DESIGN AND MANUFACTURE AN ENERGY SOURCE THAT GENERATES ELECTRICITY BY REPLACING STANDARD SPEED BREAKERS

[1]Syed Athika Sultana, M.Tech.

[2]N. Hemanth Raj, [3]CH. Hardhik Sai, [4]P. Akhil, [5]SK. Ameer Basha

[1]AssistantProfessor, ECE Department, N.E.C.,Nellore

[2]UG Scholor, N.E.C., Nellore,

[3]UG Scholor, N.E.C., Nellore,

[4]UG Scholor, N.E.C., Nellore,

[5]UG Scholort, N.E.C., Nellore

Abstract: *The goal of this project is to design and manufacture an energy source that generates electricity by replacing standard speed breakers with a more efficient mechanism called a speed breaker power generator. When a vehicle passes over the speed breakers, the speed breaker itself collapses owing to the vehicle's weight, resulting in the creation of energy through the mechanism using under the speed breakers. Although this is a non-conventional energy source, the fabrication costs are lower. The various stages of research, design, and manufacturing that were involved in the construction and manufacturing of speed breaker power generation mechanisms and the efficient mechanism, rack and pinion mechanism, and construction of various components such as springs, rack and pinion arrangement, and generator were mentioned and explained in detail in this report.*

Keywords: *Speed Breaker Power Generator; Rack and Pinion Mechanism; Electricity Generation; Vehicle Weight Utilization*

I. INTRODUCTION

Since the dawn of humanity, energy has been essential for survival and progress. Early humans relied on food for energy, later discovering fire and utilizing wood for cooking and warmth. As civilizations advanced, energy needs grew, leading to innovations such as farming, domesticated animals for labor, wind-powered ships, and water wheels for mechanical work. These early methods relied primarily on renewable sources, with the sun being the ultimate provider of energy. However, with the industrial revolution, fossil fuels became the dominant energy source, leading to increased consumption and environmental concerns.

The depletion of fossil fuels poses a critical challenge, necessitating a shift toward sustainable alternatives like solar energy. Fossil fuels are finite and contribute significantly to pollution and climate change, making renewable energy sources an urgent necessity. Harnessing solar power not only reduces dependence on non-renewable resources but also eliminates harmful emissions, promoting a cleaner environment. Governments and researchers worldwide are actively working to enhance solar energy applications, ensuring energy security and sustainability.

One significant application of solar energy is solar-powered water pumping, particularly beneficial in rural areas lacking electricity. This system utilizes photovoltaic cells to convert sunlight into electricity, driving a DC motor pump to lift water efficiently. It consists of solar panels, a power conditioner to regulate voltage, and a storage battery for non-sunny periods, ensuring an uninterrupted water supply. By integrating solar technology into water pumping systems, this project presents a viable, cost-effective, and environmentally friendly solution. It has the potential to transform agricultural irrigation, drinking water access, and rural development, ensuring a sustainable future for generations to come.

II. FUNCTIONAL OVERVIEW

This project focuses on designing and manufacturing an innovative energy source that generates electricity by replacing standard speed breakers with a Speed Breaker Power Generator (SBPG) system. The mechanism converts the kinetic energy of moving vehicles into electrical energy, providing a sustainable and cost-effective alternative to conventional power sources.

The system consists of several key functional components, including a rack and pinion mechanism, agenerator, springs, and a power storage unit. When a vehicle moves over the speed breaker, the applied force compresses the mechanism beneath it. This motion drives the rack and pinion system, converting linear motion into rotational motion, which is then used to generate electricity through a dynamo or alternator. The generated energy is stored in a battery or capacitor bank for later use, making it an efficient energy-harvesting system.

Additionally, the system incorporates real-time monitoring to assess power output, durability, and operational efficiency. It can be deployed in high-traffic areas such as highways, toll plazas, parking lots, andurban roads, ensuring continuous power generation with minimal maintenance. By utilizing renewable mechanical energy, this project offers a low-cost, eco-friendly solution to supplement electricity demands, contributing to energy sustainability and reducing dependence on fossil fuels.

