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NANO TREE WITH SUN TRACKING NANO LEAVES- FUTURE ENERGY ASPECTS

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ABSTRACT

The increase inenergy demand, reduction in existing sources of fossil fuels and the growing concern regarding environment pollution and other natural hazards, have pushed mankind to explore new technologies for the production of electrical energy in environment friendly manners.In such cases, the renewable energy sources can be the best option for us. As the renewable energy sources i.e. solar energy, wind energy, thermal energy etc areavailable in abundance, so we have to make use of them for our future needs. Also as India is a highly populated country,we have to take advantage of such an energy resourcewhich is reliable, requires less space for its installation and can produce energy in the cost effective manner.

The paper presented here emphasizes the working of a nano tree using sun tracking system. The use of sun tracking system in the traditional nanotree maximizes its efficiency by positioning the photo-voltaic leaves at the point of maximum light intensity

Keywords: NanoTree, Bio-mimicry, thermoelectric, PV cell, piezoelectric effects,Photosynthesis, solar tracker, Stepper Motor, ATmega8 Microcontroller, Nano Leaf.

I. INTRODUCTION

A nano tree is a form of renewable energy resource that is to some extent competitive with fossil fuels. It converts energy from sunlight and wind into electrical energy moreover directly by using nanoleaves and stems of artificially created trees.

The sun which is the main source of energy of a solar tree, is a hydrodynamic spherically body of extremely hot ionized gases. It generates energy by the process of thermonuclear fusion. The centre of the sun is hot about 14000000 K and with a density of about 160 g/cc(still in gaseous form), atomic collisions are frequent and violent. Occasionally hydrogen nuclei fuse or stick together. This releases energy. In sun hydrogen atoms are fused together to produce helium in a process known as the proton-proton(or PP) Cycle. Using the mass-energy equivalence equation we can precisely quantify how much energy is released during a fusion reaction. We note that 4 Hydrogen atom have slightly more mass than 1 helium atom. We can summarize it this way

- 4 H nuclei weigh 6.693 X 10^{-27} Kg
- 1 He nucleus weighs 6.645 X 10^{-27} Kg
- Missing Mass converted to energy is 0.048 X 10^{-27} Kg.

In symbols we can write PP reaction as

$^{1}H + {}^{1}H \rightarrow {}^{2}H + e^{+} + v$

$^{2}H + {}^{1}H \rightarrow {}^{3}He + \gamma$

$^{3}He + {}^{3}He \rightarrow {}^{4}He + {}^{1}H + {}^{1}H$

In the PP reaction there are some odd looking terms

- e^{+} is a strange particle called the " anti electron" or positron. This is a electron with positive charge.
- γ is a gamma ray photon which is emitted and carries away some of the energy produced in the fusion process.
- n is a neutrino is an elusive particle that carries away a tiny amount of energy in the fusion process.

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- ^{2}H and ^{3}He are isotopes of hydrogen and Helium respectively. Occasionally ^{2}H retain as 2D where D stands for Deuterium which is an isotope of hydrogen.

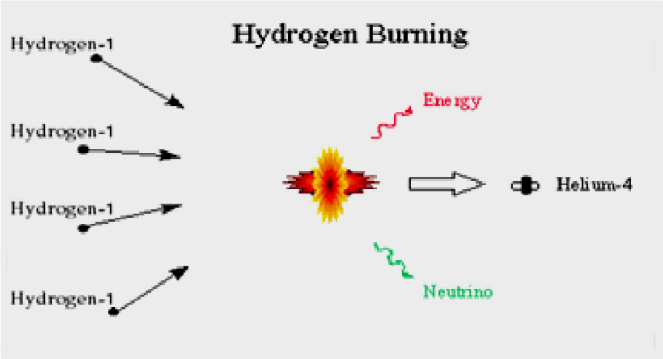

Figure 1 Hydrogen Burning Process

Solar energy is available in abundance and can be considered as the easiest and cleanest means of tapping the renewable energy.

