Solar Based Automated Vehicle

Mr. R. N.Ghule[1] Dr. D.U. Adokar[2] Mr. S. S. Vikhe[3]
[1]*Student, Electronics & Telecommunication Engg. Adsul's Technical Campus, Chas, India*
[2]*Head Of Dept, Electronics & Telecommunication Engg. Adsul's Technical Campus, Chas, India*
[3] *Student, Electronics & Telecommunication Engg. Adsul's Technical Campus, Chas, India*

INTRODUCTION

With the rapid advancement of technology and the growing concern over environmental sustainability, there is an increasing demand for energy-efficient and autonomous transportation solutions. Traditional vehicles rely heavily on fossil fuels, contributing to environmental pollution and global warming. Additionally, manually operated vehicles require continuous human intervention, which can be inefficient in applications such as remote monitoring, automated logistics, and smart agriculture.

To address these challenges, this project focuses on developing a Solar Automated Vehicle (SAV)self-sustaining robotic vehicle powered by renewable solar energy and capable of operating autonomously without human intervention. The system integrates key technologies, including solar energy harvesting, battery storage, intelligent motor control, and sensor-based navigation, to create an eco-friendly and efficient vehicle.

The vehicle is equipped with solar panels to harness sunlight, which is stored in a battery system through an MPPT (Maximum PowerPoint Tracking) charge controller. The core control system is built around an ATMEGA328 microcontroller, responsible for processing data from various sensors and making real-time decisions for autonomous navigation an ultrasonic sensor detects obstacles in the vehicle's path, allowing it to take appropriate actions such as stopping or changing direction. The motor driver circuit efficiently controls the movement of vehicle, ensuring smooth and optimized operation. By developing this system, the project aims to reduce reliance on fossil fuels, promote renewable energy use, and demonstrate the potential of automation in mobility solutions. This Solar Autonomous Vehicle can be applied in diverse fields such as smart agriculture, surveillance, industrial automation, and self-sustained transportation systems. The integration of renewable energy with autonomous mobility opens new opportunities for sustainable and intelligent transport solutions, which are crucial for the future of smart Cities and clean energy initiatives.

NECESSITY

Conventional vehicles rely heavily on fossil fuels, contributing to pollution and environmental degradation. Additionally, manually operated vehicles require continuous human control, limiting their applicability in certain areas such as remote monitoring, agriculture, and automated logistics. This project addresses these challenges by developing a solar-powered autonomous vehicle capable of self-navigation and obstacle avoidance while being completely independent of non-renewable energy sources.

OBJECTIVE

1) Developasolar-poweredautonomousvehiclethatoperateswithoutmanualcontrol.
2) Implement an energy-efficient power system utilizing solar panels, MPPT charge controllers, and battery storage.
3) Integrate an intelligent navigation system using ultrasonic sensors for obstacle detection and avoidance.
4) Ensure optimal power distribution using a microcontroller to control motors, sensors, and other components.
5) Enhance sustainability and efficiency by minimizing power losses and maximizing

solar energy utilization.

SCOPE OF THE PROJECT

1. Hardware Development: Integration of solar panels, batteries, microcontroller (ATMEGA 328), sensors, and motor driver circuits.
2. Software Implementation: -Programming microcontrollers to hand licensor data, control motors, and manage energy efficiently.
3. Autonomous Navigation: Implementing an obstacle detection and avoidance system using ultrasonic sensors.
4. Renewable Energy Utilization: Designing a power system that optimally converts and stores solar energy for continuous operation.
5. Application Areas: The vehicle can be used in agriculture, industrial automation, surveillance, and smart transportation.