III.METHODOLOGY

EXISTING SYSTEM

Piezoelectric energy harvesting is an innovative technology that converts mechanical energy into electrical energy using piezoelectric materials, which generate an electric charge when subjected to pressure or vibration. When vehicles pass over specially designed road sections embedded with piezoelectric sensors, the mechanical stress exerted on these materials produces an electric charge. This charge is then collected by electrodes, stored in batteries or capacitors, and later converted into usable electricity for various applications such as street lighting, traffic signals, and wireless sensors. The key advantages of this system include its renewable and sustainable nature, low maintenance due to the absence of moving parts, and scalability, making it suitable for highways, pedestrian walkways, and railway tracks. However, the technology faces challenges such as low energy output compared to traditional sources, high initial installation costs, and efficiency concerns that require optimized placement and design. Despite these limitations, piezoelectric energy harvesting holds

great potential as a sustainable power solution, contributing to energy-efficient urban infrastructure and smart city applications.

PROPOSED SYSTEM

This is made up of mild steel. The complete set up is fixed in this model FOOT STEP. The two L-shapes frame is fixed in the above two ends of the track. Bellow this l- shapes window, the actual power generation arrangement is constructed. This L-shapes window pushes the rack when the time of train wheel moving on these arrangement.

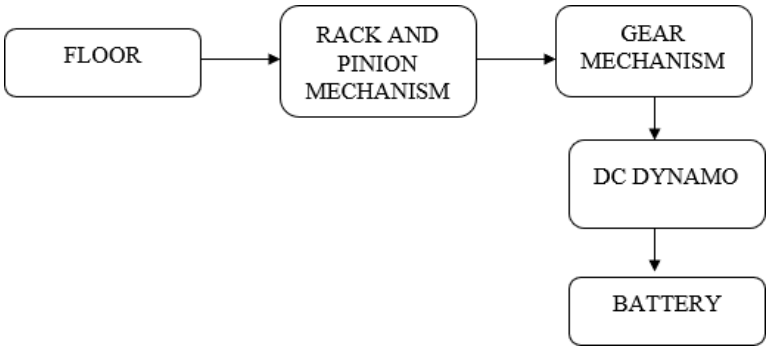

Fig.3.1:Block Diagram of ControllerPart

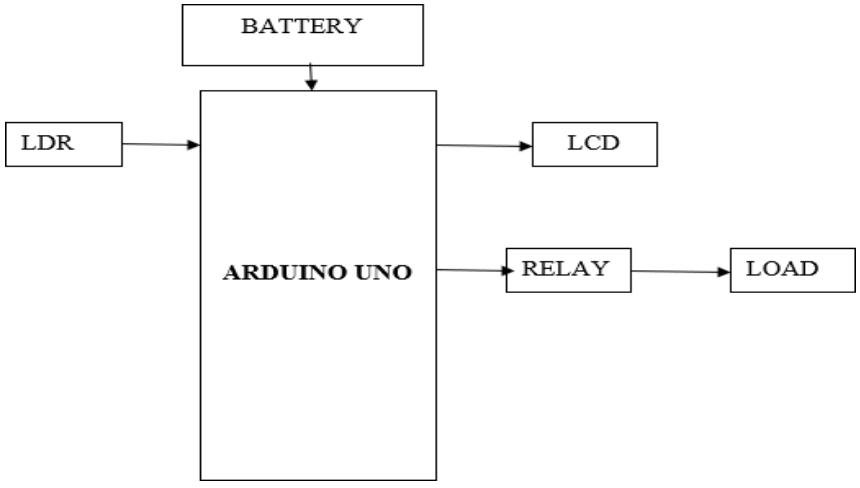

Fig.3.2 Block Diagram of Arduino UNO

IV.COMPONENTS

The components in design and manufacture an energy source that generates electricity by replacing standard speed breakersisexplained in this section. This contain both hardware and software components.

