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Energy Generation from Revolving Door

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Abstract

To meet energy demand, renewable energy and some unconventional source of energy can provide the necessary amount of clean energy for climate stabilization and reduce the consumption of fossil fuel. In this paper, prospect and feasibility of power generation by using revolving door has been investigated. The objectives of this paper is to designand fabricated of a prototype revolving door which can generate energy by amplifying the initial RPM of door shaft. Gear, pinion and motor mechanismare used as an energy generation part of the proposed revolving door. Different data are taken by applying various conditions despite the RPM in practice. The prototype can produce 4 volts and the total output depends on frequency of people passing through the door. By this arrangement, the minimum output power is obtained nearly 1.564 watts at RPM 13 and the maximum output power is found about 2.6 watts at RPM 23.

Keywords: Energy Generation, Gear, Motor, Pinion, Revolving Door

1. Introduction

Although in all aspects of life are surrounded by energy, the ability to harness it and use it for constructive ends as economically as possible is the challenge before mankind. Energy produced from the conventional sources like coal, natural gas, furnace oil, high speed diesel, etc., are responsible for producing gases like CO_2, NO_X, SO_X, etc. that causes global warming. Also, its sources are consumed much faster than nature can create them. Beside conventional sources of energy, there exist many alternative renewable energy sources[1]. The interest in this field of study comes from the undesirable effects of pollution, both from burning fossil fuels and from nuclear waste byproducts. Their means of harnessing energy, which have less damaging impacts on our environment. The possible renewable energy sources are solar, wind power, geothermal, tidal and hydroelectric[2–4]. In 2030, the world energy consumption will be 721.5 quadrillion Btu[5]. It is a challenge to meet up such huge amount. Also environmental pollution creates problems because of the excessive use of fossil fuel. Renewable energy such as solar energy, wind energy, energy generation from vibration by using piezoelectric materialsare the best solution for overcome this problem[6,7].

However, revolving door can be used as a new energy sources of energy[8,9]. Boon Edam developed an energy generated revolving door for the "Driebergen-Zeist" railway station in Netherlands[10]. That not only saves energy, but also generates energy with every person passing the doors. The station has a daily capacity of 8500 commuters and a calculation for this particular situation that indicated an energy saving of around 4600 kWh per year, a considerable saving compared to a conventional sliding entrance. The door uses a generator that harvests the kinetic energy when the door spins and a super capacitor to store the energy. The generator controls the rotating speed of the door for safety. The ceiling of the revolving door is made of safety glass and gives a clear view of the technology. A set of super capacitors stores the generated

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energy and provides a consistent supply for the low energy LED lights in the ceiling. When the lights use the stored energy from the door the main energy supply takes over. The station has a display that shows the amount of energy generated as the customers walk in and out. A report has analyzed the possibility of implementing energy-generating revolving doors in the new Student Union Building (SUB) at the University of British Columbia by making a triple bottom- line assessment[8].

The objectives of this paper are to construct of a revolving door model and to develop a mechanism to increase the speed of the shaft connected to DC motor. Moreover, to store and find out the energy generation per revolution.

2. Design and Fabrication

The revolving door is constructed by extract energy through gear, pinion and motor arrangement. So it divides the system into two parts. One is the typical revolving door part which is above the ground level and energy generation and storage part which is below the ground level. The advantage of the later part to stay below the ground level is minimizing the noise. Figure 1 displays the top view of the proposed revolving door.

In the experimental set up, three parts spinning door is used which is made of wood. The wooden parts are framed by thin MS bars and joined by a screw. These bars are welded to a rod acting as the central axis of the door. The spur gears are six in number and made of cast iron as shown in Figure 2. Gear 1 is attached to the door shaft and having 76 teeth. It is meshed with Gear 2 which has 19 teeth. Gear 2 and Gear 3 are in the same shaft. Gear 3 has 38 teeth and is meshed with Gear 4. Gear 4 and Gear 5 are in same shaft having 19 and 220 teeth respectively. Gear 6 containing 19 teeth is fixed to the motor shaft and meshed with Gear 5.

