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Smart Electricity Generator via DC Motor

Sai Ramesh G N[1], Nikil Nachappa T A[2], Vibhu V[3], Nitish A[4], Ramya P[5]

[1,2,3,4] *Electrical and Electronics Engineering, Sri Venkateshwara College of Engineering, Visvesvaraya Technological University, Bengaluru, India.*

[5]*Assistance Professor, Electrical and Electronics Engineering, Sri Venkateshwara College of Engineering, Visvesvaraya Technological University, Bengaluru, India.*

Abstract - *The Biggest problem faced by the world is the shortage of electric power, it is estimated that the power demand will be increased by 57% by 2050. During these times we need an alternate mode of generation of electricity other than solar and wind, which is renewable and at the same time cheap. This paper presents an experimental model of Generation of Electricity from footsteps is an effective way to produce and store power. This technology is eco-friendly, durable and involves people for generation purposes. This means each individual is contributing to society by being a part of it. When a person steps on the specially modified tiles which are connected to a generator while walking, then due to the kinetic energy exerted on the tile, there will be a generation of a small amount of power, which can be used simultaneously or store later supply power for various applications like street lights, telephone booths, power plugs, etc. The amount of power generated depends on the number of people stepping on them. Hence, we need to set up this in crowded places like malls, airports, theatres, etc. This technology can be used at all times, unlike solar which can produce energy only during the daytime and thus more beneficial*

Key Words: **Footstep, D.C. Motor, Rack and pinion, Renewable energy, Small Power Generator.**

1. INTRODUCTION

The utilization of locomotion of people to generate electricity is very relevant and much necessary for this generation especially in countries with very high populations like India, China and Bengal. Where utilization of mobility of people is done to its extreme [1]. By setting up this technology at places like nightclubs, party halls and sports fields where a lot of people gather and a lot of movement takes place which may be caused by dancing or from running on the field, a lot of energy can be captured and be utilised to supply to nearby street lights or to the building by which they can reduce their commercial billing expense.

Electricity is a very important commodity, a world without is difficult to imagine and yet in a survey, it is said that 87% of India's population have access to grid-based electricity, while the remaining 13% use non-grid sources or don't have access to power at all. With the daily increase in consumption of power as new industries and new infrastructure are being set up, the generation needs to be increased with the increasing demand. Most of the generation is still done by conventional methods such as thermal generation which leads to releasing a large amount of carbon dioxide and various other gasses into the environment in the process of generation of electricity. We can limit the generation by conventional methods by using alternate locally generated power renewable source which we call to reduce the carbon-dioxide emission. Another problem with the non-renewable generation system is that they are finite and will be exhausted sooner or later. While renewable energy sources are inexhaustible and can be used for as long as we want and there will not be any pollutants being released into the environment as by-products, hence it is eco-friendly [2]-[3].

Instead of using traditional renewable methods for generation, by using footsteps to produce clean electricity we utilise the untapped energy which is given out with each step a person takes. Kinetic energy is the energy of an object when it is moving from the state of rest to motion. Some kinetic energy is produced with every footstep while walking and this energy is untapped and wasted [4]. The technology helps us to convert this energy into electricity by using the kinetic energy produced by footsteps. A generator is connected to the tile through a gear mechanism, which converts kinetic energy into electrical energy by electromagnetic induction.

The working principle of the model is converting physical relative motion to electricity. This type of generation is useful for supplying electric power to electrical equipment or products which utilise less energy since the generation of energy is less as a single unit. When a person steps over the tile, then the tile moves downwards making a downward displacement and at the same time, the spring which is attached to it gets compressed. The gears which are mechanically coupled to the shaft of the DC motor rotates in the clockwise direction and thus a small amount of electric power is generated. After when the person walks over and crosses the tile, the spring which was compressed gets released and the tile tries to get back to its original position, this time the shaft of the DC motor rotates in an anti-clockwise direction thus generating another small amount of electric power.