Let’s talk about them one by one:

HARDWARE COMPONENTS

(1) Arduino UNO Controller : -

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

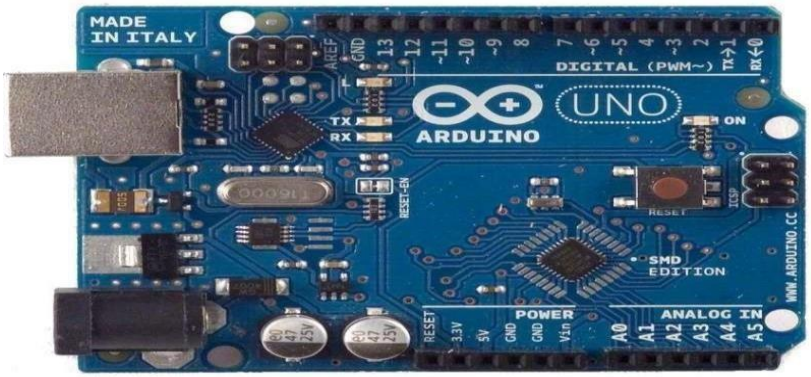

Fig3.6:Arduino UNO

(2) Lithium-ion Batteries: -

Lithium-ion (Li-ion) batteries are rechargeable energy storage devices that have become ubiquitous in modern electronics, portable devices, and electric vehicles due to their high energy density, lightweight design, and long cycle life. Li-ion batteries are a type of rechargeable battery that utilizes lithium ions as the primary charge carriers. It typically consists of one or more electrochemical cells, each containing a positive electrode (cathode), a negative electrode (anode), and an electrolyte solution. During charging, lithium ions move from the positive electrode to the negative electrode, where these are stored in the anode material.

Fig.4.2: Li-ion Batteries

(3)Rack-and-pinion:-

Units convertacylinder'slinearmotion toangularrotationthatcanexceed 360°. The rotary actuators with the rack mounted on the rod — are often used in process industries to operate quarter-turn valves. In addition to rod-type cylinders, other designs included.

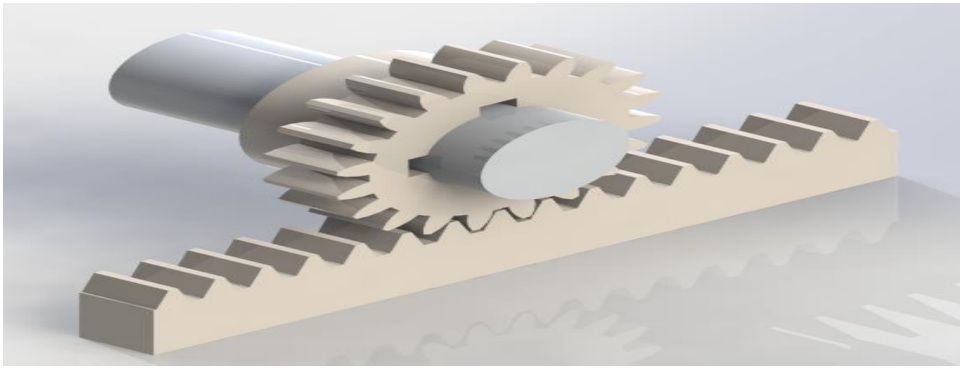

Fig.4.3: Rack and pinion

(4)LDR – Light Dependent Resistors Circuit: -

The controlling of lights and home appliances is generally operated and maintained manually on several occasions. But the process of appliances controlling may cause wastage of power due to the carelessness of human beings or unusual circumstances. To overcome this problem, use the light-dependent resistor circuit for controlling the loads based on the intensity of light. An LDR or a photoresistor is a device that is made up of high resistance semiconductor material.