For direct conversion of solar radiation into usable form, the routes are:-

Solar thermal, solar photovoltaic and solar architecture.

However the main problem associated with tapping the solar energy is the requirement to install large solar collectors. To avoid this problem we can install a nano tree having numbers of thin PV platesact as the leaves of the tree, which requires a very less space.

Wind energy is a form of renewable energy. Wind energy (or wind power) describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generator coupled with these mills can convert mechanical power into electricity.

II. What is Nano tree

A nano tree is a decorative means of producing electrical energy from the solar, wind and thermal energy. It uses multiple numbers of nano leaves which are arranged in a tree fashion. A nano tree has a tree like structure in which leaves are arranged in different angles in order to capture maximum solar and wind energy from all directions.

Why it is called as Nano tree

We know that photosynthesis is a process that occurs in trees. Trees use the energy they receive from sunlight to convert water and carbon dioxide into glucose. They use this glucose to create their own energy, storing excess glucose in their tissues for later use. Oxygen is released as a byproduct of this process.

Now Humans breathe in oxygen and eat the glucose in the plants/Trees. They convert these chemicals into energy, carbon dioxide and water in a process called respiration.In the similar manner nano trees produce energy for the society. That is why they are called as nano Tree.

Nano trees have flexible “Branches” extending from a tall, central pole at different levels. Each branch holds nano leaves. These leaves have flat surfaces made up of thermoelectric, photovoltaic and piezoelectricmaterials thatcan extract energy from the sun and wind and turn it into electricity.

The shape of the nano trees make it possible to fit more nano leaves in a space than traditional systems do. This clearly means that less land would be needed to produce same electrical energy. This design facilitates placement of

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nano leaves s in a way that they are exposed towards the sun and wind and that way they are able to harness 20-25% more energy.

Figure 2 The Nano Tree

Nano tree is an artificial tree which makesuse of renewable energy from sun, wind andconverts them into solar and wind energy.These energy harvesting trees are super eco-friendlysynthetic trees that make use ofrenewable energy from the sun along withwind power, which are an effective clean and environmentally sound medium ofgathering solar radiation and wind energy.They utilize three different energy generationtechnologies such as photovoltaic,thermoelectric and piezoelectric. Leaves aredistributed throughout artificial trees andplants and can supply entire household withmaximum efficiency. It is cost efficient andattractive looking for providing the electricpower.

Why it is needed

i. Less land requirement: - Today landsare the costlier commodity for the human society because of high population growth. It is the best option of energy generation because it requires less land as compare to traditional PV system and wind mills..
ii. Efficient energy generation:- It can generate energy very efficiently as compare to traditional system. With advancement in technologies, its efficiency can further be increased.
iii. Can collect energy from the Wind and sun: - The unique feature of the nano tree is that it can extract energy from the wind and sun also. The stem and leaves are flexible so that they can rotate or move in any direction and by shaking themselves, they generate electric energy. The photo-voltaic plate embedded in the leaves of the tree extract energy from sun also.
iv. This energy harvesting trees areecofriendly and neat form of technology.
v. These nano trees could offer frequentplug- in stations for the electric vehicles and hybrids of the near and distant future.

III. BIO-MIMICRY CONCEPT IN NANO TREE

Bio-mimicry is a developing science attempting to solve human difficulties by adapting and implementing Nature's systems to human technology. Bio-mimicry and Nanoleaf technology areintrinsic to each other. The nano leaves have been specially designed to imitate the Z-scheme ofnatural process of photosynthesis. The mechanism by which, typical plants absorb the light emitted by the sun and CO2 in the atmosphere. The artificial trees do even copy the natural re-cycling process. It is very recent that nano leaves technology started to reap even more advanced levels. It can now harvest thermal energy as well. Moreover, the leaves fixed on artificial trees are also able to collect energy derived through movement of the wind, known as kinetic energy, which is as well converted into electrical energy. It is a developing science attempting to solve human difficulties by adapting to and implementing nature's systems into human technology. This job is accomplished by way of the use of nature's design with synthetic trees, shrubs, plants and flowers all developed with nano-leaves engineered photo-voltaic(PV) cells.