2. METHODOLOGY

When a person walks, he/she produce kinetic energy with every footstep they keep. This energy can be tapped into, with the help of a tile. The tiles are designed such that with enough force, they make a linear displacement, thus converting the kinetic energy to linear motion. This is further converted to rotational motion with the help of gears and delivered to the motor. Hence by the principle of electromagnetic induction, an equivalent power and voltage are generated from the motor, which can be stored and later used. Since we need to supply AC as power, so use an inverter to convert back the DC Power stored in the battery into AC

The working of the model is bifurcated into two sections; one is Mechanical and another Electrical. The mechanical section goal is to convert the vertical motion of tiles, which is caused by people stepping on the tile, into rotational motion and to be delivered to the DC motor. As for the electrical section, the goal is to store the energy generated by the DC motor into a battery and later use an inverter along with it for supplying AC power. We have used two 12V 300rpm permanent magnet type DC motors.

For the mechanical section, two factors impact the output power generated; they are the weight of the person which signifies the force exerted and vertical displacement of the tile. We can't control the force exerted on the tile but have made the mechanism such that, if a person having a minimum weight of 50Kg, steps on the tile only then the linear motion takes place. The tile is designed such that, it can have a maximum liner motion of 12cm. We used a rack and pinion mechanism owing to its simplicity in design and fabrication, to convert vertical motion which is caused by the people stepping on the tile, to rotational motion. We have used four gearwheels in this paper. The spring is used to increase the rpm and also to get the tile back to its original position after the displacement takes place. Then each time when the tile is pushed, some power is generated which is equivalent to the force and speed exerted on the tile. When the tile retraces back to its initial position due to inertia after the push, then again small amount of power is generated. The rack is connected to the gear wheel and it is in turn coupled to the generator shaft with the help of another gear wheel.

Suppose an 80Kg person steps on the tile, then about 784.8N of force is generated. This force is delivered to the motor after some losses and an output power of 1.56 Watts is produced for one footstep. Then each motor generates a maximum voltage of 2V for each revolution which makes it a total of 4V as one revolution takes place in the clockwise direction while stepping on the tile and another revolution in an anti-clockwise direction when the tile gets back to its initial position due to inertia (the voltage may vary depending upon how fast the force is applied). Since we are using two motors, a total of 8V is generated and about 3 Watts of output power is obtained. The motors are having an average efficiency of 30%. Since this energy is not sufficient to deliver to high power equipment, we use a battery to store this energy and use it later. Suppose if we can set up several such tiles then, we can use much bigger batteries to store the power.

Fig.1 shows the block diagram of the work show of the entire system. The force exerted on the tile which is nothing but the linear motion is converted into rotational motion using rack and pinion mechanism and then with the help of gears, the force is delivered to the generators and the generators start producing electricity. This energy is converted to DC and made to store in battery and later inverter circuit is used to supply power to the load from it.

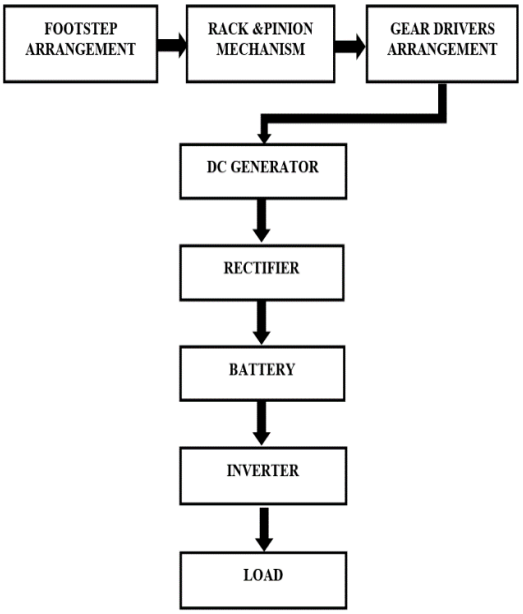

Fig-1: Block diagram of the whole system model

3. COMPONENTS AND EXPERIMENTAL MODEL

Fig.2 shows the model of the product after being assembled. The major components that are being used for this paper are:

- *Rack and pinion gears*: They are two gears, one is circular and another one is linear, which is a type of linear actuator that converts linear motion to rotational motion and vice-versa.
- *DC Motors*: A motor is an *electrical* machine that converts electrical energy to mechanical energy but it also works as a generator by the principle of electromagnetic induction.
- *Rectifier circuit*: A *rectifier* is used to convert alternating current into direct current. It is used to

supply direct current to the battery for the storage of energy.