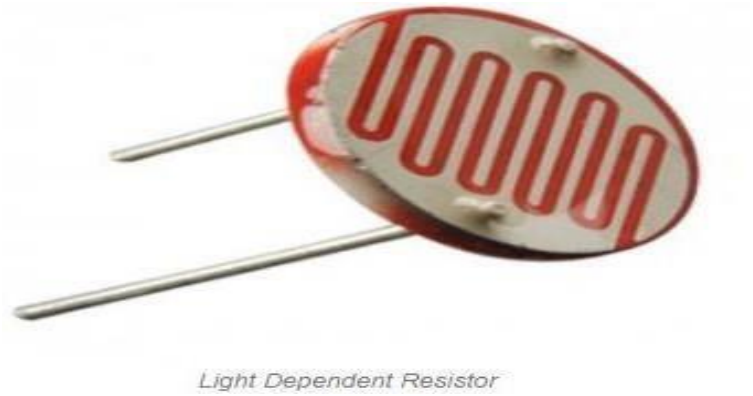

Fig 3.7: Light Dependent Resistor

(5)LCD (Liquid Cristal Display):-

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular toeach other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the controllers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

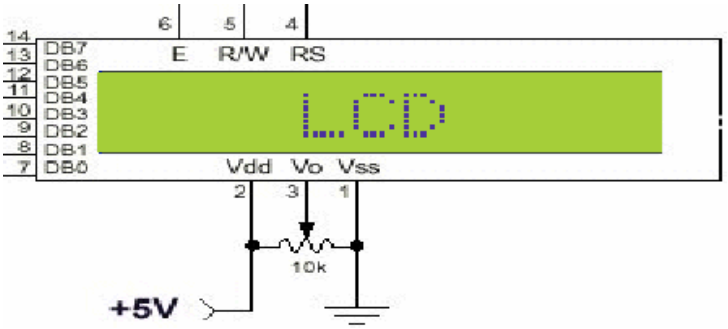

Fig 3.11: Pin diagram of 1x16 lines LCD

(6) Relay :-

A relay is an electrical switch that opens and closes under the control of another electricalcircuit.Intheoriginalform,theswitchisoperatedbyanelectromagnettoopen orcloseoneormanysetsofcontacts.Arelayisabletocontrolanoutputcircuitofhigher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.

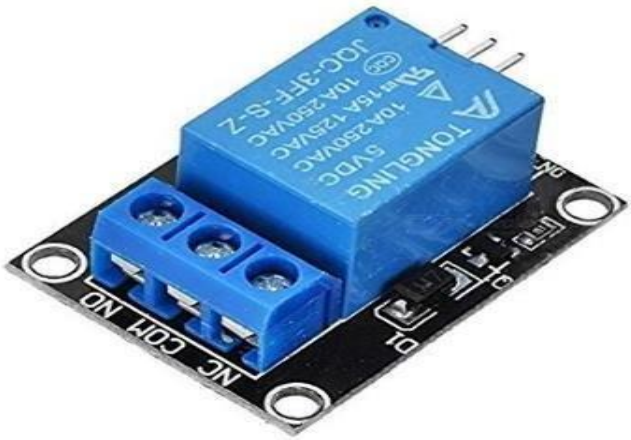

Fig.3 .12: Relay for AC

SOFTWARE COMPONENTS

(1) Arduino IDE:-

The Arduino IDE provides a user-friendly interface for programming Arduino boards, making it accessible to beginners and experienced developers alike. It supports a wide range of Arduino-compatible boards, including the popular Arduino Uno, Nano, Mega, and others, as well as third-party boards based on the Arduino platform. The IDE is available for Windows, macOS, and Linux operating systems, allowing users to develop Arduino projects on their preferred platform.

