WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

"AUTOMATIC BOGIE SEPARATION TECHNOLOGY FOR ENHANCED TRAIN SAFETY DURING FIRE HAZARD"

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A B S T R A C T:

The Hybrid Energy-based Intelligent Train control with Arduino LCD interface, next arriving station announcement, fire detection system, and solar energy represents a step forward in transportation technology. An integrated train system incorporates diverse innovations to create a unique balance of efficiency, safety, and sustainability in rail-based travel. In measuring Atit score, hybrid energy sources would use traditional fuels and solar energy to minimize energy consumption while also reducing environmental impact. The plugin Arduino LCD interface provides real time information to both passengers and operators, improving transparency for operators and experiences for passengers. Throughout every portion as a collective integrated train system, the fire detection system optimizes passenger safety by ensuring rapid identification and mitigation as hazardous situations arise. Additionally, utilizing solar energy again minimizes the carbon footprint while also reinforcing rail-based travel as sustainable practice. In summary, a Hybrid Energy-based Intelligent Train encompasses ideas of modern development of rail-based transportation that integrates a holistic idea combined with safety, innovation, and environmental management.

Keywords: Hybrid Energy, Intelligent Train System, Real Time Monitoring, Fire Detection System, Railway Safety, Arduino Interface

Introduction

Transportation is tremendously important for economic development, as it allows the movement of goods and people from one region to another. In India, the railways network is the backbone of transportation (the most commonly utilized mode of transportation as it's low cost). With the ever-growing demand, due to rapid economic growth in recent years, there is a need for rail systems that are safer, more efficient, and environmentally friendly. The Hybrid Energy Based Intelligent Train allows for rail systems to operate along this vision, with an innovative hybrid energy train that applies traditional fuels alongside renewable solar energy, therefore helping to mitigate the impact on the environment at the same time as increasing the energy resilience of the service. The intelligent train system integrates an Arduino LCD interface that gives real-time status updates of the train, reminders of stations-making the travel experience even easier for passengers (announcements); and reports of energy usage for the railway management; thereby increasing operational efficiency.

The development of modern fire detection technology will also ensure safety via advanced sensors that are integrated within the train. A pool of recent research supports an integrated approach to current rail transportation systems. Velavan et al (2017) reported upon operational railway sustainability via hybrid energy systems. Sharma et al (2018) elaborated on an automatic announcement system that improved fare paying passenger experience. Kumar et al (2019) reported upon enhanced safety with fire detection of the compartment of a passenger train. Zhang et al (2020) reported on solar and its feasibility in railways. Gupta et al (2021) studied and proposed an intelligent integrated hybrid renewable system. The combined recent railway research proposed here highlights the speed with which rail transport is becoming more automated and considering the integration of renewable energy systems.

Structure

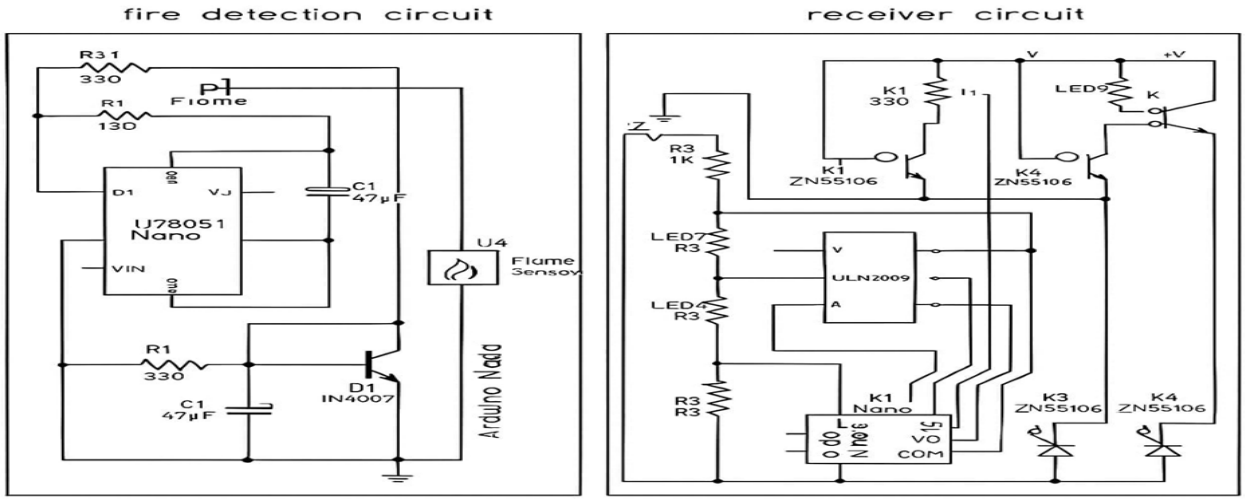
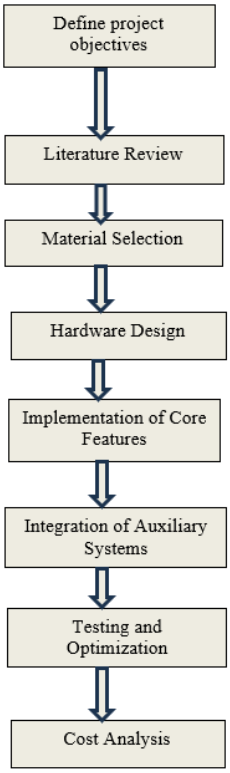