- *Inverter circuit*: An inverter is used to convert direct current into alternating current. As the power supplied to load must always be alternating current.

Fig- 2: Experimental Model setup

The Table-I describes about the different mechanical components and their specifications used in this paper. The model is completely made out of Mild Steel. It is a carbon steel which is having less amount of carbon in it so it's also called as low carbon steel. Because of having less carbon, it is more ductile, weldable and machinable.

Table-1: Specifications of the Components

SI. No.	Components	Specification
1	Generator	Voltage: 12V Type: Permanent Magnet type DC Motor RPM: 300 rpm
2	Pinion	Outer Diameter: 40 mm Circular Pitch: 4 mm Tooth Depth: 2.5 mm Module: 1.8 Pressure angle: 20 No. of tooth: 24
3	Rack	Pitch Diameter: 15 mm Linear Pitch: 4 mm Length: 200 mm No. of Tooth: 44
4	Spring	Outer Diameter: 19 mm Inner Diameter: 15 mm Wire Diameter: 2mm

4. TECHNIQUES USED IN MANUFACTURING

4.1 Arc Welding

It is a process which is used to join two or more metals together by electrical heating method. An electric arc is formed between the electrode and the joining metals which then fuses the metals together. The power supply used can be either Direct Current or Alternating Current.

4.2 Drilling

It is a process to drill or punch holes of circular cross section. It is a rotating tool which is pressed against the metal or any other material. We have done to screwing things together. Some of the operations that are done using drilling machine are Drilling operation, Reaming operation, Boring operation, Knurling operation, Thread cutting, Chamfering, Grooving and Forming.

4.3 Lathe Turning

It is a process where the material or the work piece rotates at high speeds while the tool isn't rotating but making linear movements, thereby making patterns or removing out the extra portions on the work piece. Some of the operations that are done using this machine are Facing, Turning, Taper turning and Eccentric turning.

4.4 Laser Beam Machining (LBM)

In this process, a Laser is used to cut metal sheets or plates with very high accuracy. They are very much suitable for mild steel, aluminum plates and stainless steel. They can punch holes and even cut sheets which are small, intricate and complex in nature with high quality since it produces very small heat affected zones.

2. MATHEMATICAL CALCULATION

$Let\ us\ consider,$

$The\ weight\ of\ a\ person\ stepping\ on\ the\ tile = 80Kg$

$Height\ of\ foot\ step = 12\ cm = 0.12\ m$

$Then,$

$Work\ done = Force \times Distance$

Where ,

$Force = 80Kg \times 9.81 = 784.8\ N$

Then,

$$Output\ Power = \frac{Work\ done}{Time\ in\ seconds}$$

$$= \frac{784.8 \times 0.12}{60}$$

$$= 1.56\ Watts\ (\ for\ one\ pushing\ force)$$

$$Power\ developed\ for\ one\ hour = (3600\ \times\ 1.56)\ Watts$$

$$=\ 5.62\ \text{KW}$$

$$Power\ developed\ for\ one\ hour = (24\ \times\ 5.616)\ Watts$$

$$=\ 134.88\ KW$$

$$Power\ developed\ for\ one\ month = (30\ \times\ 134.88)\ KW$$

$$= 4046.4\ KW$$

$$Power\ developed\ for\ one\ year = (12\ \times\ 4046.4)\ KW$$

$$=\ 48556.8\ \text{KW}$$

2. RESULT AND DISCUSSION

2.1 Power Output

Power is generated each time the tile is pushed and hence we can have two cases where the case-I is downward motion due to force applied and case-II is upward motion of tile after the force applied is released. In both cases power is produced.

Though the power is produced during both the cases, the amount of power developed is more during upward motion and less during downward motion when compared to each other. It is because of moment of inertia of the spring which forces the tile to move up faster, while it is restoring back to its original position. In the case-I the in shaft of the motor rotates in clockwise direction and in case-II the shaft of the motor rotates in anti-clockwise direction. During this transition from clockwise to anti-clockwise direction some amount of power is lost due to friction and also because for the transition that takes place has to slow down the shaft that is rotating in clockwise direction and then later gain the rotation speed in anti-clockwise direction. It is the same during anti-clockwise direction to clockwise direction also.

