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Eco Step Power-Gen: Harnessing Renewable Energy from Footsteps and Speed Breakers

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Abstract

Eco Step Power-Gen" endeavors to revolutionize renewable energy generation by tapping into the latent kinetic energy from human footsteps and vehicular traffic on speed breakers. This pioneering project seeks to develop and deploy innovative technology capable of capturing and converting mechanical energy into electrical power. Through meticulous research, design, and testing phases, the project aims to assess the viability and effectiveness of energy generation from these unconventional sources. By integrating specialized equipment such as piezoelectric materials and kinetic energy harvesters into pedestrian walkways and roadways with speed breakers, the project endeavors to harness previously untapped energy resources. The overarching objective is to contribute to environmental sustainability by reducing reliance on fossil fuels and mitigating carbon emissions associated with conventional energy production. Collaboration with urban planners, transportation authorities, and local communities will be pivotal in ensuring the seamless integration and scalability of this eco-friendly solution. By harnessing the power of human movement and vehicular traffic, "Eco Step Power-Gen" strives to pave the way towards a greener and more sustainable future. The Footprint design is powered by electricity generated by human steps and vehicle movement. The electricity generated is stored in the battery and is used to charge it. The electricity stored in the battery is used to charge the portable phone using the RFID card. The energy put away within the battery can be used to charge the phone. The Footprint framework is powered by the ESP8266 node MCU and includes the following components: Dynamo RFID sensor USB cable LCD display LCD driver (I2C).

Keywords: Footstep Energy, Speed Breaker Energy, RFID sensor, ESP8266 NODE MCU, LCD Driver (I2C)

INTRODUCTION

As the global community grapples with the pressing need for sustainable energy solutions, "Eco Step Power-Gen" emerges as a promising endeavor at the forefront of renewable energy innovation. This paper introduces a groundbreaking project poised to harness the untapped potential of human movement and road infrastructure for electricity generation [1]. In an era marked by increasing urbanization and transportation demands, the concept of deriving power from footsteps and speed breakers represents a paradigm shift towards decentralized and environmentally friendly energy sources. The urgency of transitioning towards renewable energy cannot be overstated, with climate change posing unprecedented challenges to ecosystems and human

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societies worldwide [1415]. Against this backdrop, "Eco Step Power-Gen" offers a compelling solution that not only addresses energy sustainability but also aligns with broader efforts to combat climate change and reduce carbon emissions. By capitalizing on the kinetic energy inherent in everyday activities such as walking and vehicular travel, this project holds the potential to revolutionize urban infrastructure and pave the way towards a greener future [1,5,6].

This invention is reliant on the piezoelectric effect impact rule, which states that some materials have the ability to accumulate electrical charge due to their weight and the pressure placed on them. The ability of some materials to produce an electric charge in response to mechanical stress applied to them is known as the piezoelectric effect. It is the process via which pressure, strain, or mechanical vibrations applied to piezoelectric material are transformed into electrical form [712]. The term "piezoelectricity" refers to a few materials' ability to generate an electric potential in response to a linked weight. Piezoelectric material put into the body can provide the illusion of a changing weight applied by moving people into the electric current. This electric current is then stored in a battery and spread further through RFID cards [5]. In order to generate power, a speed breaker is also included. The newest method to generate electricity with less input is the speed breaker power generator (SBPG). Within this framework, a rack & pinions mechanism is employed in the generation of power. A car's reach for the speed breaker causes the rack to descend and use pinions to produce linear to rotational motion. The DC generator receives the rotating motion and produces DC electricity. The power produced can be utilized either for personal or business purposes, and are situated close to the speed limit switch [34]. The basic concept is that we can generate energy that can be stored in a rechargeable battery by using the Speed breaker and piezoelectric tiles, which are put beneath foot traffic. A liquid crystal display can show how much energy has been stored. Public spaces like bus stops, theaters, train stations, shopping centers, etc. will find usage for this project. Thus, these systems ought to be installed in public areas where people must use this system to pass via entrances and exits while walking.