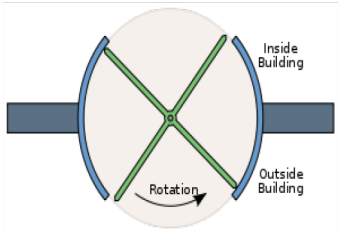

Figure 1. Revolving door (top view).

The motor is positioned in the groove of the wooden piece and connected to the base with the help of nut and bolt. So it cannot displace while rotating. The terminals of motor are connected to the Wheatstone bridge circuit. Figure 3 and 4 show the schematic diagram of a Wheatstone bridge circuit and used Wheatstone bridge circuit, respectively.

In Figure 4, the diodes are arranged in such a way that it can convert the change in polarity and allow the battery to charge when the door rotates in both directions. Used diode for the proposed revolving door is shown in Figure 5. All wires are connected together by soldering.

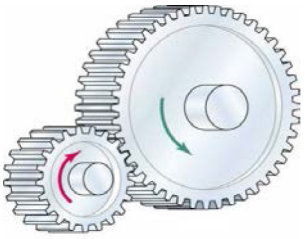

Figure 2. Spur gear.

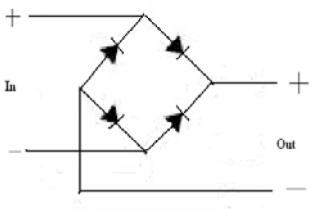

Figure 3. Schematic diagram of a Wheatstone bridge circuit.

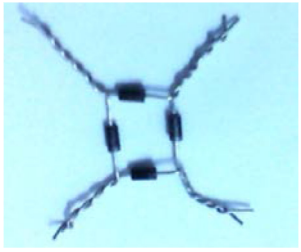

Figure 4. Wheatstone bridge circuit.

Figure 5. Silicon diode.

Figure 6 shows the DC motor which is used in revolving door for energy generation. Moreover, Figure 7 shows the revolving door system with integrated gear arrangement and Figure 8 shows the schematic of gear arrangement.

Figure 6. DC motor.

3. Working Principle

The revolving door produces power by harnessing energy that dissipated by human during walked through the door. As people use the door, the integrated gears connected to the central axis of door revolve. Due to the gear ratio the rotation given to door has increased about 92 times, which is applied to the motor shaft. A DC motor coupled with the integrated gears produce electricity. A bridge circuit is used to filter current, and in one direction. A rechargeable battery is used to store the energy. Figure 9 illustrates the flow diagram of the system.

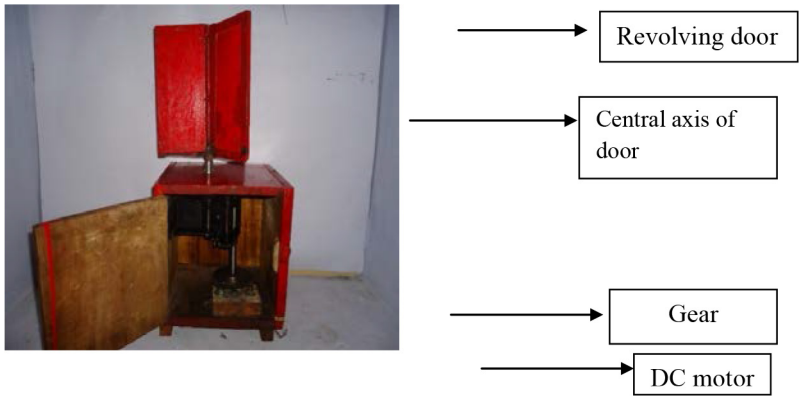

Figure 7. DC motor.