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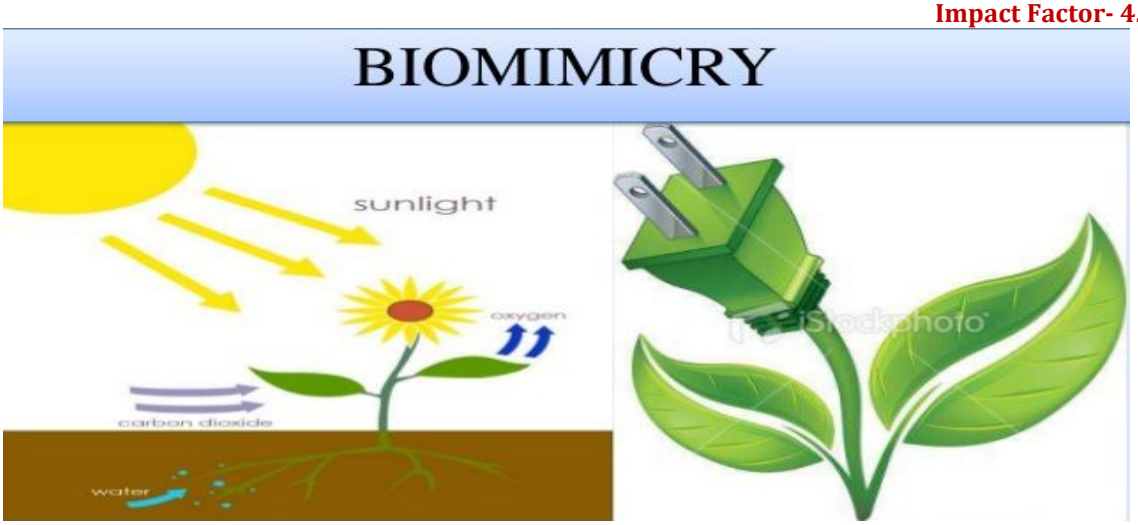

Figure 3 Biomimicry Science

This emerging yet brilliantmethod of energy creation is both cleanand renewable with a broad range ofapplications.In bio-mimicry concept, trees are fittedwith nanoleaves. The nano-leaves havebeen specially designed to imitate thenatural process of photosynthesis (anorganic mechanism by which plants absorbthe light emitted by the sun and CO2 in theatmosphere, turning it into nutrients andoxygen). The artificial trees will even copythe natural recycling process of carbondioxideto oxygen conversion. It is onlyrecently that nano-leaves technologystarted to progress to even more advancedlevels; It can now harvest thermal energyin addition to solar.The nano-leaves transform the whole solarspectrum of light; converting detectablelight, infrared and ultraviolet intoelectricity. This works in conjunction withthe piezo-electric generators that convertwind energy into electricity providingefficient, cost effective and attractivelooking solutions, while providing thesustainable electric power.For constructing the artificial tree the firststep is to construct the nano leaves. Itutilizes three different energy generationtechnologies such as photovoltaic, thermoelectric and piezoelectric.

IV. NANO LEAF

Solar Botanic's artificial leaf called the“Nano leaf”. A very thin photovoltaic filmon one side of Nano leaf converts the lightfrom the sun into energy. On the otherside of the Nano leaf thin thermo voltaicfilm converts the heat from the solarenergy into electricity. Small amounts ofpiezoelectric power are generated by stalksconnecting to a branch. Nano leaf is thinlike a natural leaf and the wind outsideforces pushes the Nano leaf back and forth, and in petiole, twig and branchesmechanical stresses appears. Whenthousands of Nano leaves, flap back andforth due to wind, millions of Pico wattsare generated. Stronger the wind and moreenergy is generated.