BLOCK DIAGRAM

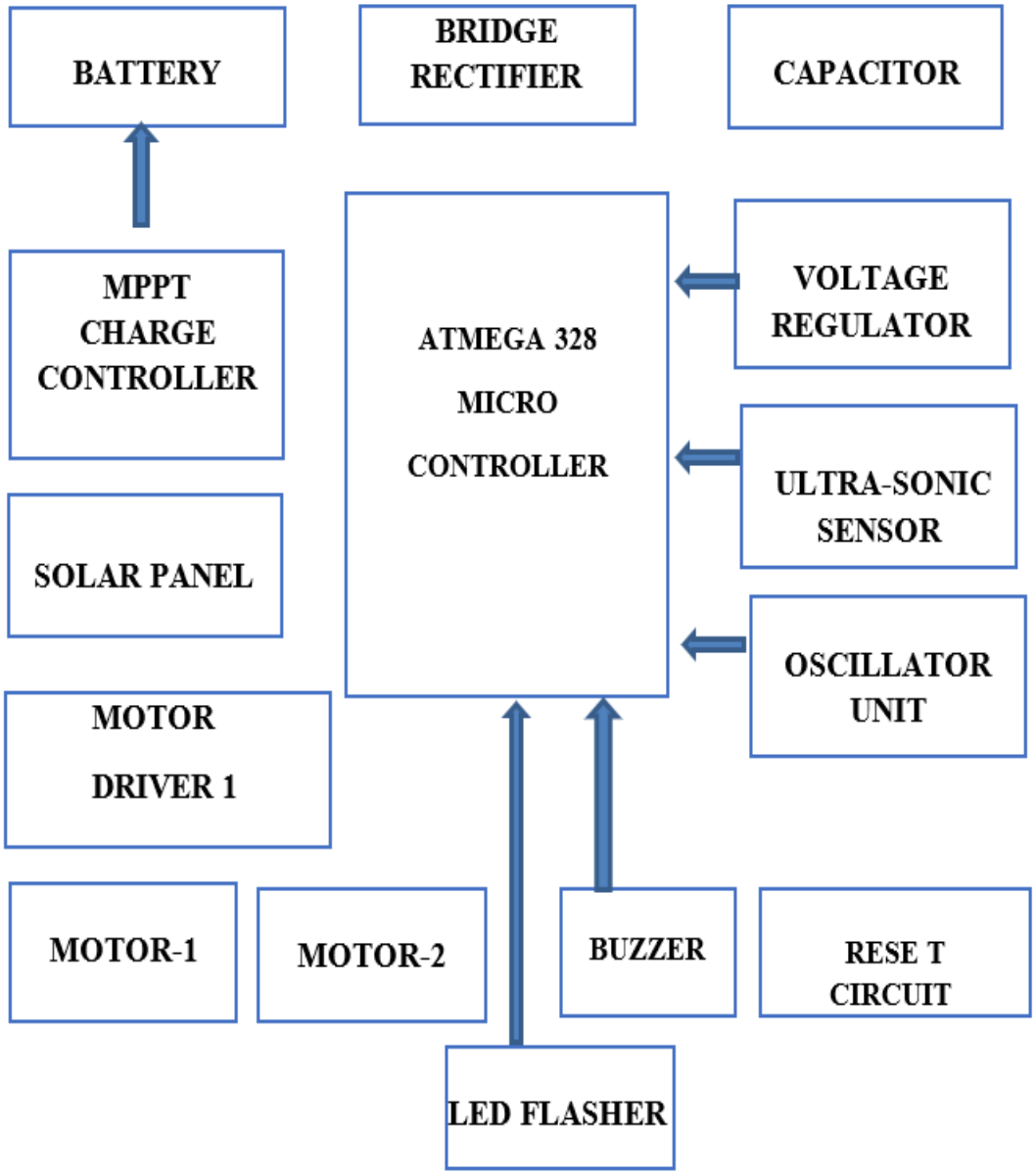

Fig. Block Diagram of solar automated Vehicle

CIRCUIT DIAGRAM

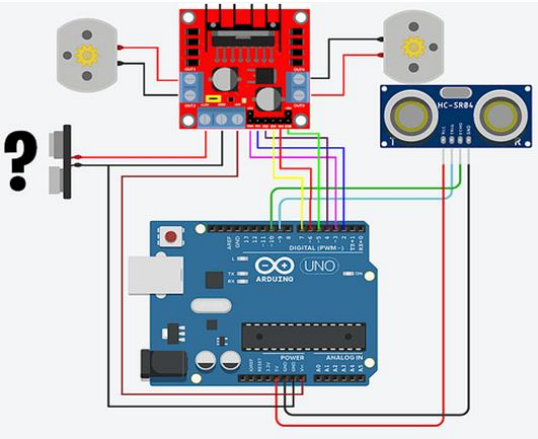

Fig. Circuit diagram of solar automated vehicle

For navigation, the vehicle is equipped with an ultrasonic sensor (HC-SR04) that continuously scans the environment for obstacles. The sensor sends ultrasonic waves and measures the time taken for the waves to bounce back after hitting an obstacle. This data is processed by the microcontroller, which determines the distance of the obstacle. If an object is detected within a certain range, the system decides whether to stop, turn, or adjust its path accordingly.

The motor driver (L298N) receives commands from the microcontroller and controls the DC motors, which are responsible for the movement of the vehicle. The motor driver allows the vehicle to move forward, backward, or turn based on sensor input. If the ultrasonic sensor detects an obstacle ahead, the microcontroller sends signals to the motor driver to stop or turn in a different direction to avoid a collision.

Additionally, a buzzer is included in the circuit to provide alerts when an obstacle is detected or in case of any malfunction. The oscillator unit and reset circuit ensure the smooth operation of the microcontroller, maintaining accurate signal processing and allowing system resets if needed

WORKING PRINCIPLE

The Solar Automated Vehicle (SAV) is designed to operate independently, utilizing solar powers its primary energy source. The system consists of several key components, including a solar panel, MPPT charge controller, battery, microcontroller, ultrasonic sensor, motor driver, and motors. The solar panel captures sunlight and converts it into electrical energy. This energy is then regulated and optimized using an MPPT (Maximum Power Point Tracking) charge controller to ensure efficient power conversion. The MPPT charge controller supplies