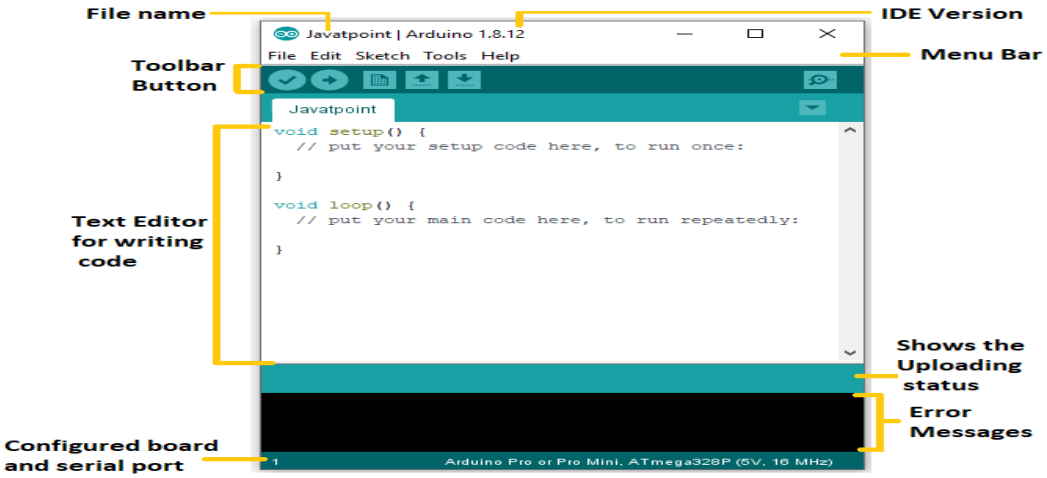

Fig.4.8**:** Arduino IDE

(2)THINGSPEAK: -

ThingSpeak is an IoT analytics platform service that allows aggregating, visualizing and analyzing live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by the devices to ThingSpeak. With the ability to execute MATLAB code in ThingSpeakQQQ can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

Internet of Things (IoT) describes an emerging trend where a large number of embedded devices (things) are connected to the Internet. These connected devices communicate with people and other things and often provide sensor data to cloud storage and cloud computing resources where the data is processed and analyzed to gain important insights. Cheap cloud computing power and increased device connectivity is enabling this trend.

IoT solutions are built for many vertical applications such as environmental monitoring and control, health monitoring, vehicle fleet monitoring, industrial monitoring and control, and home automation.

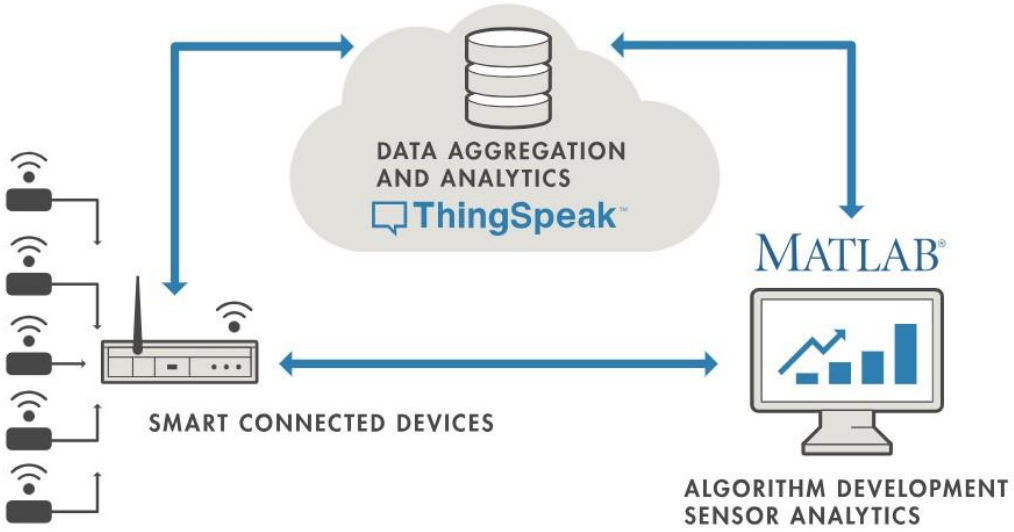

Fig. 3.11: ThingSpeak Platform

IV.WORKING PRINCIPLE OF PROPOSED SYSTEM

The pushing power is converted into electrical energy by proper driving arrangement.The rack & pinion, spring arrangement is fixed at the FOOT STEP which is mounded bellow the L-shapes window. The spring is used to return the tiles window in same position by releasing the load. The gear wheel is coupled to the generator shaft with the help of another gear wheel. The generator is used here, is permanent magnet D.C generator. The generated voltage is 12Volt D.C. By increasing the capacity of battery and inverter circuit, the power rating is increased. This arrangement is fitted in FOOT STEPs; the complete arrangement is kept inside the floor level except the pushing arrangement.