Fig 1: Circuit diagram

The following diagram depicts both the fire detection and receiver circuit utilizing an Arduino Nano. The fire detection circuit consists of a flame sensor and voltage regulator that allow for the detection of a flame, while the receiver circuit, using ULN2009 and ZN55106 transistors, is comprised of LEDs and relays to activate alarms, or, otherwise, responsive devices to alert user in the event of a fire.

Methodology:



This approach adopts a quantitative format, and a survey method is typically used to gather data. A structured questionnaire is used for the purpose of data collection and the respondents are selected using stratified random sampling to ensure the representation is fair and evenly distributed. Data is collected using univariate and multivariate descriptive with inferential statistics primarily to identify relationships. The data collection and analysis

process includes: (1) collecting data, (2) coding the data, (3) analyzing data, and (4) making the report with interpretation. This systematic approach, yields fair, dependable, reliable, and objective results that can be used to generalize findings to a larger population.

Components used:

Arduino nano:

The Arduino Nano is a compact microcontroller board featuring 16 digital pins, offering a surprising amount of flexibility for a device its size. It's suitable for a wide range of applications—seriously, it handles everything from basic hobbyist experiments to large-scale industrial automation. Engineers and developers frequently use it for rapid prototyping and testing new concepts. Thanks to its versatility, if you've got an idea, chances are you can implement it with a Nano.

Fig.1 Arduino nano

Arduino pro mini:

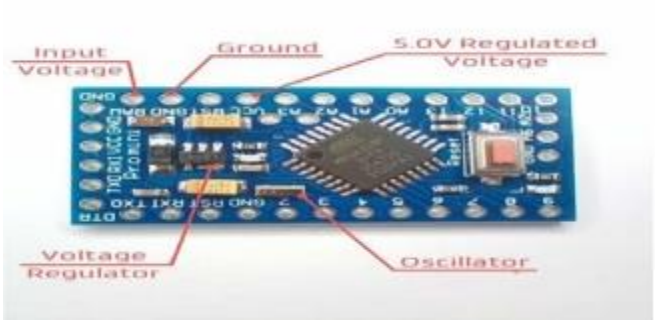


Fig.2 Arduino pro mini

The Arduino Pro Mini is a small and universal microcontroller board that is used in projects where there is limited space or where there is need for a smaller size. It is basically a low-cost version of the Arduino Uno with the same functionality but in a much smaller size.

Solar Panel:

Fig.3 Solar Panel

Solar panels, or photovoltaic (PV) panels, are panels that capture sunlight and transform it into electricity via the photovoltaic effect. Made up of several solar cells usually made from semiconductor materials such as silicon, these panels receive sunlight and create an electric current. When light hits the surface of a solar cell, it energizes electrons within the semiconductor material, causing them to flow and create an electrical current. This current is then collected by metal contacts on the solar cells and channeled through wires to be used as electricity. Solar panels come in various sizes and configurations, from small portable chargers to large-scale arrays used in residential, commercial, and industrial settings.

d) Lithium-ion Battery:

Fig. 4 Lithium-ion Battery

Lithium-ion energy storage devices widely used in various electronic devices, from smart phones and laptops to electric vehicles and renewable energy storage systems. These batteries utilize lithium ions as the charge carriers, moving between the positive and negative electrodes during charging and discharging cycles. Typically, the positive electrode (cathode) is made of lithium cobalt oxide or other lithium-based compounds, while the negative electrode (anode) is typically graphite. In the process of charging, lithium ions migrate from the cathode down to the anode with the help of an electrolyte, generally lithium salt dissolved in an organic liquid. On discharging, on the other hand, the lithium ions migrate back from the anode to the cathode, giving away energy that drives the gadget. Lithium-ion batteries present several benefits that include high energy density, low self-discharge rate, and relatively long life span over other rechargeable battery technologies.