power to both the battery and the electronic components. A battery (usually a lithium-ion or lead-acid battery) stores excess energy, allowing the vehicle to operate even when sunlight is not available. The ATMEGA328 microcontroller acts as the brain of the system, processing data from the sensors and controlling the movement of the vehicle. The voltage regulator ensures that the microcontroller receives a stable operating voltage.

The ultrasonic sensor continuously scans the surroundings to detect obstacles. When an obstacle is detected, the microcontroller processes the sensor data and decides the next course of action (e.g., stopping or changing direction). The microcontroller sends signals to the motor driver circuit, which controls the DC motors responsible for the movement of the vehicle. The motor driver (L293D or similar) amplifies the low-power control signals from the microcontroller to drive the high-power motors. The vehicle moves forward until an obstacle is detected. If an obstacle is detected, the system makes real-time adjustments to avoid a collision. A buzzer is included to provide alerts, such as obstacle detection or low battery warnings. The oscillator unit and reset circuit ensure smooth operation of the microcontroller by maintaining proper clock signals and allowing system resets when necessary. the Solar Autonomous Vehicle operates using a combination of solar energy, sensor-based navigation, and motor control to move without human intervention. The system is powered by a solar panel, which converts sunlight into electrical energy. This energy is regulated by an MPPT charge controller to ensure efficient charging of the battery, which serves as the main power source for the vehicle. A voltage regulator ensures a stable supply of power to the ATMEGA 328 microcontroller, which acts as the brain of the system, processing input from various sensors and controlling the movement of the motors.