Advantages

- Reliable, Economical, Eco-Friendly.
- Less consumption of Non- renewable energies.
- Excellent linearity over their dynamic range
- Wide frequency range, high frequencies can be measured
- Compact yet highly sensitive
- No moving parts - long service life
- Self-generating - no external power required

Applications

Foot step generated power can be used for agricultural, home applications, street- lighting. Foot step power generation can be used in emergency power failure situations.

Metros, Rural Applications etc., To control a high-current circuit with a low- current signal, as in the starter solenoid of an automobile, To detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays).

V. RESULTS AND DISCUSSION

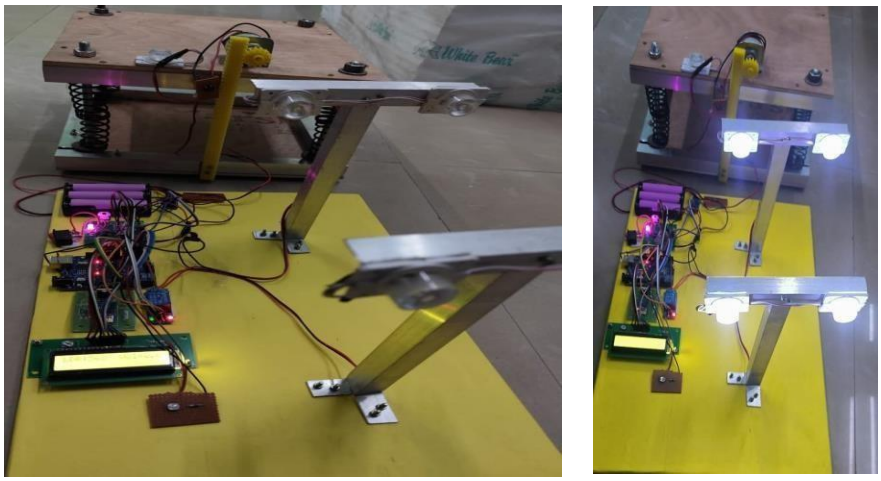

Fig4.1:FinalSetupoftheProject

The above image refers to the final setup of the project. The setup includes a spring-loaded platform, a rack and pinion mechanism, and an electronic control system with an Arduino, LCD, and sensors. The rack and pinion mechanism is likely used to convertheverticalmotion(fromvehiclespassingoverthespeedbreaker)intorotational motion, which thendrives a generator to produce electricity. The stored energycould be used for powering streetlights, traffic signals, or other small electrical loads.

