical limitations, however, with either a central or an on-board computer mean that a certain level of autonomy is needed for navigation. For example, a central computer typically stops a vehicle from entering a location occupied by another vehicle. An onboard computer with added intelligence may be capable of surpassing the stopped vehicle. However, in both cases, for computational simplicity, the basic planned paths consist of straight lines or `lanes'. To enable the vehicles to change lanes, without stopping to turn, while staying on the planned path, curves with a continuous curvature are needed. Van der Molen and Geerts [12] describe the application of clothoids to enable changing between lanes.

2.1 Key Research Studies on Object Following Robot

Several research papers and projects have contributed valuable insights into the design and implementation of object-following robots. Below are some notable studies:

- Study on IR Sensor-Based Object Tracking: Research has shown that IR sensors are effective for tracking nearby objects but have limitations in distinguishing between multiple objects and in dealing with external light interference.
- Ultrasonic Sensor-Based Autonomous Tracking: A study demonstrated the feasibility of using ultrasonic sensors for precise distance measurement, making them an ideal choice for object-following applications.
- Arduino-Based Object Following Robots: Various projects have successfully implemented Arduino-based control systems to integrate multiple sensors for object tracking, proving its feasibility for low-cost robotic applications.
- Comparative Analysis of Sensor-Based and Vision-Based Tracking: Research comparing different tracking methods has highlighted the advantages and limitations of each approach, providing useful insights into optimizing object-following algorithms.

III. COMPONENTS

This section provides an in-depth discussion of the hardware components used in the Object-following robot project. Each component plays a crucial role in ensuring the proper functioning of the robot, from processing sensor data to controlling motor movements. Below is a detailed explanation of each component.

3.1 Arduino Uno

The Arduino Uno is the microcontroller board used as the brain of the robot. It is based on the ATmega328P microcontroller and features 14 digital input/output pins, 6 analog inputs, and a USB connection for programming Arduino, a power jack, an ICSP header, and a reset button. It contains all the necessary modules needed to support the microcontroller. Just plug it into a computer with a USB cable or power it with an adapter to get started. You can experiment with your Arduino without worrying too much about it. In the event of a worst-case scenario, you could buy a new one as the Uno is very economical compared to other boards like raspberry pi, STM, etc.

Fig- 1 Arduino Uno

© 2026 IJIRCCE | Volume 14, Issue 4, April 2026 DOI: 10.15680/IJIRCCE.2026.1404041

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3.2 Motor Driving Shield

The motor driver shields acts as an interface between the Arduino Uno and the DC motors. Since Arduino cannot directly provide sufficient current to drive the motors, the motor driver shield is used for power amplification and direction control. A motor driver shield is an add-on circuit board that plugs directly onto a microcontroller (like Arduino) to easily control the speed and direction of motors. It acts as an intermediary, supplying high current from an external power source to motors, which the low-power pins of a microcontroller cannot provide. Key features and details include:

- Function: Controls DC motors, stepper motors, and servo motors.
- Common Types: Often based on L293D or L298N ICs, enabling H-Bridge control for direction.
- Key Benefits: Simplifies wiring, protects the microcontroller, and often includes, or supports, stackable designs for multiple motors.
- Components: Usually features screw terminals for motor/power connection, motor driver chips, and, in some cases, shift registers (like 74HC595) to save Arduino pins.
- Usage**:** Popular in robotics for driving two to four DC motors and/or two servos simultaneously