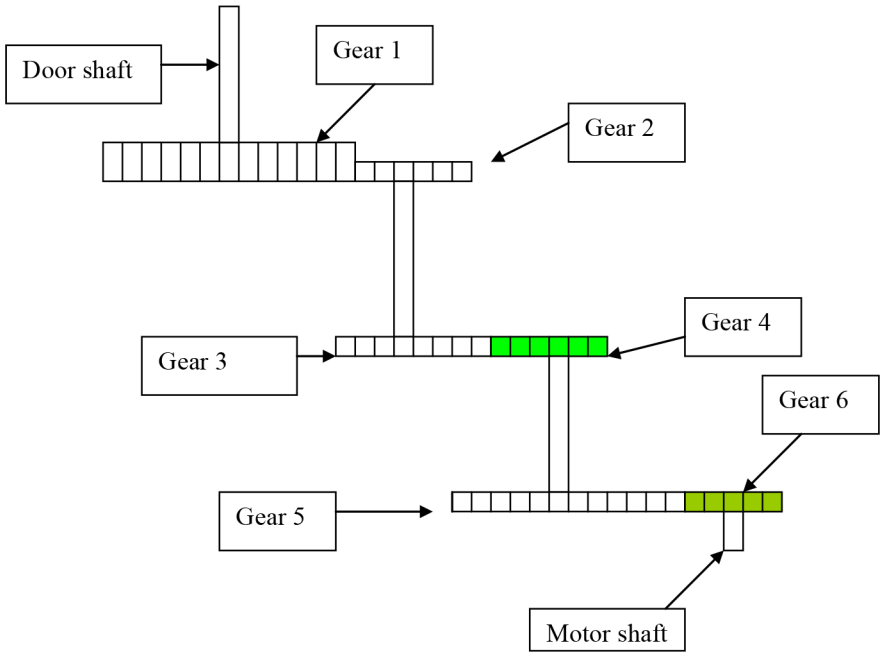

Figure 8. Schematic of gear arrangement.

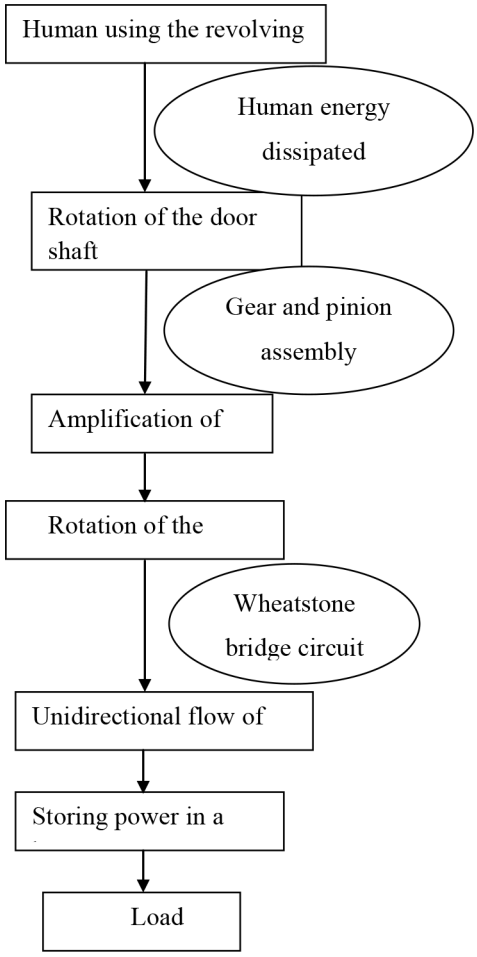

Figure 9. Flow diagram of the system.

4. Results and Discussion

The performance of the system is shown in the Figure 10. The data are collected by applying various conditions. The rotation of the door shaft is varied, though in practical uses, it may not vary such amount.

By the Figure 10, it is shown that initially the voltage of battery is 2.87 volts and it gets increased as the rotation of door increased. During this measurement, each time the door undergoes one complete rotation and the terminal voltage of the battery is listed. From Figure 10 it is clear that, from rotation 2 to 4 the storage in the battery is intense, but it becomes gradually lower as the battery is advancing to its capacity voltage. Figure 11 shows the rotation of door shaft versus terminal voltage of motor curve.

Figure 11 indicates that, the terminal voltage of motor with respect to rotation of door shaft. The terminal voltage increases to a limit with an increase in RPM of the door shaft. But in practice the RPM of door shaft does not vary too much and is low so the terminal voltage becomes low. In Figure 11 the lowest RPM is considered 13.5 and the respective terminal voltage found is 6.8 volts. Figure 12 shows the output power of motor with respect to the RPM of door shaft.