Aim

The goal of the Eco Step Power-Gen project is to transform renewable energy production by using kinetic energy from the footsteps and speed breaker, which is then distributed through RFID cards for the purpose of charging.

Objective

- Develop innovative technology to capture and convert kinetic energy from footsteps and speed breakers into electrical power.
- To charge your phone with RFID.
- Foster collaboration with stakeholders for seamless integration and scalability.

Block Diagram

Here, the speed breaker mechanism and piezo electric sensor work together to generate electricity in two different ways. A voltage is created across the piezoelectric plate when weight is applied to it. In a similar manner, the electricity generated by the speed breaker is also kept in the battery for charging. After that, our monitoring circuitry receives this. A microcontroller interfaces an LCD with a piezo sensor to enable the user to monitor voltage and charge a connected battery. Additionally, RFID is integrated with a microcontroller to identify authorized users. It also includes a USB port for charging mobile devices, allowing users to connect cables to fully charge their phones from batteries [fig 1].

Working

Power Generation Through Piezoelectric Sensor

The piezoelectric effect impact theory underlies the operation of the Footstep power generator. The capacity of some materials to produce electric charges in response to mechanical stress applied to the piezoelectric plate is known as the piezoelectric effect. Thus, you can create an electrical current by squeezing specific crystals. The unit cell of piezoelectric crystals is symmetrical in most crystals. The

atoms inside the piezoelectric plate may not be symmetrically organized, but their electrical charges are precisely balanced a positive charge in one location cancels out a negative charge nearby and the piezoelectric crystals are often electrically neutral. On the other hand, deforming the structure by stretching or compressing the piezoelectric crystal results in negative charges [56]