Figure 4 Nanp Leaf

A small part of thesunlight is reflected by Nano leaves thatstrikes them. Rest of the spectrum and thegreen light is efficiently converted intoelectricity. Nano leaves convert thevisible light and invisible light, known a radiation, which can feel only.Nano leaves have uniquecombination of photovoltaic and thermovoltaic that converts thermal radiation intoelectricity. They are an emerging form ofrenewable energy through collectingenergy from the sun and

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wind andconverting it to electrical energy. These leaves are distributed throughout artificialtrees and plants, and when operating atoptimum efficiency can supply a wholehousehold with electricity.
SolarBotanic's Nanoleaves createelectricity in three ways:
1. Nanophotovoltaic generators in the leafdirectly convert solar energy toelectricity.
2. Nanothermoelectric cells convert solarheat to electricity.
3. Nanopiezo generators can also convertwind energy in to electrical energy.

Solar Energy + Wind + Heat energy= Electrical Energy

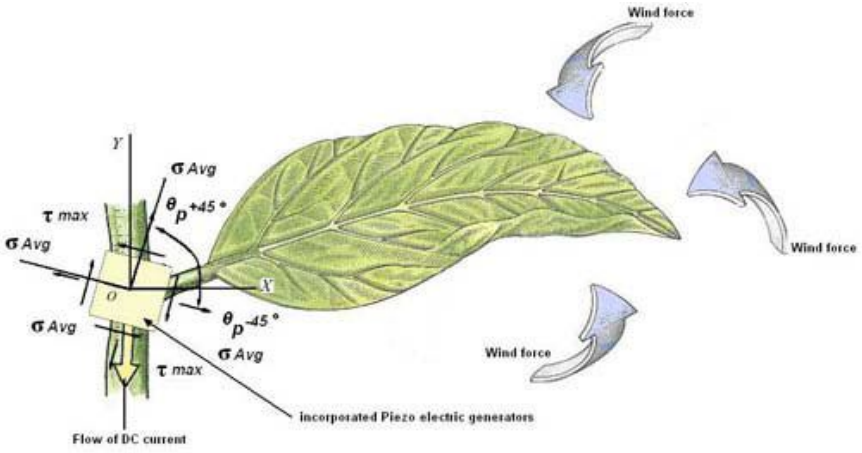

Figure 5 Working of a Nano Leaf

V. COMPOSITION AND DESIGN OFNANO LEAVES

The nanotrees mimic the Z-scheme ofnatural photosynthesis by creating spacefor electrons to move between the catalystsin their stem. The trunks carry out thehydrogen-generating portion of theiraction, while the branches carry out theoxygen-generating portion. This allowsboth the reactions to take place simultaneouslyfor maximum efficiency. Under simulatedsunlight, they can convert 0.12 percent ofthe light into fuel, efficiencycomparable to that of natural photosynthesis.

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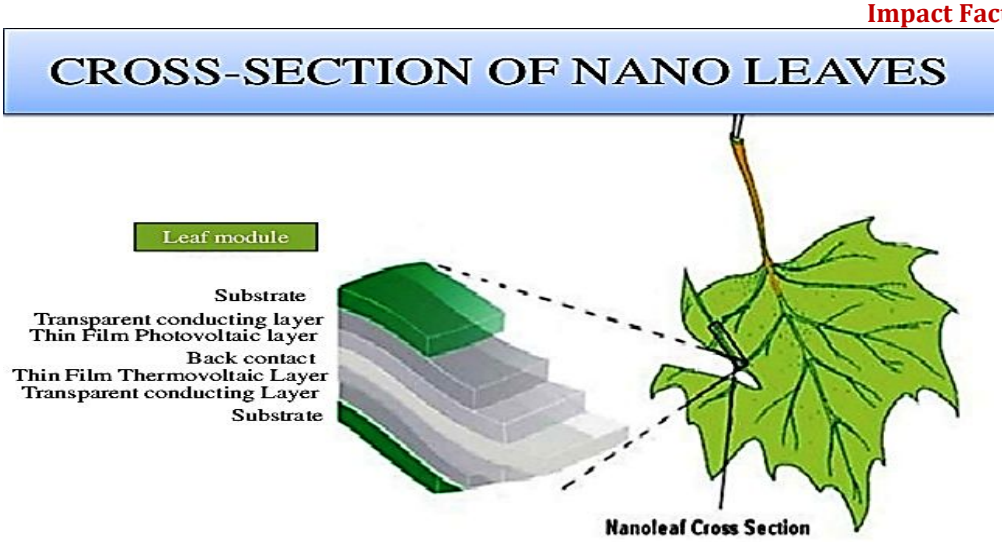