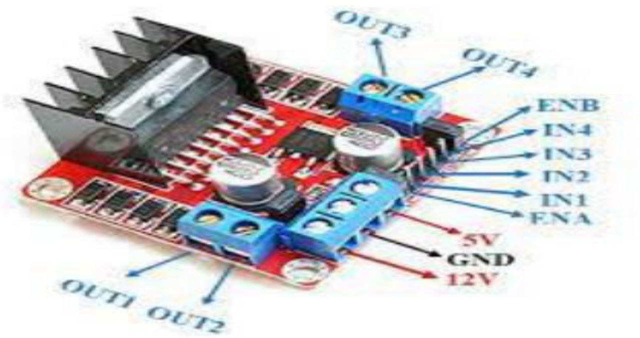

Fig-2 Motor Driving Shield

3.3 Infrared (IR) Sensors

Infrared (IR) sensors are used for object detection and directional control. These sensors detect the presence of objects based on infrared reflection. n Infrared (IR) sensor is an electronic device that emits or detects infrared radiation to sense characteristics of its surroundings, such as detecting motion, measuring temperature, or identifying objects. They function by interpreting infrared light, which is invisible to the human eye, to trigger actions in robotics, security systems, and automation.

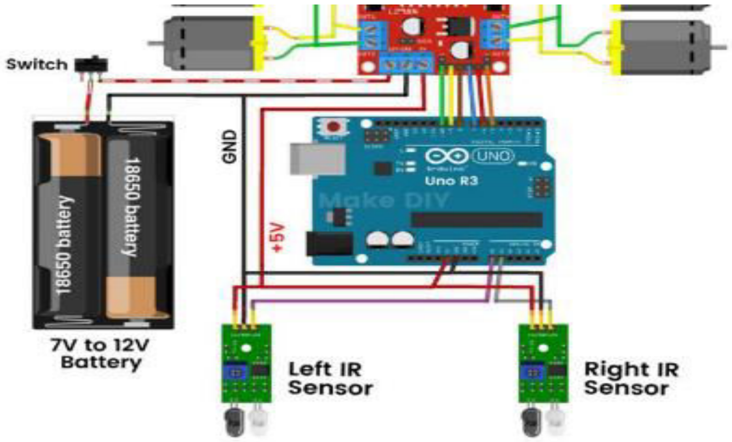

Fig-3 IR Sensor and Circuit

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3.4 Servo Motor

A servo motor actuator is a high-precision, closed-loop device used to control angular or linear position, velocity, and acceleration. It integrates a motor (AC/DC) with a sensor for positional feedback to achieve accurate motion, commonly used in robotics. A servo motor is used to rotate the ultrasonic sensor, allowing the robot to scan its surroundings.

IV. MODEL AND WORKING PRINCIPLE

The robot operates based on a sequence of sensor data processing and movement control**,** ensuring that it efficiently follows objects while avoiding obstacles. Below are the key steps in its working principle:

The servo motor moves the ultrasonic sensor from left to right, scanning the surroundings to detect objects in its path. If an object is detected within a specified range, the robot processes the distance data and determines whether to move forward, stop, or turn**.** The infrared (IR) sensors detect objects and help in guiding direction chang**es**, ensuring that the robot can avoid obstacles or adjust its path accordingly. The Arduino Uno processes all incoming data from the ultrasonic sensor and IR sensors and makes real-time decisions based on pre-programmed conditions.

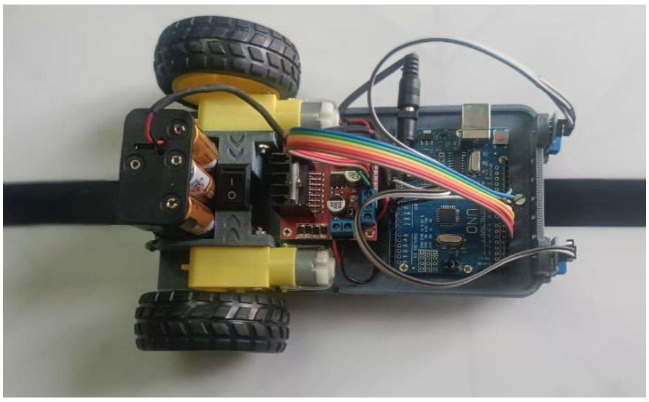

Fig-4 Working Model

The motor driver shield receives signals from the Arduino and sends appropriate commands to the DC motors**,** instructing them to move forward, turn left, turn right, or stop. If the object moves away, the robot continuously tracks its position and adjusts its movement to maintain a consistent following distance. The power management system, including the Li-ion batteries**,** ensures that all components receive adequate power for smooth operation without voltage drops affecting performance. A feedback loop mechanism is implemented in the code, ensuring that sensor readings are continuously updated, reducing errors, and improving movement accuracy. Adaptive Speed Control**:** The robot adjusts its speed dynamically based on the distance of the detected object. If the object moves closer, the robot slows down, and if it moves away, the robot increases its speed to maintain an optimal following distance. Obstacle Avoidance Mechanism**:** If the sensors detect an obstacle in the path, the robot analyses the surroundings and decides whether to stop or change direction. This prevents collisions and ensures smooth navigation.