16X2LCD Display:

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc.

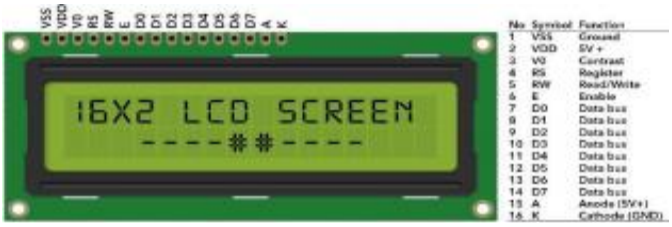


Fig.5 16X2 LCD Display

These displays are mainly preferred for multi-segment light-emitting diodes andsevensegments. The most important advantages of this module are cheap; easy to program, animations, and no restrictions for showing custom characters, special and even animations, etc.

DC Motor:

Fig.6 DC Motor

A DC motor, as abbreviated as Direct Current motor, is an electro-mechanical device that changes electrical energy in to the form of mechanical energy through the interaction of magnetic fields. It works on the Lorentz force principle, in which a current-carrying conductor inserted within a magnetic field will have a force. In a conventional DC motor, a permanent magnet or electromagnet generates a magnetic field, whereas the current is fed by brushes and a commutator too the rotor windings. When electric current passes through the rotor windings, it produces a magnetic field that interacts with the stationary magnetic field, making the rotor turn.

Servo Motor:

Fig.7 Servo Motor

A servo motor is a type of rotary actuator that enables precise control of angular position, velocity, and acceleration. It consists of a motor coupled with a feedback mechanism, typically a potentiometer, encoder, or digital sensor, allowing for closed-loop control. Servomotors are commonly used in various applications where precise motion control is required, such as robotics, CNC machines, 3D printers, and industrial automation systems. The motor's movement is controlled by sending electrical signals, usually in the form of pulses, to the motor's control input.

GPS:

Fig.8 GPS

The Global Positioning System (GPS) is a satellite-based navigation system that provides location and time information to users anywhere on or near the Earth's surface. Developed and maintained by the United States government, GPS consists of a constellation of at least 24 satellites orbiting the Earth, along with ground control stations and user devices. These satellites continuously broadcast signals containing information about their precise or bits and the current time. GPS receivers, typically found in smartphones, navigation devices, and other electronic gadgets, receive these signals and use them to calculate their own position, velocity, and time.

Thermistor:

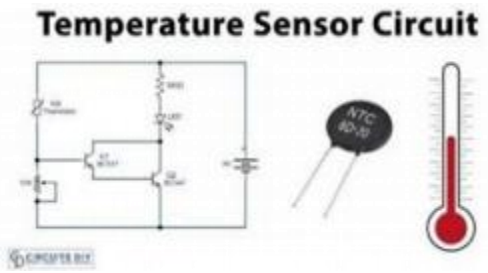


Fig.9 Thermistor

A thermistor is a deposit types of temperature sensor that responds showing a change in resistance along with a corresponding change in temperature. This semiconductor device is based on temperature sensitive materials, which are routinely oxides or polymers, causing its electrical resistance to vary predictably with temperature changes either way. Thermistors are subdivided into two main categories, namely negative temperature coefficient (NTC) and positive temperature coefficient (PTC). NTC thermistors show a reduction in resistance as there is increase in temperature, whereas PTC thermistors show an increase in resistance with an increase in temperature.

IR Sensor:

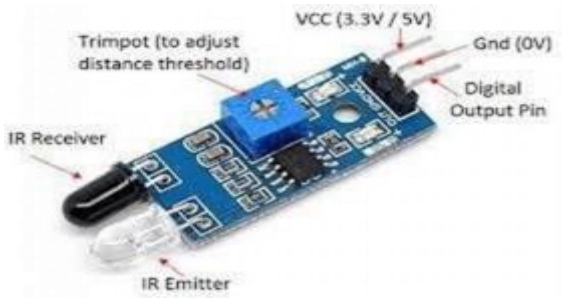


Fig.10 IR sensor

An infrared (IR) sensor is a sensor that detects infrared radiation emitted or reflected by objects around it. IR sensors operate on the principle that all objects at a temperature greater than absolute zero radiate thermal radiation in the form of infrared light. IR sensors are widely utilized for many applications like proximity sensing, motion detection, and temperature measurement.