Figure 6 Cross-sectional View of a Nano Leaf

Thermal Energy

This is captured through the use of thermo voltaic (TV) cells which convert thermalenergy into electricity by using semiconductingmaterials (a material which isbetween a metal and an insulator; itsconductivity increasing with temperaturerise).

Light Energy

There are also tiny photovoltaic cells (PV)incorporated in the nanoleaves. Thesesmall PV cells capture the light raysemitted by the sun. The light is thenconverted into electricity.

Kinetic energy

Kinetic energy is harnessed throughmovement. The wind produces motion instems and branches. This motion iscollected via piezovoltaic (PZ) cells. ThePZ has semi-conducting devicesincorporated into the artificial structure oftrees and plants. The PZ and the semiconductingdevices convert typical wind energy (kinetic energy) into electricity.

Titanium Oxide (Tio_2)

The nano leaves are designed by using theTiO_2nano particles because it's very effective and cheaper power generating nano particles.

Titanium dioxide is produced invarying particle sizes, oil and waterdispersible, and with varying coatings forthe cosmetic industry. This pigment isused extensively in plastics and other applications for its UV resistant propertieswhere it acts as a UV absorber, efficientlytransforming destructive UV light energyinto heat.

VI. MECHANISM OF PRODUCTION OFELECTRICITY

When Sun light falls on the nano-leaf, thephotons are absorbed into it,this energy causes the electrons tobecome free. The electrons move towardsthe bottom of the nanoleaf and exitthrough the connecting nano wiresworking as trunk. This flow of electrons isreferred to as low electricity.

- In the same manner when theenvironment is hot, the thermo voltaiclayerproduces the electrical energy.
- If leaf is getting stress due to wind orrain, then piezo electric layerproduces the electricity.
- If other type of light falls on the nanoleaf, thenphoto voltaicproduces theelectricity.
- The output of each layer is connected tothe single storing deviceat the bottomof the tree.

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The photovoltaic, piezovoltaicand thermovoltaic energy harvesters arelinked to individual junction boxes, fromwhere they are amalgamated and fedcollectively into an inverter. This convertsthe electricity from Direct current (DC)into Alternating Current (AC). Theelectrical power now is suitable fordomestic and industrial uses. Artificialenergy trees can be used for both domestic and even industrial purposes. Themanufacturers of the system estimate thata six meter area of nanoleaves would generate enough electrical power to supplyan average household. More, intricate isthat, artificial trees can be constructed atvarious areas, like, deserts, parks, office,premises and industries etc.