V. ADVANTAGES

- Work efficiently in hazardous environment: -

This robot can work in such a critical environment where it is risky to deploy human for working such as chemical plants, mines. AGVs can work in conditions that people cannot, such as extreme heat or cold or the presence of hazardous chemicals. Reduced expenses and fewer downtimes as a result of higher safety standards can help many organizations become more profitable. AGVs carry no such risk in comparison to human operators, who are always in danger of colliding with something or losing focus due to fatigue.

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- Reduced Labor Costs:

An AGV installation by a business is a one-time expense that, with modest upkeep, can last up to a year. Long-working AGVs can provide several options for businesses to save labor costs. Instead of the ongoing expenditures related to a new hire, such as health insurance, a salary rises, payroll taxes, vacation time, etc., a corporation just pays a single fee for the equipment - the original investment.

Increased safety: Keeping safety in mind, AGVs are created. They don't traverse operator paths because they have their own tracks to go on. Wearable technology also allows for control of them. When material handling devices are in use, this lessens the chance of human mistake. Human-operated machinery, such as forklifts, on the other hand, relies on human input, which may be compromised in a number of different ways, and lacks numerous built-in safety precautions

- Increased Accuracy:

People commit errors. AGVs can remove some of the human element's susceptibility for flawed procedures, leading in waste reduction and production growth that improves operations' accuracy and productivity. In addition, unlike human employees who have a set workday, AGVs may operate continuously. Along with the apparent improvements in accuracy and efficiency, using AGVs in conjunction with a warehouse management system or warehouse control system may speed up processes like inventory management and material ordering.

- Increased productivity and output:

The advantages of AGVs, including reduced direct labor expenses, less indirect costs, fewer mistakes, and enhanced safety conditions, increase total productivity. AGVs can operate continuously, around-the-clock, seven days a week, unlike people who must take breaks and who become weary or distracted. AGVs can be set up to take the quickest path or finish a particular job.

VI. APPLICATIONS

The object-following robot has significant applications in diverse fields, making it a valuable technological development. Some of the key areas where it can be applied include:

- **Industrial Automation:** Object-following robots can be used in warehouses and factories to automate material handling, reducing the need for human labor and increasing efficiency.
- **Smart Shopping Systems:** The robot can assist customers in carrying goods in supermarkets, providing an enhanced shopping experience.
- **Security Surveillance:** Autonomous patrolling robots can be equipped with object-tracking capabilities to monitor suspicious movements in restricted areas.
- **Personal Assistance:** These robots can be used in homes to carry small objects or assist elderly and disabled individuals with daily activities.
- **Educational Purposes:** Object-following robots serve as an excellent learning tool for students and researchers studying robotics, embedded systems, and sensor-based control.

By implementing this project, we aim to contribute to the field of autonomous robotics and demonstrate a practical application of sensor-based motion control. This project not only improves the efficiency of object transportation but also paves the way for future advancements in smart robotics and automation systems

VII. CONCLUSIONS

Nowadays, robots are widely used in various critical and dangerous finds. it can be used in various intelligence fields. It can be used for rescue operations, navigation problems, search operations, medical attention, military search and rescue, etc. There are many caves, that are like mazes where humans could get lost. This robot can find its way out again. It can also be used in too small or dangerous caves where humans can't enter. High-performance sensors can be used by us for the better-performance robot. Instead of using a path, we may add an ultrasonic sensor to let the robot move in the natural environment by avoiding any obstacle it may face while moving. We can add PID control to make our function well by managing the speed of our motor which is done by calculating the error value.

