Harnessing Maximum Solar Power using Arduino control

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Abstract— With the approaching inadequacy of nonrenewable resources, people are considering using alternate sources of energy. From all alternative obtainable resources energy from the sun is the most extensive and it's relatively serene to convert it to electrical energy. Use of solar panel to convert sun's energy to electrical is incredibly widespread, however owing to transition of the Sun from east to west the mounted solar panel could also be able to generate optimum energy. The projected system solves the issue by an arrangement for the solar panel to trace the Sun. This paper relies on the utilization of solar panel coupled to a servo motor to trace the Sun so most sun light is incident upon the panel at any given time of the day and year. This can be higher compared to mounted panel technique which may not be thus economical. Moreover, the code is built using C++ programing language and targeted to Arduino UNO controller. The efficiency of the system has been tested and compared with static solar panel on many time intervals, and it shows the system react the most effective at the 10-minutes intervals with consistent voltage generated. Therefore, the system has been proved to be operating for capturing the utmost sunlight source for prime efficiency solar gathering applications. Moreover the work may be increased by using RTC (Real Time Clock) to follow the Sun. This helps in maintaining the specified position of the panel although the power is interrupted for some time.

Key words: Solar Power, Arduino UNO and programming , LDR, Peizoelectric

I. INTRODUCTION

As of the major census reports the population of the earth is very likely to clock the 7.5 billion mark by the end of 2016 out of which quite comprehensively a chief portion is educated enough to realize the what precious value energy actually holds. The necessity of energy is intensifying gradually and in order to cope up with the enhancing comforts of the human lifestyle. Energy is the most crucial parameter now-a- days when it comes to our existence. Until there comes a time till they are completely exhausted we are particularly showing a tendency to largely use these standard energy sources like, fossil fuels, natural gas, gasoline, coal, oil atomic energy etc. to fulfill this increasing demand. The non-renewable resources are decreasing at a well-known pace day each passing day. The rising energy demand is also because of the frightful depletion rate of the principal energy resources put a large price tag on natural flammable energy resources. Moreover, the uninterrupted use of fossil fuels has affected the atmosphere to a drastic extent, decreasing the ecosphere and cumulatively summing to global warming and complimenting the increasing demand for energy, the continuous reduction in existing sources of fossil fuels and also the growing concern relating to environment pollution, have pushed mankind to explore new technologies for the production of power using clean, renewable sources, like solar energy, wind energy, etc. Among the non-conventional, renewable energy sources, solar energy affords huge potential for conversion into electrical power. The conversion of solar energy into electricity represents one among the most promising and challenging energy technologies, in continuous energy providing department, being clean, silent and reliable, with very low maintenance prices and nominal ecological impact. Solar energy is free, totally inexhaustible, and involves no polluting residues or greenhouse gases emissions. Completely different researchers estimate that covering 0.17% of the land on earth with 100% efficient solar conversion systems would offer 20 to 22 TW of power, nearly double the world's current consumption rate of fossil energy. This proves the potential of alternative energy which in turn points out to the requirement of tracking mechanism in solar systems. Sunlight basically has two elements, the direct beam that carries about90% of the solar energy, and the diffuse sunlight that carries the remaining. The diffused portion is the blue sky on a clear day and it increases proportionately on cloudy days. Because the majority of the energy is within the direct beam. A typical solar battery converts solely thirty to 40% of the incident solar ray into electrical energy. Therefore to induce a constant output, an automatic system is needed that ought to be capable to constantly move the solar panel. The Sun tracking System (STS) was created as a prototype to solve the issue, mentioned earlier above. It is fully automatic and keeps the panel facing of sun till it is visible. "The distinctive feature of this method is that rather than taking the planet as its reference, it takes the sun as a guiding source. Its active sensors constantly monitor the sunlight and rotate the panel towards the direction wherever the intensity of sunlight is maximum.