Fig4.2:OutputreadingofLDRandVoltageinLCD

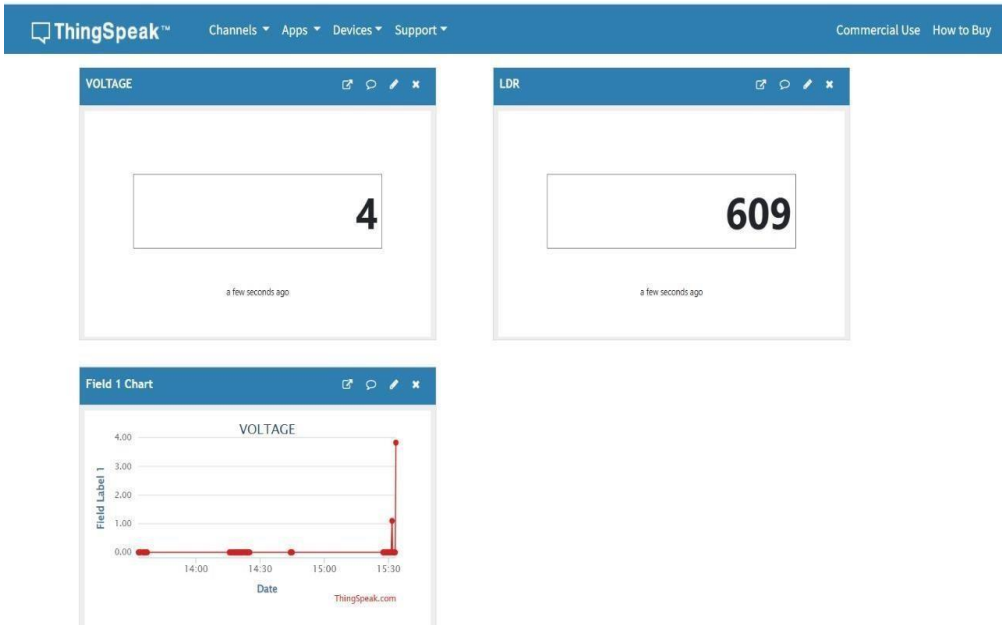

Fig4.4:LDRandVoltageValuesinThingSpeak

This image depicts a ThingSpeak dashboard, an IoT analytics platform used for visualizingandmonitoringsensordata.Thedashboardcontainsthreewidgetsdisplaying real-time data. The first widget shows the voltage value, which is currently at 4. The secondwidgetdisplaystheLightDependentResistor(LDR)reading,withavalueof609. Additionally, a time-series graph labelled "Field 1 Chart".

VI.CONCLUSION AND FUTURE SCOPE

Conclusion

The project on electricity generation using speed breakers is an innovative approach to harnessing kinetic energy from moving vehicles and converting it into usable electrical energy. This system represents a sustainable and eco-friendly solution that can significantly contribute to the development of renewable energy sources in urban infrastructure. The principle behind this project is based on converting the mechanical energy exerted by vehicles passing over a speed breaker into rotational energy, which is then used to drive a generator, ultimately producing electricity. The generated power can be stored in batteries or directly used for street lighting, traffic signals, and other essential public utilities.

The need for alternative energy sources has grown substantially due to the rapid depletion of fossil fuels and rising environmental concerns. This project addresses these challenges by utilizing an untapped source of energy—vehicle movement on roads. The system consists of a spring-loaded speed breaker equipped with a rack and pinion mechanism, which converts the up-and-down motion of vehicles into rotational motion. This rotation is then transferred to a generator to produce electricity. The entire setup is integrated with a control circuit that regulates power generation and distribution.

Whenever a vehicle passes over the speed breaker, it depresses the platform, causing the rack to move in a linear direction. The rack engages with a pinion gear, which rotates as a result of the downward motion. The rotational energy generated is transferred to a dynamo or generator, producing electrical energy that can be

stored or directly used for applications like lighting up nearby areas. This method ensures continuous energy generation in high-traffic areas, making it a viable renewable energy solution.

Future Scope: -

The future scope of this project is vast, with numerous opportunities for advancements and large-scale implementation. As technology continues to evolve, the efficiency and applicability of speed breaker-based energy generation can be enhanced significantly. Future developments could include advanced materials, better energy storage solutions, automated monitoring systems, and integration with other renewable energy sources.

One major area of improvement lies in efficiency enhancement. Current systems experience energy loss due to friction and mechanical inefficiencies. Future designs could utilize magnetic gears, advanced lubricants, or frictionless mechanisms to reduce energy dissipation. Additionally, research into piezoelectric materials could eliminate the need for mechanical gear systems altogether, directly converting pressure into electrical energy. This would reduce maintenance costs and increase system lifespan.

Another promising direction is smart energy management. Integrating IoT (Internet of Things) technology can allow real-time monitoring of energy production and distribution. Smart sensors and cloud-based analytics can track vehicle density, optimize energy storage, and ensure that the generated electricity is efficiently used in nearby infrastructure. This would create a self-regulating energy network that minimizes wastage and maximizes output.