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REFERENCES

[1]. A review on challenges of autonomous mobile robot and sensor fusion methods. Alatise, M.B. and Hancke, G.P.Akure, Nigeria: IEEE, 2020, Vol. 8.
[2] A master-slave separate parallel intelligent mobile robot used for autonomous pallet transportation. Li, G., et al. 3, s.l.: Applied sciences, 2019, Vol. 9.
[3] A review of autonomous agricultural vehicles. Roshanianfard, A., et al. Hokkaido: J. Terramech, 2020, Vol.91, pp. 155-183.
[4]. Design of a control system for an autonomous vehicle ebased on adaptive-pid. Zhao, P., et al. s.l. : Int. J. Adv. Robot. Syst., 2012, Vol. 9, p. 44
[5] Irimescu, A., Marchitto L., Merola, S. S. Combustion process investigations in an optically accessible DISI engine fueled with n-butanol during part load operation. Renew Energy, 2015; 77: 363-76.
[6] Kumar, C., Athawe, M., Aghav, Y., Gajendra, B. M. Effects of ethanol addition on performance, emission and combustion of DI diesel engine running at different injection pressures. SAE Technical Paper, 2017; 01-0626.
[7] Meng, F., Yu, X., He, L. Study on combustion and emission characteristics of a n butanol engine with hydrogen direct injection under lean burn conditions. Int J Hydrogen Energy, 2018; 43(15): 7550-7561.
[8] Ozsezen, A. N., Canakci, M., Turkcan, A., Sayin, C. Performance and combustion characteristics of a DI diesel engine fueled with waste palm oil and canola oil methyl esters. Fuel, 2011; 88: 629-636.
[9] Papagiannakis, R. G., Hountalas, D. T. Combustion and exhaust emission characteristics of a dual fuel compression ignition engine operated with pilot Diesel fuel and natural gas. Energy Conversion and Management, 2014; 2971–2987.
[10] Irimescu, A., Marchitto L., Merola, S. S. Combustion process investigations in an optically accessible DISI engine fueled with n-butanol during part load operation. Renew Energy, 2015; 77: 363-76.
[11] Kumar, C., Athawe, M., Aghav, Y., Gajendra, B. M. Effects of ethanol addition on performance, emission and combustion of DI diesel engine running at different injection pressures. SAE Technical Paper, 2017; 01-0626.
[12] Meng, F., Yu, X., He, L. Study on combustion and emission characteristics of a n butanol engine with hydrogen direct injection under lean burn conditions. Int J Hydrogen Energy, 2018; 43(15): 7550-7561.
[13] Ozsezen, A. N., Canakci, M., Turkcan, A., Sayin, C. Performance and combustion characteristics of a DI diesel engine fueled with waste palm oil and canola oil methyl esters. Fuel, 2011; 88: 629-636.
[14] Papagiannakis, R. G., Hountalas, D. T. Combustion and exhaust emission characteristics of a dual fuel compression ignition engine operated with pilot Diesel fuel and natural gas. Energy Conversion and Management, 2014; 2971–2987.
[15]CF-pursuit: A pursuit method with a clothoid fitting and afuzzy controller for autonomous vehicles. Shan, Y., et al. s.l.: Int. J. Adv. Robot. Syst., 2015, Vol. 12, p. 134.
[16] Line Follower Using Arduino and Its Applications. MdYounus, Pooja Gadekar, Adhiraj Walse. s.l.: International Journal of Applied Engineering Research, 2019, Vol. 14.0973-4562.
[17] Navigation of autonomous vehicles for oil spill cleaning indynamic and uncertain environments. Jin, X. and Ray, A. 4, s.l.: Int. J. Control, 2014, Vol. 87.
[18] Experimental analysis of maze solving robot using LSRB algorithm. Selvakumar. R 2R.V.S. Abhiram, 3K. PranayReddy. Coimbatore: International Conference on Computer Communication and Informatics (ICCCI), 2022, Vol. 22.

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