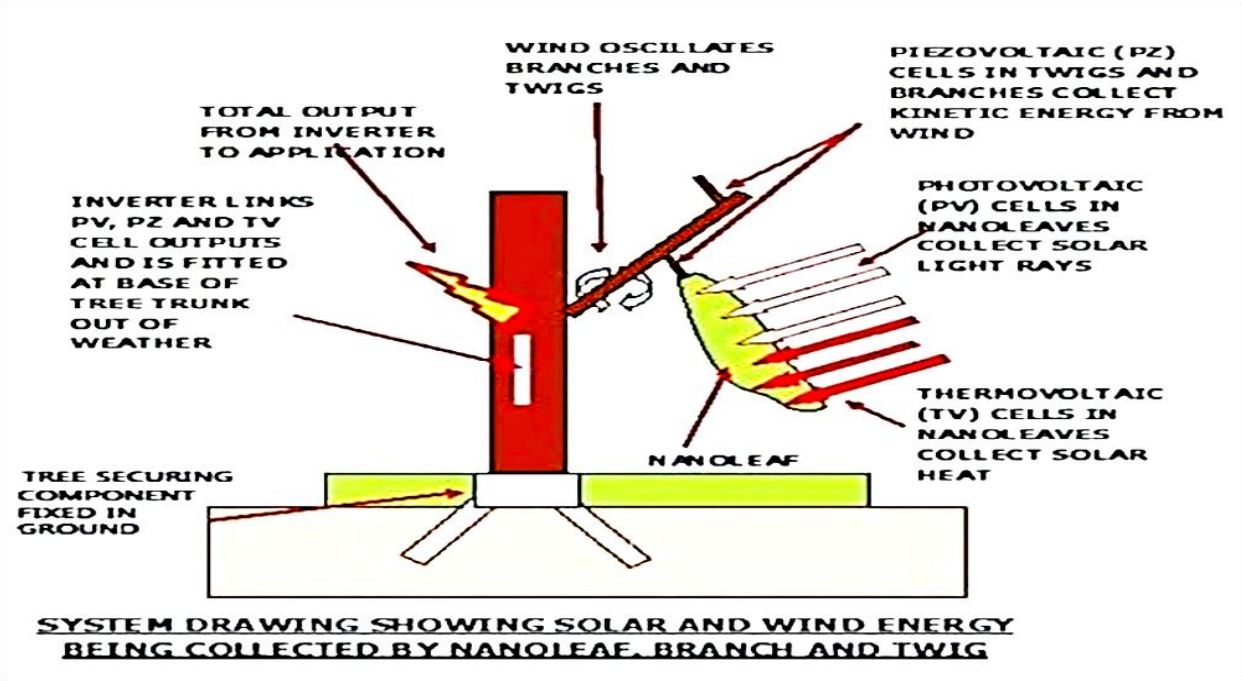

Figure 7 Mechanism of Electricity Production

Solar Tracking System

A *solar tracker* is a device that orients a payload toward the Sun. For flat-nano leaf, trackers are used to minimize the angle of incidence between the incoming sunlight and a nano leaf. This increases the amount of energy produced from a fixed amount of installed power generating capacity.

Sunlight has two components, the "direct beam" that carries about 90% of the solar energy, and the "diffuse sunlight" that carries the remainder. The diffuse portion is the blue sky on a clear day and increases proportionately on cloudy days. As the majority of the energy is in the direct beam, maximizing collection requires the Sun to be visible to the leaves as long as possible.

The energy contributed by the direct beam drops off with the cosine of the angle between the incoming light and the panel. In addition, the reflectance (averaged across all polarizations) is approximately constant for angles of incidence up to around 50°, beyond which reflectance degrades rapidly.

For example, trackers that have accuracies of ± 5° can deliver greater than 99.6% of the energy delivered by the direct beam plus 100% of the diffuse light. As a result, high accuracy tracking is not typically used in non-concentrating PV applications.

The Sun travels through 360 degrees east to west per day, but from the perspective of any fixed location the visible portion is 180 degrees during an average 1/2 day period (more in spring and summer; less, in fall and winter). Local horizon effects reduce this somewhat, making the effective motion about 150 degrees. A solar panel in a fixed

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orientation between the dawn and sunset extremes will see a motion of 75 degrees to either side,would lose 75% of the energy in the morning and evening. Rotating the Leaves to the east and west can help recapture those losses. A tracker rotating in the east–west direction is known as a single-axis tracker.