II. NECESSITY

In general our country has relatively sunny days for around 7 to 9 months in a year and partially cloudy sky for the rest of the time. This makes our country, particularly the area in the western region involving the states of Rajasthan Gujarat and Madhya Pradesh prosperous in the capability of harnessing solar power. At present there are several projects done using solar panels collecting solar radiations and converting it to electricity. However most of those do not take under consideration the difference of the suns angle of incidence by installing the panels on a mounted considerate structure which extremely influences the

amount of solar power collected by the panel. The planned model of the Dual Axis Solar Tracker is the most compatible for obtaining maximum efficiency

III. CURRENT GLOBAL SCENARIO OF THE USAGE OF SOLAR POWER

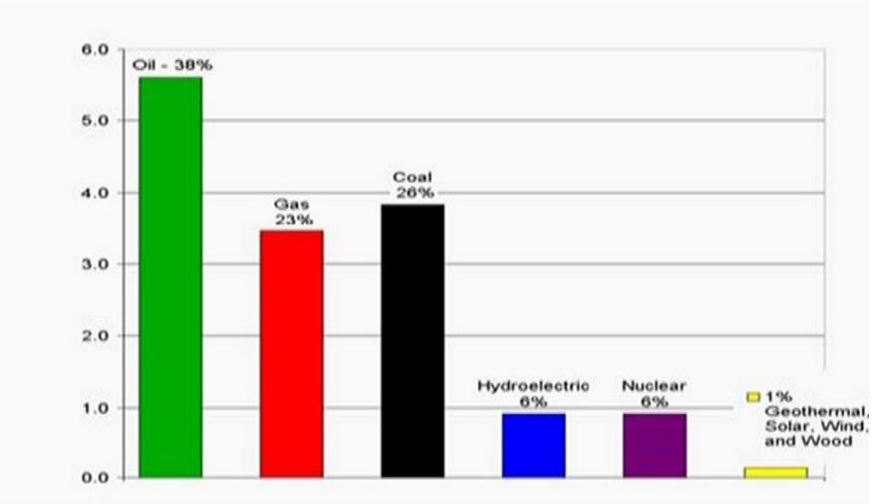

Fig. 1: Current Global Scenario of sources used for generating electricity

The above bar graph shows the global energy sources which are utilized to generate electricity. As concluded from it, oil acquires the first position with a maximum utilization of 38%, while non-conventional sources acquire 1% only.

IV. OBJECTIVE

The major purpose of the Solar Tracking unit : As the angle of incidence lies between -90 °after sunrise and 90° before sunset passing 0° at noon. This reduces the solar radiations down to almost 0% at sunrise and sunset and about almost 100% in the afternoon. This variation may causes solar panel to lose up to 40% of the collected energy.

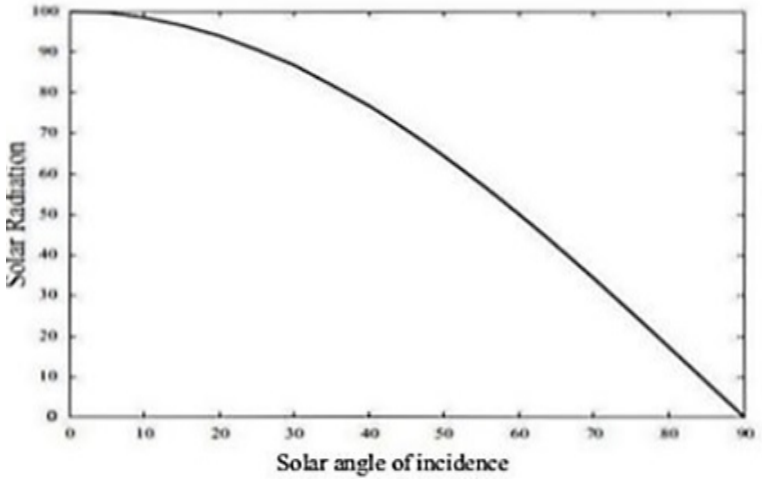

Fig. 2: Curve for relationship between solar angle of incidence and solar radiation

At any time of the month or a day, the position of the sun is decided by two angles in the spherical co-ordinate system- the Altitude angle which is the angle of the sun n the vertical plane in which the sun lies and the Azimuth angle which represents the angle of the projected position of the sun in the horizontal plane. Above figure shows that the sun rays received are maximum when the angle of incidence is 0 degrees i.e. the solar panel is perpendicular to the sun.

The Dual Axis Solar Tracker used to solve this problem consists of two essential parts:

1) The solar panel
2) The tracking system

Dual Axis Trackers have two independent degrees that may act as the axis of rotation. Either of these axes are normal to each other. The primary axis is the reference axis that is fixed with respect to the ground can be considered a primary axis. The other axis which will take the primary axis as reference can be taken as secondary axis.