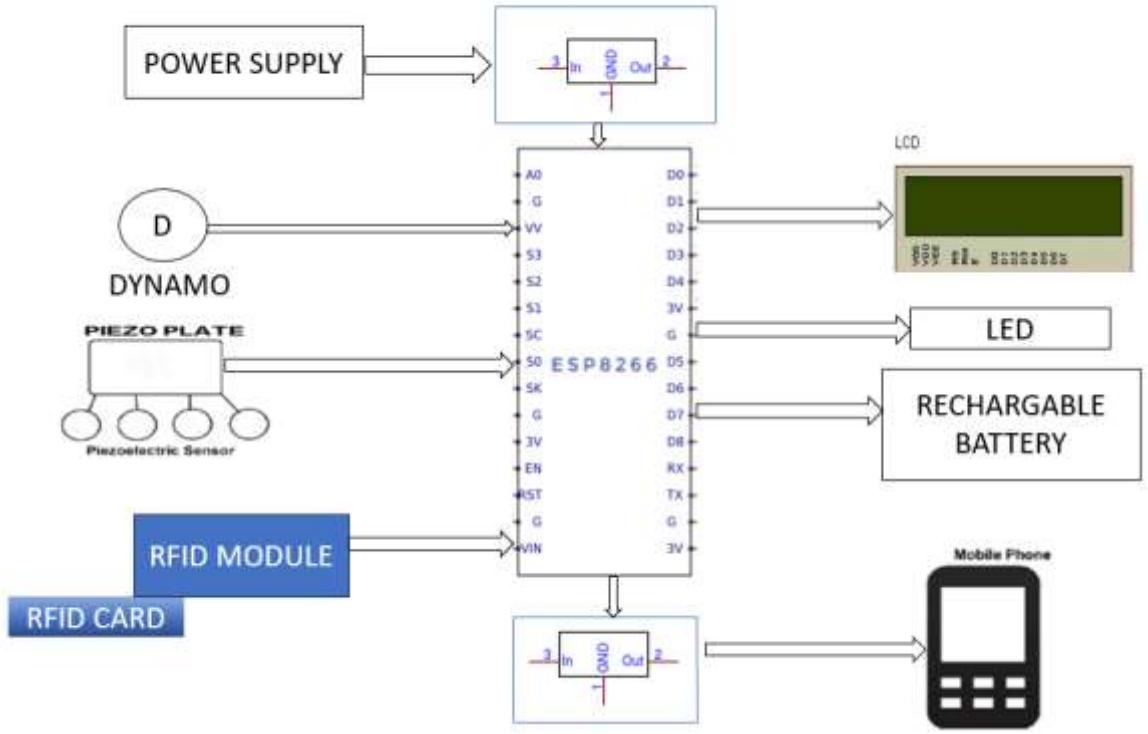

Fig 1. Block diagram of eco step power-gen: harnessing renewable energy from footsteps and speed breaker

Net positive and negative charges show up on the crystal's opposite exterior sides as a result of this effect, which permeates the entire structure. Even though they are not placed symmetrically, the charges in a piezoelectric crystal are typically perfectly balanced. Squeezing the crystal which is greatly emphasized in this image will cause the charges to become unbalanced. Net positive and negative charges now appear on the opposing crystal faces as a result of the charges' effects no longer canceling each other out. Piezoelectricity is the ability to create voltage across a crystal's opposing faces by applying pressure on it. The same process of creating piezoelectricity from a piezoelectric crystal in the shape of a coin-shaped disc has been applied in this project [7,15,16].

Power Generation Through Speed Breaker Mechanism

Both conventional and unconventional energy sources can be used to generate power. We demonstrate the conversion of kinetic energy to rotational energy and rotational energy to electrical energy. The process of producing energy using speed breaker configurations is straightforward yet highly effective. Driving on the road are a lot of different vehicles. These cars are exceeding several of the speed limiters that are in place. Our intended speed breaker is intended to take the place of these conventional speed breakers. This device is electro-mechanical. This system generates and stores electricity through the use of combined electrical and mechanical technology. The generation will follow the traffic density in a proportional manner [2,3,4].

The speed breaker system transmits to rack and pinion arrangements when the vehicle load is applied. The top of the speed breaker descends due to the weight of the car. The pressure rod is fastened to the

hydraulic press's small piston on one side and the speed breaker's bottom on the other. The force is converted four times from small to huge piston by the hydraulic press. Three rakes are fastened to a big piston. Each rack has two one-way pinion connections. The rotation of the pins is caused by the rack's back and forth motion. Each pinion is attached to a fly wheel, which stores energy for times when demand is low and releases it when needed [fig 2].

A flywheel is attached to a big gear, and a big gear is attached to a small gear that is attached to a generator. Electrical energy is produced by generators from rotational energy. The system reverses after the car passes the speed breaker because the expansion of the springs returns it to its initial state. A battery is charged by the charging [8,9,10].