Sun Tracking Circuit

The proposed system consists of

i) ATMEGA8 microcontroller
ii) Nano leaf
iii) Two LDRs
iv) L293D Motor Driver
v) Stepper motor

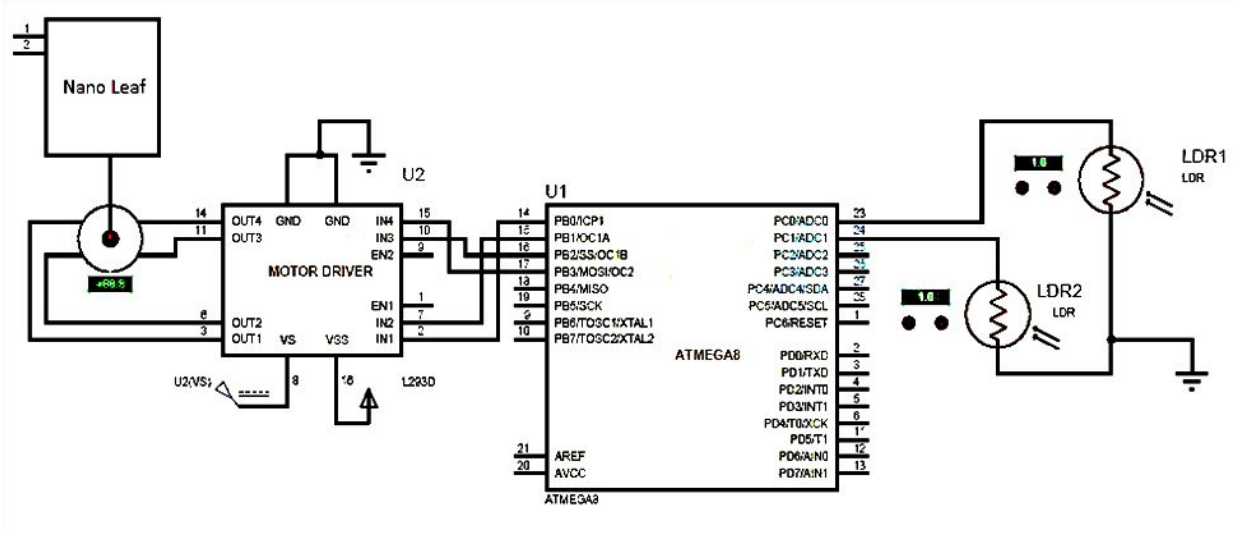

Figure 8 Solar Tracking Circuit

ATMEGA8 is AVR Family Microcontroller. It is based on advanced RISC architecture. It is an 8 Bit Microcontroller. It has 4KB flash memory,5KB of EEPROM and 1KB of RAM. It has 23 programmable pins. It supports peripheral features like two-8-bit timers, one 16 bit timer, 6 channel ADC with 10-bit resolution, programmable USART, Serial peripheral interface, 2 wire serial interface, etc.

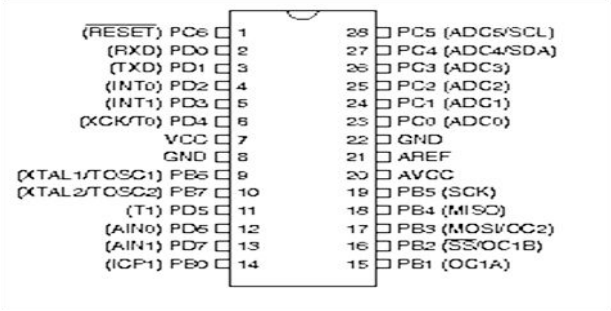

Fig 9ATMEGA8Microcontroller

VII. LDRs

Light Dependent resistors are the resistors whose resistance values depend on intensity of the light. As the intensity of light falling on the LDR increases, resistance value decreases. In dark, LDR will have maximum resistance. The output of a LDR is an analog value which is converted to digital value. This can be done using analog to digital converter. An ATmega8microcontroller has analog to digital converter internally embedded in it. It has six ADC

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channels from ADC0 to ADC5. The two LDRs are connected to ADC pins i.e. PC0 and PC1. ADC conversion is done using successive approximation.

Nano leaves are connected to stepper motor. A nano leaf has thin layer of photovoltaic cells arranged in an order. Photovoltaic cell is nothing but a solar cell.

Photo resembles light and voltaic is electricity. Solar cell is made up of semiconductor materials i.e. silicon. When a light ray from sun is incident on the solar cell,some amount of energy is absorbed by this material. This energy is self sufficient for the electron to jump from one orbit to other inside the atom. Cells have one or more electric field that directs the electrons which creates current. By placing metal contact energy can be obtain from these cells.