PERFORMANCE ANALYSIS

The Solar Automated Vehicle (SAV) is an independently operated system that utilizes solar power and an MPPT (Maximum Power Point Tracking) charge controller. Its key components include a solar panel, MPPT charge controller, battery, microcontroller, ultrasonic sensor, motor driver, and motors. The system converts solar energy into electrical energy, optimized by the MPPT controller for efficient power conversion. A lithium-ion or lead-acid battery stores excess energy, vital for operation when sunlight is unavailable. An ATMEGA328 microcontroller acts as the brain, processing sensor data and controlling movement. A voltage regulator ensures stable operation. The ultrasonic sensor continuously scans for obstacles, and upon detection, the microcontroller processes this data to decide on the next action (e.g., stopping or changing direction). The microcontroller communicates with an L293D motor driver, which controls the DC motors to move the vehicle. The motor driver empowers the motors to move forward until an obstacle is detected, at which point the system makes real-time adjustments to avoid collision. A buzzer provides alerts for obstacle detection or low battery warnings. An oscillator unit and reset circuit ensure smooth operation of the microcontroller by managing clock signals and system resets when necessary.

The Solar Autonomous Vehicle combines solar energy, sensor-based navigation, and motor control for autonomous movement. It is powered by a solar panel that converts sunlight into electrical energy, regulated by an MPPT charge controller for efficient battery charging. A voltage regulator provides a stable power supply to the ATMEGA 328 microcontroller, which acts as the system's "brain," processing sensor inputs and controlling motor movement. Designed for autonomous operation, this vehicle is suitable for applications in smart agriculture, automated surveillance, and energy-efficient transportation. This project demonstrates a sustainable and intelligent.

CONCLUSION

The Solar Autonomous Vehicle is an innovative and sustainable solution that integrates solar energy with autonomous navigation to achieve energy-efficient and self- operating mobility. By utilizing solar panel, MPPT charge controller, and battery storage, the vehicle operates independently without relying on external power sources, making it an eco-friendly alternative to conventional vehicles. The ATMEGA 328 microcontroller, along with ultrasonic sensors and motor drivers, enables intelligent obstacle detection Nand autonomous movement ensuring smooth navigation in various environments. This project demonstrates the feasibility of renewable energy-powered autonomous vehicles, which can be used for applications such as smart agriculture, automated logistics, and surveillance systems. By Reducing dependence on fossil fuels and leverage the Solar Autonomous Vehicle contribute green Rand more technologically advanced future in the field of transportation and automation.

Applications

1) Autonomous robot cars
2) Obstacle-avoiding vehicles
3) Smart transportation systems
4) Solar-powered autonomous vehicles (when integrated with a solar panel and battery system)

REFERENCE

[1] Pankaj P. Tekale and S.R. Nagaraja, "Designing and Development of an Autonomous Solar-Powered Robotic Vehicle", Computational Vision and Robotics of the series Advances in Intelligent Systems and *Computing*, vol. 332, pp. 163-168, 2015, ISSN 2194-5357.

[2] K Karthikeyan and SR Nagaraja, "Solar Powered Terrestrial Ground Exploration Vehicle", International Journal of Applied Engineering Research, vol.10, no.69,2015, ISSN 0973-4562.

[3] TomMathewsandV.Gopi,"EmbeddedSystemBasedPowerManagementforBattery Operating Robotic Vehicle", 2014 International Conference on Circuit Power and Computing Technologies [ICCPCT].

[4] Kyung-Bok Sung Kyoung- Wook Min, Ju-WanKimand Jung-Dan Choi, "Autonomous Vehicle Guidance System with infrastructure“, Signal Processing and Communication Systems (ICSPCS) 2013 7th International Conference.

[5] Nathir A. Rawashdeh and Hudhaifa T. Jasim, "Multi-Sensor Input Path Planning for An Autonomous Ground Vehicle", Proceedings of the 9th International Symposium on Mechatronics and its Applications (ISMA13), April 9–11, 2013.

[6] M. Durali, G. Amin Javid and A. Kasaiezadeh, "Collision avoidance maneuver for an autonomous vehicle", Advanced Motion Control 2006. 9th IEEE International Workshop.

[7] Masoud Samadi and MohdFauzi Othman, "Global Path Planning for Autonomous Mobile Robot using Genetic Algorithm", 2013 International Conference on Signal- Image Technology & Internet-Based Systems.