CIRCUIT-DIAGRAM

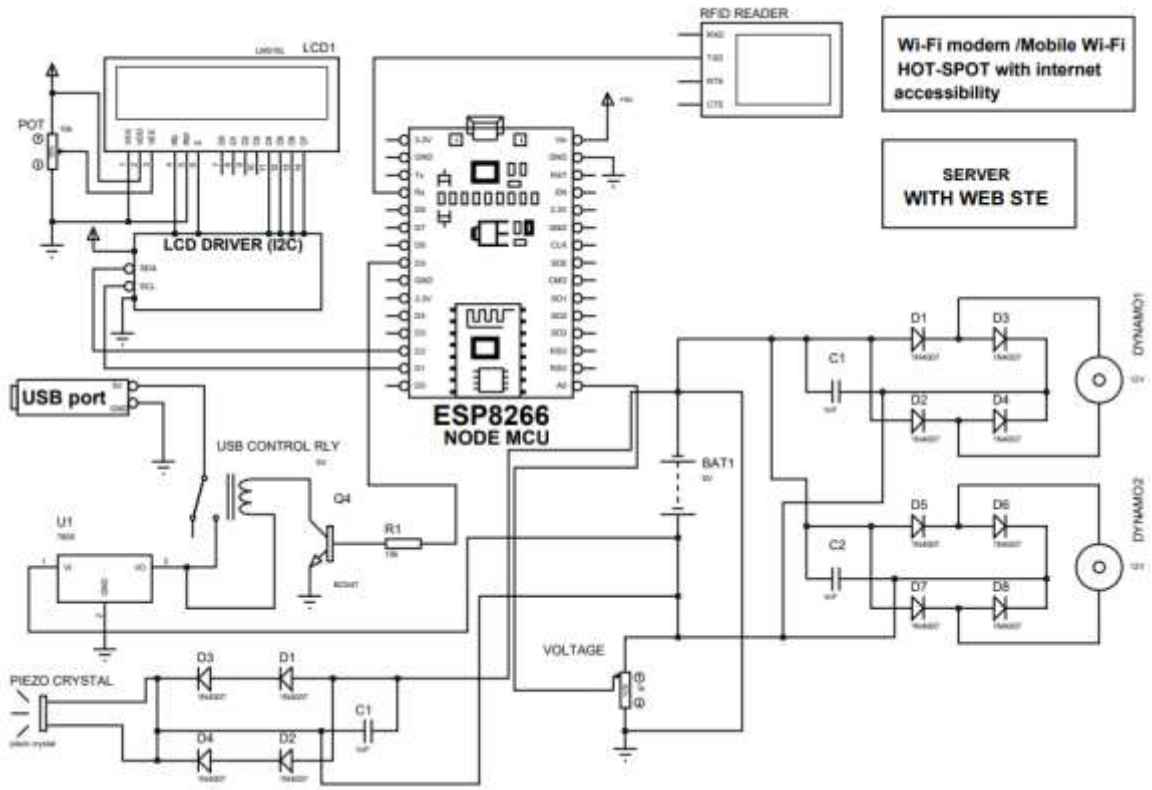

Fig 2. Circuit diagram

Power calculations and result analysis

In this project, three piezo are connected in parallel on a single tile, arranging the series connections parallel to one another. Consequently, the equivalent capacitance increases when four piezoelectric discs are connected in series. The power produced changes according to the steps in the piezoelectric array that is being used. The voltages acquired are derived from real-world outcomes: Minimum emf = 2V/step. Maximum emf = 8V/stepAssuming that the system user weighs 55 kg on average, the average calculation is: It is necessary to take actions to improve the battery's 1 V charge. = 680• Increasing the 9 volts of the battery: Total number of steps needed = (9 × 680) = 6120

If this system is used in a location where it is easy to obtain footsteps as a source, such as a college biometrics department, the time necessary for 6120 steps would be

6120 / (60 × 2) = 51 minutes if two steps take one second [5,7,12,].

In the case of speed breaker, Let's consider, The mass of vehicle driving over the speed breaker = 98Kg (Approximately)

- Height of speed breaker = 15 cm
- Weight of the body = 98 Kg × 9.8 = 960
- Distance traveled = Height of the speed breaker = 15 cm
- Work done = weight of the body × distance travelled by the pressure of vehicle
- Power = work done/second = (960 × .15)/60=2.4watts
- Output power developed for 1 vehicle passing over the speed breaker
- Power developed for 60 min = 144 watts
- Power developed for 24 hours = 3.45 KW , [2,3,13]

CONCLUSION

The implications of "Eco Step Power-Gen" extend far beyond mere energy generation. By reducing reliance on fossil fuels and mitigating carbon emissions, it offers a tangible pathway towards a cleaner, more sustainable future. Moreover, its integration into existing urban infrastructure underscores its practicality and scalability, paving the way for widespread adoption in communities around the world. The listed system is unconventional, and the method of producing power is also conducive to echo chambers. The fact that it doesn't rely on any outside sources is a benefit. We will be able to lower power outages and load shedding by utilizing this technique. The daily need for street illumination might be met by the stored electricity. It can also be used for any other beneficial task, such as toll booths or roadside signal systems.

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