Main components of this system

The Solar tracking system consists of two main parts:

1) A circuit for sensing ,programming and controlling the microcontroller (here -Arduino UNO) and motor driver.
2) The circuit required for solar panel

V. METHODOLOGY

Block Diagram:

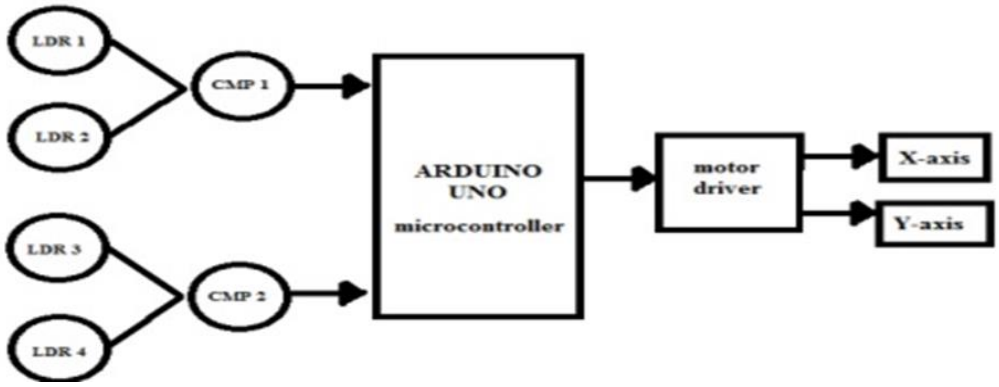

Fig. 3: Block diagram of the system using LDR, Arduino UNO etc.

Hardware Components

- The main components are

1) Solar panel
2) Sensors(LDRs)
3) 3.Servo motor
4) Motor driver
5) Arduino UNO (Microcontroller)

Hardware Description

Solar Panels: Solar panel refers to a design such to absorb the sun's radiations as a source of energy for the generation of energy. Panels may sometimes be referred to photovoltaic which means "light-electricity". Solar cells or PV cells as they are also called at times rely on the photovoltaic effect to absorb the energy of the sun and cause charge to be generated and current to flow between the two oppositely charged layers. A solar panel is a packaged, connected assembly of photovoltaic cells. .A photovoltaic (PV) module is a packaged, connect assembly of almost 600 photovoltaic solar cells

Sensors: The main component to design a high quality solar tracking device one is supposed to us good quality sensors. A sensor is termed as a sensing or a detecting device that measures a particular measurable physical quantity and processes it into a signal which can be read by an observer or by an instrument.

Light Dependent Resistor: Light Dependent Resistor (LDR) is made of a semiconductor device having high resistance. It is also known as a photo-sensor. LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. As stated above the resistance of an LDR can be very high, sometimes as high as 100000 ohms, but when they are illuminated with light resistance drops drastically. LDR's are cheap and simple in construction. The LDRs with change in the intensity of light is shown in the table below:

LIGHT INTENSITY	LDR OUTPUT (V)
DARK	0.58
AVERAGE	3.30
BRIGHT	4.8

Table 1: Light intensity measurement

Servo Motor: A servo motor is an electromechanical device which converts the generated electrical pulses into limited mechanical movements. The shaft of a servo motor rotates in bounded step increments when electrical command pulses are applied to it in the proper sequence. There are three main types of servo motors, they are:

1) Permanent Magnet Servo Motor
2) Variable Reluctance Servo Motor.
3) Hybrid Synchronous Servo Motor.

Advantages of servo motor

1) The angle of is proportional to the applied input pulse.
2) Even at standstill the motor has full torque.
3) On point particular positioning and repeatability of movement since good servo motors have an accuracy of about 3 – 4% of a step and this error is non-cumulative from one step to the next.
4) Excellent response to starting, stopping and reversing

Motor Driver: (L298N) is primarily a dual type bridge motor driver, so with the help of a single motor driver board we can interconnect two DC motors which can be controlled in either direction i.e. clockwise and anticlockwise direction. If the motor has a fixed direction of motion we can make use of all the four I/O's to connect the DC motors. It has output current of 600mA and peak output current of 2A per channel more ever for the protection of circuits back EMF output diodes. Features of IC L298N