In Figure 12, the output power is obtained by simply multiplying the terminal voltage of the motor and the current rating of corresponding RPM. At the lowest RPM of Figure 12, which is 13, the corresponding terminal voltage and current is 6.8 volts and 0.23 ampere respectively. So the output power is 1.564 watts. It is clear that the output power gets improved with the increase in RPM. Figure 13 indicates the output power of motor with respect to successive entry of person.

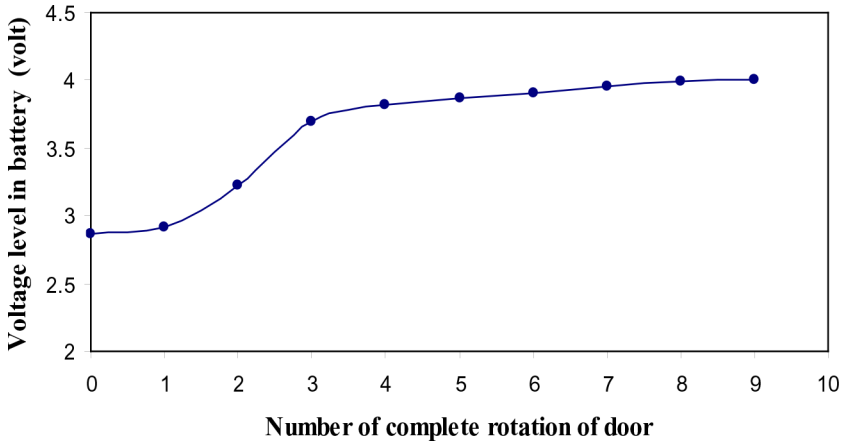

Figure 10. No of complete rotation of door versus voltage level in battery.

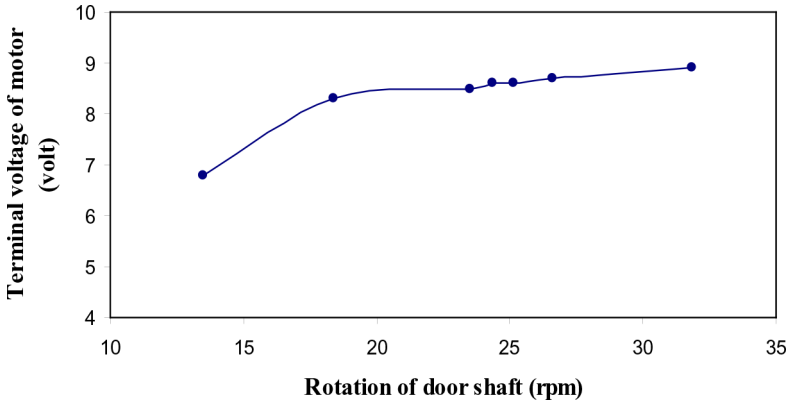

Figure 11. Rotation of door shaft versus terminal voltage of motor.

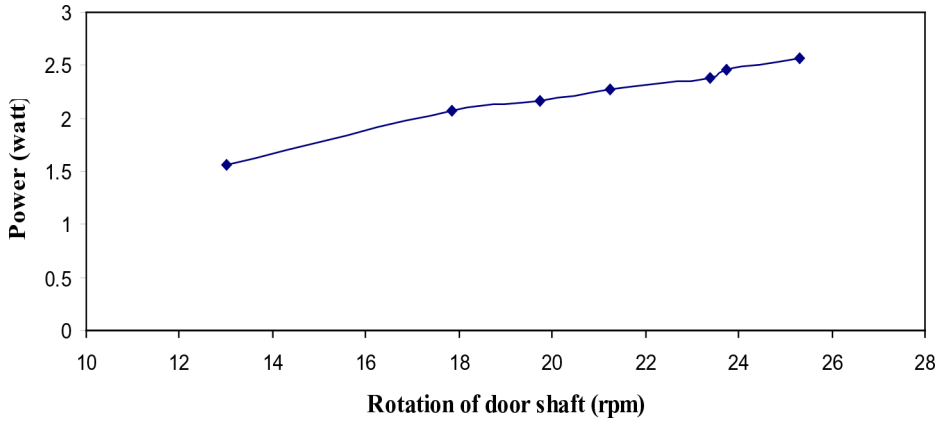

Figure 12. Rotation of the door shaft versus output power of motor.