Hybrid renewable energy systems could further expand the potential of this technology. Speed breakers could be combined with solar panels and wind turbines in urban areas to ensure continuous power generation. For instance, speed breakers in parking lots could generate power during peak hours, while solar panels could supplement energy production during the day. This hybrid approach would make renewable energy solutions more reliable and resilient.

Wireless energy transmission is another futuristic innovation that could enhance the feasibility of this project. Instead of relying on wired connections, inductive charging or wireless power transfer technologies could distribute the electricity generated by speed breakers over longer distances with minimal energy loss. This would enable decentralized power distribution systems where multiple energy-harvesting units collectively contribute to a city’s energy grid.

REFERENCES

[1] Kadirgama , K, A wad, Mohammed, M. N., Tao, H., & Bash, AA.K. (2023). Sustainable Green Energy Management: Optimizing Scheduling of Multi-Energy Systems Considered Cost and Emission Using Repuisive Frog-Attractive Leaping.Sustainability, 15(14), 10775

[2] Abed, A. A., Suwaed, M. S., Al-Rubaye, A. H., Awad, O. 1,Mohammed,_M. N., Tao,H.,Karah Bash,:&A.2023).Optimizing Energy and Reserve Minimization Sustainable Microgrid with Electric Vehicle Integration: Dynamic and Adjustable Manta Ray Foraging Algorithm. Processes, 1 1(10), 2848.

[3] Kuan, _T.C. et(2024). Digital Transformation Towards Sustainability in Higher Education :New Approach of Virtual Simulator for Series and Parallel Diodes for a Sustainable Adoption of E-Learning Systems. In: Hamdan, A., Aldhaen, E.S. (eds) Artificial Intelligence and Transforming Digital Marketing. Studies in Systems and Control.vol487. Springer,DecisionCham.https://doi.org/10.1007/9783-031-35828-9_48

[4] Teng, L.M., Yusoff, K.H., Mohammed, M.N., Jameel Al-Tamimi,A.N., Sapari, N.M., Alfiras, M. (2024). Toward Sustainable Smart Cities: Smar Water Quality Monitoring System Based on loT Technology. In:Hamdan, A.,Aldhaen, ES. (eds) ArtificialIntelligence and Transforming Digital Marketing. Studies in Systems,Decisionand Control,vol487.Springer,Cham.https://doi.org/10.1007/978-3-031- 35828-9 _49

[5] Alfiras, M., Bojiah, J Mohammed, M.lbrahim, F. M Ahmed,H.M. & Abdullah, O.(2023).Powered education based onMetaverse: Pre-and post-COVID comprehensivereview.OpenEngineering, 13(1), 20220476

[6) Mohammed, M. N. Al-Rawi, o. Y. M., Al-Zubaidi, S. Mustapha, S.,& Abdulrazaq, M. (2022, June). Toward Sustainable Smart Cities in the Kingdom of Bahrain: A New Approach Smart Restaurant Management and Ordering System During Covid-19. In 2022 IEEE International Conference on Automatic Control and Intelligent Systems (2CACIS) (pp. 7-11). IEEE.

[7] Mohammed, M. N., Dionova, B. W., Al-Zubaidi, S., Bahrain, S. H.K., & Yusuf, E. (2022). An loT-Based Smart Environment forSustainable Healthcare Management Systems. In Healthcare Systemsand Health Informatics (pp. 51-74). CRC Press

[8] Mohammed,M J., & Sharif, A. (2023). Toward Sustainable SmartAl-yousif, S., Alfiras, M., Rahman, M., AlTamimi, A.Cities: Design and Development of Piezoelectric- Based FootstepPower Generation System. In Artificial Intelligence and TransformingDigital Marketing (Pp. 215-224). Cham: Springer Nature Switzerland.

[9] 4 M. Islam, et al., "Generation of Electricity Using Road TransportPressure," vol. 9001, pp. 2319-5967, 2015.