1) Light in weight and has small dimension
2) Super driver capacity

3) 600mA output current capacity per channel.
4) Highly immunity to noise.
5) Selection switch for power
6) Motor direction indication LED

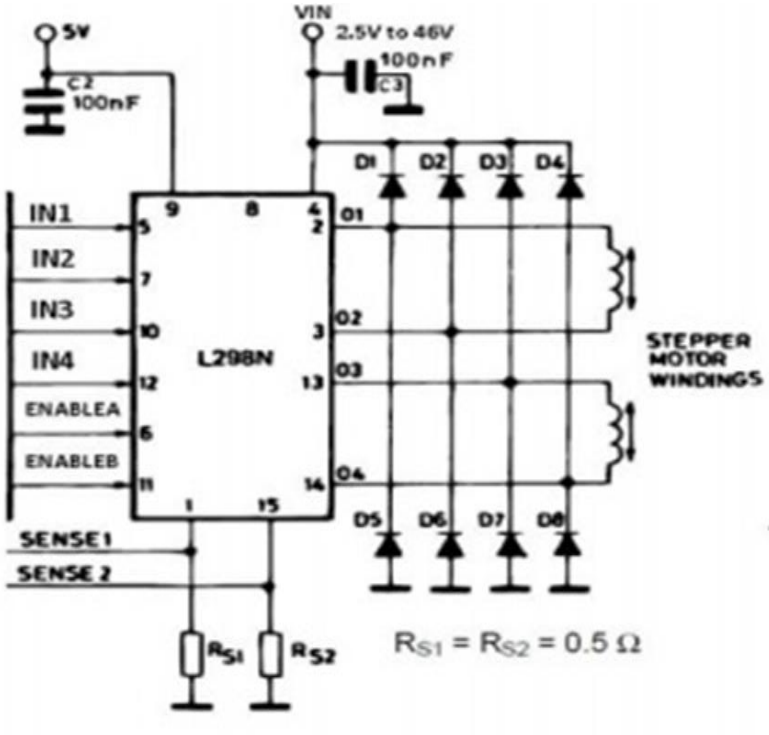

Fig. 4: Pin configuration of L298N Dual DC Motor Controller

Arduino UNO: Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings. Arduino projects can be stand-alone, or they can communicate with software running on a computer. In this development, Arduino UNO is used as the main controller because it satisfies the conditions:

1) Microcontroller board based on the A Tmega32S.2. 14 digital input/output pins (of which 6 can be used as PWM outputs 6analog
2) A 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button