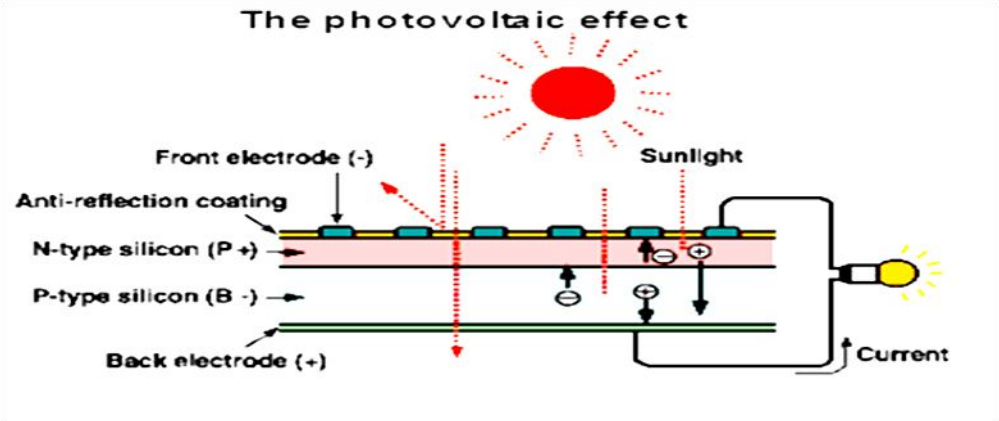

Figure 10 Photo Voltaic Effect

Stepper motor rotates the leaf in a stepwise angle. To drive this motor a driver IC is used. Driver IC amplifies the input voltage and protects the microcontroller from back EMF. Generally, motors generate back EMF, which may damage the controller. The driver IC used is L293D. It has H Bridge internally made up oftransistors. This IC has 16 Pins. Output pins are connected to the stepper motor pins. Input pins are connected to the controller pins as shown in the circuit diagram. Leaf is arranged in such a way that light on two LDRs is compared and panel is rotated towards LDR which have high intensity i.e. low resistance compared to other. When the intensity of the light falling on right LDR is more, leaf slowly moves towards right and if intensity on the left LDR is more, leaf slowly moves towards left. In the noon time, Sun is ahead and intensity of light on both the leaf is same. In such cases, leaf is constant and there is no rotation.

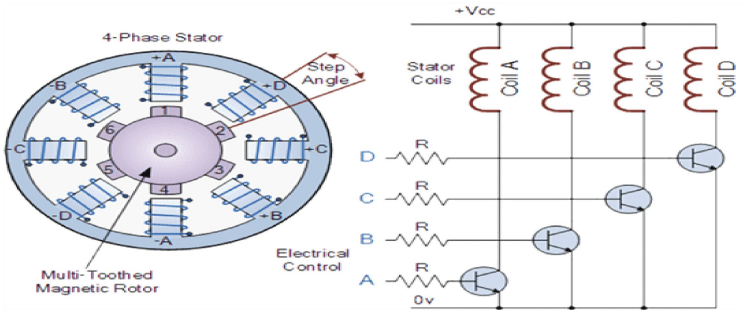

Fig. 11 Stepper Motor

VIII. CONCLUSION

Nano tree are intended to bring visibility to renewable technology and to enhance the landscape and architecture they complement, usually in a commercial or public context. By using sun tracking system in the nano tree, the nano leaves can be rotated in required direction following the sun path to get maximum energy from the sun. This project

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has presented a means of controlling a sun tracking nano leaves with an embedded micro-controller system. Specifically, it demonstrates a working of nano tree with tracking system for maximizing solar cell output by positioning its leaves at the point of maximum light intensity. By using this new technology, we can harvest the energy of the sun and wind by embodying substantiated science.More researchwill need to bring the technology fromlaboratory to home for common use.

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