The voltage produced for each footstep varies a lot, as the amount of force exerted is not the only factor but how fast that force is applied also determines the output voltage obtained. Consider if the motors rotate at 50 rpm, then a voltage 2V and similarly if the motors rotate at 200 rpm, then a voltage of 8V is obtained.

In the Fig. 3, it is a graph of weight v/s output power. The line graph indicated in green is the graph of theoretical values and the bar graph represented in orange is the theoretical values of output power obtained for equivalent weight of person. We can see that the power produced in actual is less than theoretically calculated power. This is because of loss due to friction due to the mechanical parts used.

Generally, Power generates when a person weighting as little as 10 Kg but in actual the minimum weight of the person necessary to make the tile move is 50 Kg. So, people weighing less than 30 Kg generally don't generate any electricity and people weighing less than 50 Kg don't produce significant amount of power and hence only people above the weight of 50 Kg and less than 120 Kg can produce minimum sufficient energy for supplying power to small appliances or for storage purposes. The model is designed for weights up to 120 Kg and anything more than, the model may not be able to bare the tension and may mechanical breakdown or lead to failure.

2.1 Motor Comparison

In this paper we have used permanent magnet type DC motor but there are other motors also which can be used such as Stepper motor and BLDC motor.

A DC motor has high efficiency of 30% as a generator while a Stepper motor has almost equal efficiency of 32% as a generator whereas the BLDC motor has very less efficiency of 3.8%.

Both DC motor and Stepper motor has high torque at low speeds hence works effectively as a generator whereas the BLDC motor does have high torque compared to other two.

A stepper motor works smoothly as generator while the DC motor is a bit noisy and vibrates a bit whereas the BLDC motor vibrates a lot as a generator.

The cost of DC motor is very less and cost of Stepper motor is a bit more than DC motor while BLDC motors are very costly. Hence, we have used a DC motor because of its advantages over others.

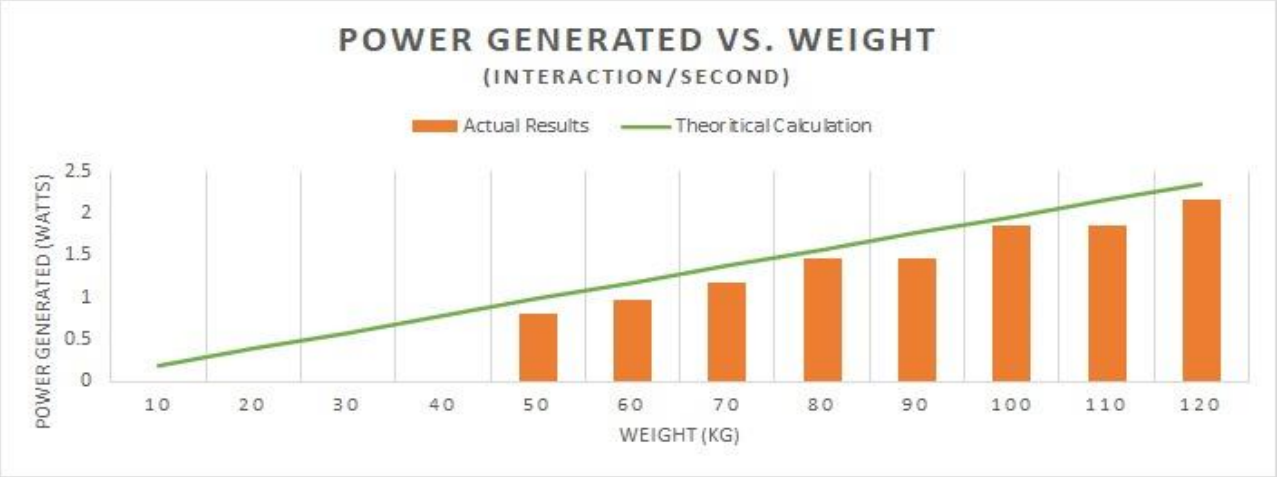

Fig-3: Graph of Power Generated Vs. Weight

3. CONCLUSIONS

With the increasing electricity demand, there is a shortage, and due to which there may not be an uninterrupted supply of sources. Hence, we can use this technology to minimize this shortage and help people. On installing this product in malls and offices, they can generate electricity for free and use the same for powering up their buildings, by which they can save a great deal of money on the electricity bill.