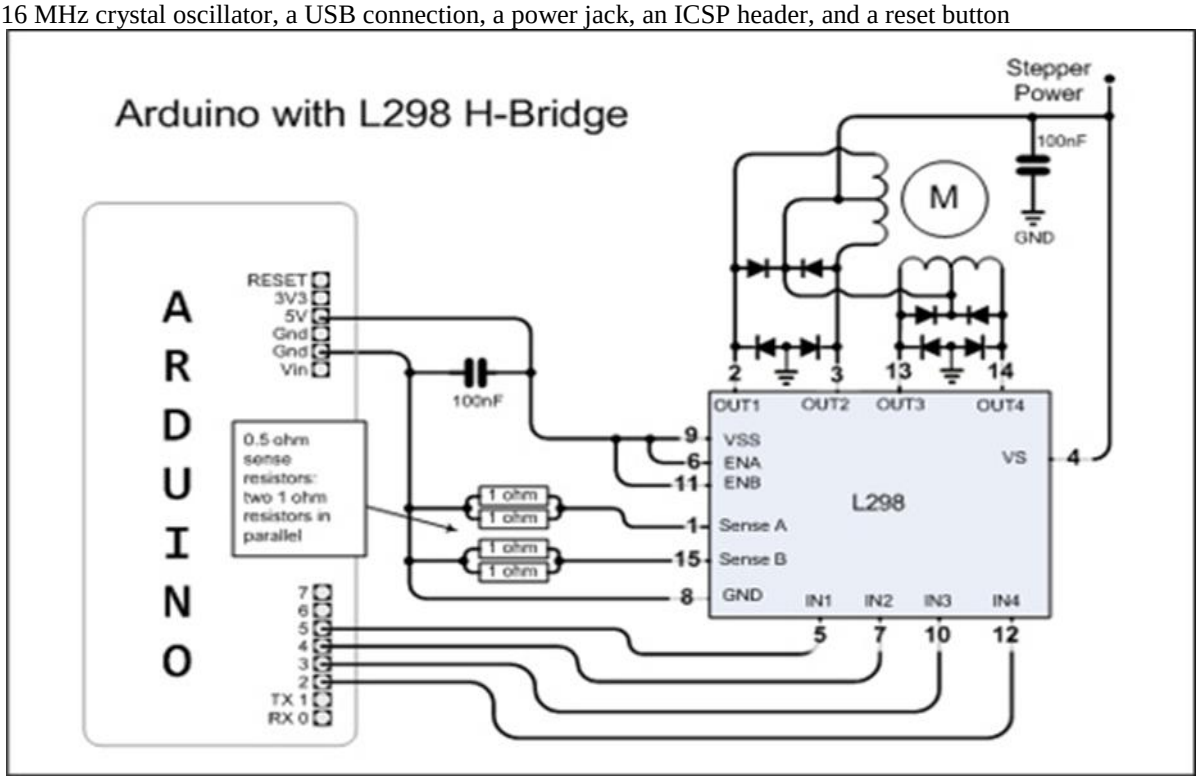

Fig. 5: Pin diagram of the Arduino and L298

VI. WORKING

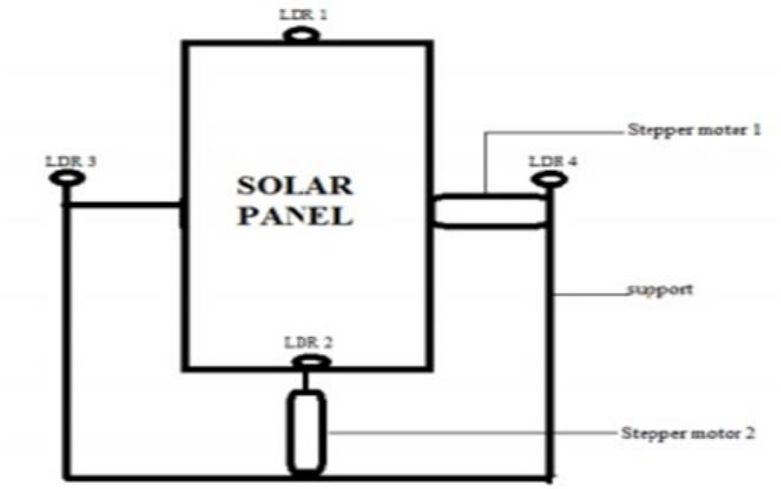

Fig. 6: Basic diagram of Dual Axis Solar radiation tracker

The block diagram of the closed-loop solar tracking system and composition and interconnection of the system. For this approach, the major issue of solar tracking is how to automatically guide the solar panel to follow the sun as accurately as possible. This is a sensor-based system consisting of the LDR sensor, comparator and microcontroller. For the tracking operation, the LDR sensor measures the intensity of light as a reference signal for the input. The unbalanced condition in voltages generated by the LDR sensor generates a feedback error voltage. The error in terms of voltage is proportional to the difference between the sunlight location and the solar panel location. At this time the comparator compares the error voltage with a specified threshold (tolerance) value. If the comparator output goes high state, the motor driver is activated so as to rotate the dual-axis (azimuth and elevation) tracking motor and bring the PV panel to face the Sun. Accordingly, the feedback controller performs the vital functions: PV panel and sunlight are constantly monitored and send a differential control signal to drive the solar panel until the error voltage is less than a pre-specified threshold value.

