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Innovative Power Harvesting With Stepper Motor

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ABSTRACT
This paper present the innovative way of generating electricity using the principle of thermodynamics law. This law states that energy cannot be created nor destroyed but can be transform from one form to another. In this work, mechanical energy is converted into electricity using stepper motor which acts as a generator. Mechanical energy is freely generated and available such as in gym room and Children Park. The main aim of this work is the production of clean energy employing this mechanical energy as a driving force with a simple set up configuration. The AC output voltage of the motor is further amplified with voltage doublers circuit to give high DC output. Without load the output of the doublers circuit is 35V DC when RPM of the driving wheel is 24. When a 2.2 K resistor is connected as load it can deliver an output power of 220mW with 10mA current.
Keywords: stepper motor, voltage doubler, rpm, mechanical energy, voltage level indicator.

I. INTRODUCTION

With the growth of industries and modern electrical and electronics appliances the needs and requirements of electricity also rises linearly. There are many ways to meet these demands through different energy sources like wind, water, coal and solar energy at very high coast. But the demand of power is still at large. To fulfill these demands to some extend the basic generation of clean electricity from stepper motor is shown in Fig. 1. The four wire of bipolar stepper motor is connected to the voltage doubler circuit before any load is applied. The voltage doublers circuit acts as a rectifier as well as stepping up of output voltage

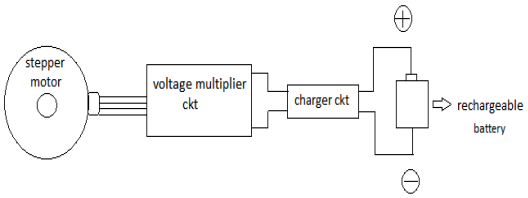

Fig. 1 electricity generation with stepper motor

In recent years to meet power shortage many experts comes up with creative and innovative ideas to generate electricity. By using Neodymium magnet mill electricity can be generate as presented by [1]. Clean energy can also be harvested from human step with piezoelectric crystal which converts surrounding vibration into electric output [2]. With the principle of electromagnetic induction conversion of force energy into electrical energy is already reported by [3]. Another innovative way of producing electrical energy using DC motor with simple set up of rack and pinion is also presented by [4]. Others used peltier module which work with the principle of seebeck effect which generate DC voltage when the two junction of the module is kept at different temperature [5], [6]. In this work high DC voltage generation method is presented using stepper motor as shown in Fig. 1. To obtain high DC output, voltage multiplier or voltage doubler circuit is used instead of bridge rectifier as it required fewer components and deliver more output power.

II. MODULE OPERATION

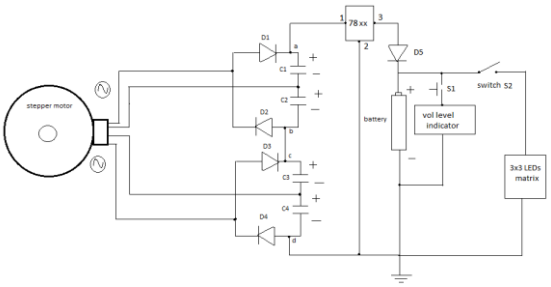

Fig. 2 set up circuit configuration

Bipolar stepper motor with four wires is used for generation of power as shown in the set up circuit configuration Fig. 2. Stepper motor is a brushless motor which divide its 360^0 full rotation into many discrete step angles. It consists of rotor and stators which work with the principle of electromagnetism. In order to rotate the rotor, the stators are energize in sequence manner. But here stepper motor will be used in reverse way in which the rotor is rotated mechanically and AC output is obtained from its 2 input wires. The output of the stepper motor is rectified and step up with voltage doubler circuit using few passive components as shown in Fig. 2. From the high output of the doublers circuit rechargeable battery can be charge through

voltage regulator and a diode. The harvested power which is stored in a battery can efficiently light low power white LEDs or can drive any electronic components which requires low power consumption. The voltage level indicator circuit monitors the level of voltage content of a battery when charging. In order to avoid unnecessary consumption of power by the voltage level indicator circuit, a push button switch is connected in such a way that the switch is closed only when press and remain open otherwise.

This can be implemented and installed in gym room and Children Park where mechanical energy can be directly converted into electrical energy following the law of conservation of energy where energy can be transform from one form to another. The transfer of energy from the rotating wheel of a cycle or from treadmill to the rotor of stepper motor can be done through a conveyor belt in order to increase the rpm of motor. The more the rotor rotates; the motor will produce more output voltage. The two output of voltage doublers circuit are connected in series for obtaining high DC voltage. The mechanism of driving the rotor with a large diameter wheel is shown in Fig. 3

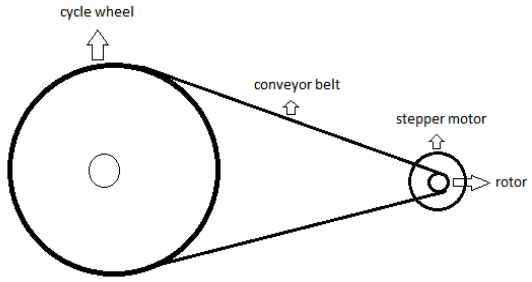

Fig. 3 rotor driving mechanism with conveyor belt

Another innovative approach to harvest power from mechanical energy is shown in Fig. 4. In children park seesaw and swing are very common and most of the time during day they are used continuously. If a system is designed in such a way that the rotor of the motor is attached with any rotating axis of seesaw or swing, enough power can be obtained. This energy can be used effectively to light up the park with low power LEDs during night time which in turn can cut down the cost of power supply.