This paper can be further improvised by using a ratchet mechanism and make the motor rotate in one direction only irrespective of the direction of movement of rack and pinion and thus the speed of rotation does not decrease each time a person steps on it, which means when the shaft of motor is already rotating and the tile is pressed then an additional force is given to the shaft of the motor and losses can be minimized but then again only downward force will make the motor rotate if we were to use this mechanism. Scotch Yoke mechanism can be used to overcome this problem of generation of electricity irrespective of the direction of the movement of the tile. Which means that the motor spins faster each time a force is applied on the tile, thus making it highly efficient.

REFERENCES

[1] Nandan, Shivendra, and Rishikesh Trivedi. "Design and Fabrication of Mechanical Footstep Power Generator." Available at SSRN 3555638 (2020)

[2] Hossain, Md Emran, Md Rokib Hasan, Kazi Tahsan Ahmed, and Md Naoshat Munim Shawon. "Design and performance of power generation using speed breaker with the help of Rack and Pinion mechanism." In 2017 4th International Conference on Advances in Electrical Engineering (ICAEE), pp. 7-11. IEEE, 2017.

[3] Mechanism Santhosh, M. R., B. Shashi Kumar, and T. Yuvaraja. "Energy harvesting using speed breaker mechanism." In 2017 international conference on electrical, electronics, communication, computer, and optimization techniques (ICEECCOT), pp. 201-204. IEEE, 2017.

[4] Somalaraju, Kalyan, and Jai Govind Singh. "Enhancement of Power Generation From Electromagnetic Scavenging Tile." In 2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC), pp. 405-410. IEEE, 2020.

[5] Dalabeih, Daifallah, Batool Haws, and Sawsan Muhtaseb. "Harvesting kinetic energy of footsteps on specially designed floor tiles." In 2018 9th International Renewable Energy Congress (IREC), pp. 1-4. IEEE, 2018.

[6] Vanz, Elena, and Justyna Karakiewicz. "Pedestrian as generator: Implementing a stand-alone piezo power generating device in the urban context." In International Conference on Computer-Aided Architectural Design Futures, pp. 154-171. Springer, Berlin, Heidelberg, 2015.

[7] Sarala, T., M. Poornima, and H. D. Lekhana. "Generation And Utilization Of Electricity Using Footsteps As A Source Of Energy." In 2020 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), pp. 378-382. IEEE, 2020.

[8] Kumar, C. Nithivesh, K. Gowtham, M. Manikandan, P. Bharathkanna, and T. Manoj Kumar. "A review on various method of power generation in automobile suspension system." International Journal of Latest Trends in Engineering and Technology (IJLTET) 5, no. 1 (2015): 89-95.

[9] Gupta, Rajat, and Rahul Gupta. "Hydraulic Speed Breaker Power Generator." J. Eng. Res. Appl. www. ijera. com ISSN 3, no. 6 (2013): 502-506.

[10] Munaswamy, B., Prudhvi Ch. V. Srikanth, B. Kirankumar, and Kumar Er Pradeep. "Mechanical footstep power generation." India International Journal of Engineering Trends and Applications (IJETA)–Volume 5 (2018).

BIOGRAPHIES

"**Sai Ramesh G N** pursuing Under-Graduate programme in B.E (2017-2021) in Department of Electrical and Electronics Engineering from Sri Venkateshwara College of Engineering, under Visvesvaraya Technological University, Bengaluru, India."

"**Nikil Nachappa T A** pursuing Under-Graduate programme in B.E (2017-2021) in Department of Electrical & Electronics Engineering from Sri Venkateshwara College of Engineering under Visvesvaraya Technological University, Bengaluru, India "

"**Vibhu V** pursuing Under-Graduate programme in B.E (2017-2021) in Department of Electrical and Electronics Engineering from Sri Venkateshwara College of Engineering, under Visvesvaraya Technological University, Bengaluru, India. "

"**Nitish A** pursuing Under-Graduate programme in B.E (2018-2021) in Department of Electrical and Electronics Engineering from Sri Venkateshwara College of Engineering, under Visvesvaraya Technological University, Bengaluru, India. "

"Ramya P working as Assistant professor in Electrical and Electronics Department at Sri Venkateshwara college of Engineering past from 8 years. Published around 08 papers in reputed National, International conferences and journals."