VII. ADVANTAGES

- The conservation of non-renewable energy resources solar power eases the use of decreasing natural resources such as oil, coal and gas. Presently, we are living in a highly demanding environment where the usage of energy is growing at an alarming rate. It is very important to conserve the earth's natural resources, not only to obtain healthy environment but also for future generations to meet their own needs.
- Lower amount of Waste and Pollution solar power system considerably reduce the amount of waste production. For example, the entire procedure of converting coal to electricity produces a lot of dust, discarded solid waste, toxins and harmful emissions, as well as wasting energy, heat, land and water. Emissions such as Sulphur Dioxide, Nitrogen Oxide and Carbon Dioxide are proven to have negative impact on crop growth, health of the people and water. Ecological balance is also at risk of being destroyed. Furthermore, pollutants from kerosene used for lighting purposes is reduced with the use of solar power systems, as well as the decrease in use of diesel generators to generate electricity.No production of Green House Gases Solar power systems produce electricity without the emission of carbon dioxide. A single Solar system can offset approximately six tons of CO2 emissions over its twenty year life span.
- Limiting the use of conventional energy sources solar power improves energy efficiency and is therefore it is beneficial to us. Use of solar energy for generation of electricity reduces the consumption of conventional power for built up cities. It is cheaper and hence can be used for industrial and commercial purposes to run various operations. Thus, the use of this system to generate power is among the most efficient ways of generating power.
- Wide application range – The solar tracker can be used for various applications and can be implemented in various parts of the world
- Generation efficiency Over 40% increase in radiation reception from sun comparing with fixed installation. With dual axis tracker, over 45% increase in radiation reception from sun will be gained.
- Independent control it can be installed anywhere, where no manual operation is involved. LDR sensors play a vital role in making the system automated by sensing the intensity resulting in generation of pulse, thus making the system independent.

VIII. LIMITATIONS

1) When due to cloudy atmosphere it is difficult to track the sun.
2) Panel rotations require an extra power from outside of power used that produce by panel itself.
3) Fixing arrangement of LDR at perpendicular to sun light is somewhat problematic 4) LDRs are very sensitive elements and so may get damaged in extreme climatic conditions.

IX. RESULT

The following graph shows the analog values of light intensity with respect to time. We obtain a new .result every 2 milliseconds throughout the day. This Graph is indicated for the time zone of 10 am to 12 pm. At around 8:00 am there is much improvement in intensity values by the tracking panel compared to the static panel. But as time passes difference in current between these decreases up to around 1:00 pm. After that when the sun sets more towards west this difference increases again. The highest current of static panel and tracking panel is 0.24amp and 0.38amp respectively at 12:00 pm. But the voltage the variation is lesser compared to the current as the voltage has no direct link with the sun light intensity. Maximum power output of the static panel and tracking solar panel is 3.18 and 4.03 watt respectively is found at 12:00 pm. Much more power gain is achieved in the morning and afternoon because the tracking system can accurately track the sun at these times while the static system cannot not. For both technologies power reduces rapidly from 3:00 pm to 5:00 pm because of the low duration of day light.

X. CONCLUSION

Solar tracking has to perform a really vital role at the moment role in increasing the efficiency of solar panels in recent years, therefore proving to be a far better technological accomplishment. Here the major importance of a dual axis star tracker lies in its higher efficiency and property to administer a higher output compared to a set solar panel or a single axis solar tracker. The tracking system is intended such it will harness the solar power possible in all potential directions. Generally, in a single axis tracker that moves solely on one axis it's not practical to trace the utmost solar power. In case of dual axis trackers, if the solar rays are perpendicular to panel throughout the year. Hence, maximum possible energy is harnessed throughout the day furthermore as throughout the year. Thus, the output efficiency will increase indicating that the efficiency is about 30 -40% more comparatively.

XI. FUTURE SCOPE

In Future the typical traditional standard energy isn't adequate to be used thus there's a necessity of use non-conventional energy sources .This Project is incredibly helpful for power supply in rural areas wherever able to use high sensitive solar panels which may add to the sun light additionally and by connecting variety of solar tracker assemblies we are going to able to manufacture ample amount of power which can be able to provide power to medium size village. We are able to create use of solar panels in our day to day life for street lighting, in cell phones chargers, water heaters, etc. If we combine this solar panel mounted on a piezoelectric material we are likely to achieve results in our favour. As we know a piezoelectric generator converts mechanical energy into electricity and is employed in energy gathering devices. In this paper, the synchronization conditions in reference to the excitation vibrations are studied. We need to shift our focus to show that a phase shift of 90° between the vibration excitation and the displacement of bending material provides the utmost power from the mechanical excitation. However, the piezoelectric material is susceptible to power losses; therefore the bender's displacement amplitude is optimized so as to inflate the amount of power that is regenerate into electricity. Also in this paper, we use active energy gather to regulate the ability flow, and all the results are achieved at a frequency of 200 Hz that is well below the generator's resonant frequency.

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