There are different types of IR sensors, including passive and active sensors. Passive IR sensors detect changes in infrared radiation levels caused by the movement of objects within their detection range. They are commonly used in motion-activated lighting systems, security alarms, and occupancy detection in buildings.

Battery Management System:

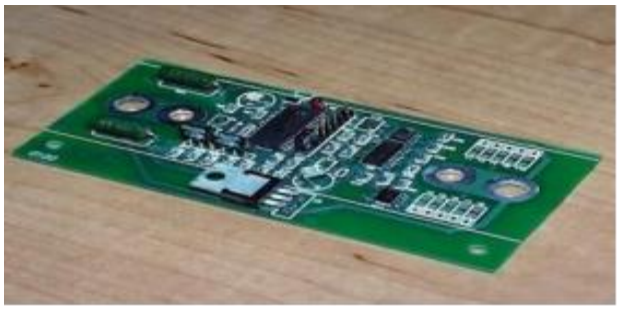


Fig.11 Battery Management System

A Battery Management System (BMS) is an electronic system designed to monitor, control, and protect rechargeable batteries. BMSs are commonly used in applications ranging from consumer electronics to electric vehicles and renewable energy storage systems. The primary functions of a BMS include monitoring the battery's state of charge (SoC), state of health (SoH), and state of safety (SoS). This involves measuring parameters such as voltage, current, temperature, and sometimes even impedance to accurately assess the battery's condition and performance. It also regulates the charging and discharging of the battery to enable safe and efficient usage.

Results:

The project on "Automatic Bogie Separation Technology for Improved Train Safety Due to Fire Hazard" produced a smart train system, which improves safety, efficiency and sustainability. The hybrid energy system uses solar power, integrated automated station announcements, fire detection system, alongside the project team preventing potential fires through passenger detection technology which significantly protects passengers' security and privacy. This system has the automatic bogie separation technology that ensures passengers and crews can react quickly to the fire hazard and the smart train system allows for significant reductions in fossil fuel needs which mitigate climate change impacts, enhance real-time communication with passengers, and improve their comfort and safety from an environmental perspective. In summary, the project showcases a modern, sustainable, and intelligent rail transport method while emphasizing efficiency and performance through very important safety measures.

Conclusion:

In conclusion, the use of hybrid energy, automatic station announcement systems, and fire detection systems in smart trains represents significant advancement in sustainable transportation. Harnessing a mix of solar energy and other renewable sources dramatically reduces reliance on fossil fuels, and provides opportunities for further reducing carbon emissions and overall environmental impact. The automatic announcement system improves the passenger journey and accessibility, offering on-time notifications and all-around efficiency. The fire detection systems and other safety measures

create modes of transportation with improved diversity, security, and safety by detecting and eliminating fire hazards as they appear. Overall, the utilization of these technologies in smart trains demonstrates a holistic approach to developing smart, sustainable transportation systems.

REFERENCES:

1. Non-invasive rail track detection system using Microwave sensor, K. Vijayakumar, S.R. Wylie, J.D. Cullen, C.C. Wright, A. I. Shama's
2. International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue7-July 2013 Automatic Broken Track Detection Using LED-LDR Assembly, Avinash. VanimiReddy, D.ArunaKumari0
3. High speed detection of broken rails, rail cracks and surface faults, Prof.MDhanasekar, Wirtu, L Bayissa& M Dhanasekar.
4. Spencer Ackers, Ronald Evans, Timothy Johnson, Harold Kess, Jonathan White, Douglas E Adams, Pam Brown, "Crack detection in a wheel end spindle using wave propagation via modal impacts and piezo actuation", Health Monitoring and Smart Non-destructive Evaluation.
5. Paper J.Trehag, P. Handel, and M. Ögren, _Onboard estimation and classification of a railroad curvature, IEEE Trans. In strum. Meas., vol. 59, no. 3, pp. 653-660, Mar.2010
6. Paper L.Beales, Track system requirements, Railway Group Standards, GC/RT5021, Railway Safety, London, Oct.2003
7. C.Saravanan, Dr.M.A.Panneerselvam, and I. William Christopher, "A Novel Low-Cost Automatic Solar Tracking System, "International Journal of Computer Applications, 31(9), pp.62-67, October 2011.
8. "SOLAR VEHICLES AND BENEFITS OF THE TECHNOLOGY", by John Connors, ICCEppaper2007.
9. Shen, X. J, Y. Zhang, and Sh. Chen. "Investigation of Grid-Connected Photovoltaic Generation System Applied for Urban Rail Transit Energy-Savings."2012 IEEE Industry Applications Society Annual Meeting (October 2012). doi:10.1109/ias.2012.6373995.