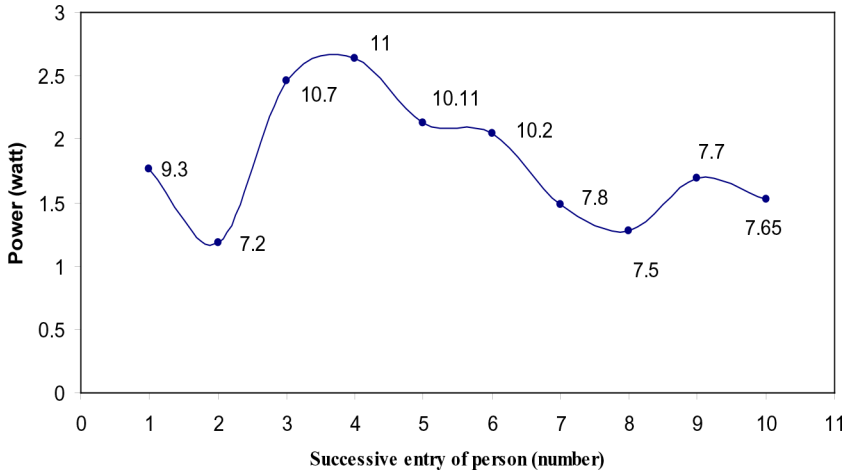

Figure 13. Successive entry of person versus Power with terminal voltage of motor.

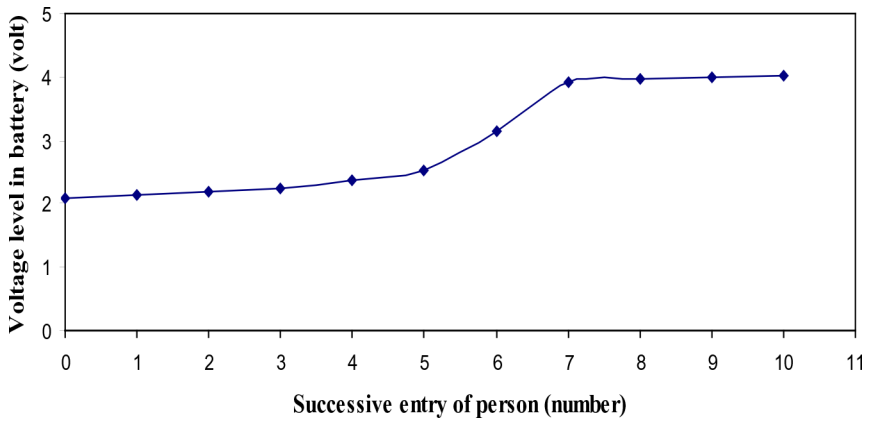

Figure 14. Successive entry of person versus Voltage level in battery.

From Figure 13 it can be seen that, at first one person passes through the door then two persons one after one and it continues up to 10 persons. There show much fluctuation in the curve, this is due to the variation in RPM of the door shaft which also causes the rise and fall of the terminal voltage of the motor. Figure 14 indicates the charge storage in battery as people passed through the door.

From Figure 14 it can be said that, initially the terminal voltage of the battery was 2.1 volts and finally it is 4.03 volts. The charge storage in the battery is more stable under this condition and less time is needed.

5. Conclusion

In this world where there is a lack of electrical power supply, this study will be helpful to solve the power crisis to some extent. This paper is based on harvesting human energy while using revolving door. The power generation of this designed revolving door depends on shaft RPM of the door and frequency of people passing through the door. By this arrangement, the maximum output power is obtained about 4 volts at RPM 23. If it is employed in places of high peoples' movement with proper designing it is possible to generate sufficient power from it.

6. Acknowledgements

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7. References

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