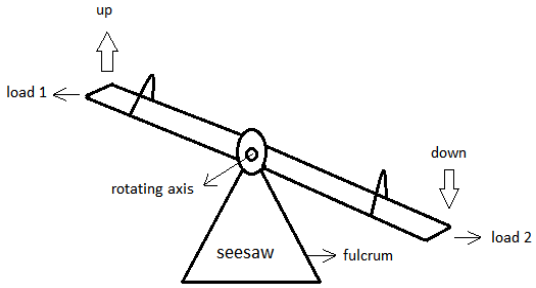

Fig. 4 rotor attached with the axis of a seesaw

Materials required for building the prototype along with circuit components of voltage doublers and voltage level indicator is shown in Fig. 5. To construct voltage doublers it required four electrolytic capacitor of 40V, 470uF and four IN4001 diode i.e. C1, C2, C3, C4 and D1, D2, D3, D4 respectively of Fig. 2. This circuit input is AC volt and gives DC output voltage which is twice times the input voltage.

Serial No	Components Used	Quantity
1	Stepper motor	1
2	Rotating wheel	1
3	Fixed stand, handle	1
4	Belt	1
5	Switch	2
6	Rechargeable battery (9V)	1
7	Diode (IN4001)	3
8	Capacitor(470uF, 40v)	4
9	LED	11
10	Resistor (1k)	3
11	Zener Diode (1N4742A)	3
12	Hookup wire	

Fig. 5 list of components

In order to monitor and check the voltage level of a rechargeable battery while charging a simple voltage level indicator is constructed as shown below in the Fig. 6. This is a simple three voltage level indicator from 3.3V till 9.2V. When the supply voltage is increased gradually from 3.3V till 9.2V all the LEDs from Led3 to Led1 start glowing subsequently. If supply voltage is below 3.3V none of the Led will glow. This circuit is connected to check voltage level as shown in Fig. 2 through a push button switch which is on only when it is pressed.

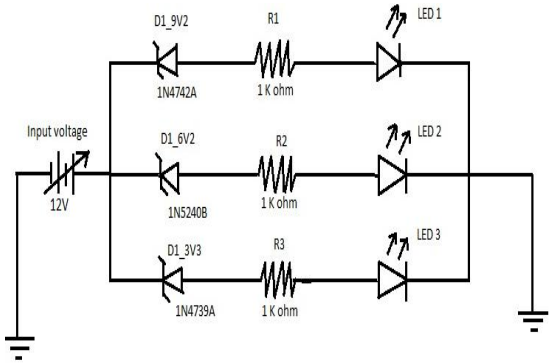

Fig. 6 voltage level indicator

Serial No	Contents	observation value
1	Diameter of the wheel	15 cm
2	Diameter of the rotor	1 cm
3	No of rotation of the rotor during one rotation of the wheel	8
4	Total voltage of the circuit without Load	35V
5	Total voltage of the circuit with load 2.2k	22Volt DC
6	Total current of the circuit with load 2.2k	10mA
7	Total power (P=I*V)	220mWatt

Fig. 7 Observation table

The various practically obtained electrical parameters are listed as showed in observation table in Fig. 7. The output power delivered across the load depends upon the value of load impedance with a constant RPM. The reading is taken with a load reference of 2.2 K resistor. The output can drive 3x3 matrix connection of white LEDs efficiently with a series connection of 3.3 K resistors as showed below in Fig. 8.

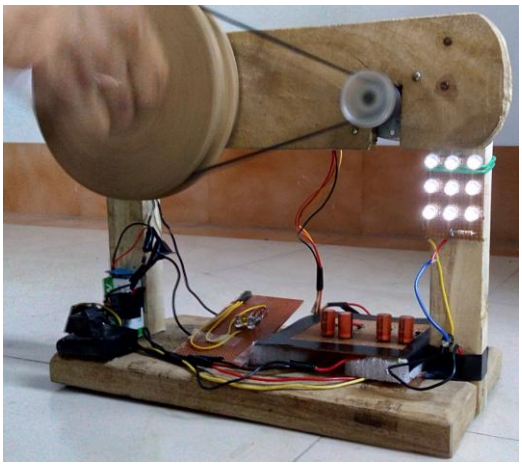

Fig. 8 prototype of the proposed model

The output voltage mainly depend upon the RPM of the rotor. The faster the rotor rotates the more output it will deliver. This prototype is design for driving wheel diameter to rotor diameter ratio of 15:1 for safety operation of the motor. The step angle of the stepper motor is 7.5^0 with 48 steps for one complete rotation. For high output current, less step angle with high voltage motor specification is preferable.

III. CONCLUSION

This proposed model is innovatively designed and tested extensively by taking wide range of readings and observations. It can light 9 white LEDs when it is connected directly to the output of doublers circuit through 3.3K resistor. With a voltage regulator 78xx rechargable battery can be efficiently charge by monitoring its voltage level. While mantaining a constant speed of 24RPM of the driving wheel, the output voltage with 2.2K load resistor produces 10mA current and 22V DC which is 220mW power. Depending upon the load connected and the RPM of the rotor the output power can be vary. Without any load connected it give a high voltage of 35V DC. When a rechargable battery of 9V, 200mAh is connected as load it draws a current off 100mA which will take 2hrs to charge the battery completely at 100% efficiency. As long as the rotor is rotated with some mechanical means as presented here; it will produce clean energy and can cut down the cost of power to some extend. The obtained electrical parameters with the prototype is shown in Fig. 7 and Fig. 8 respectively.

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