ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Fabrication of Solar Tracking and Wind Energy Water Pumping System

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ABSTRACT

This project is a combination of mechanical engineering and sustainable development in developing countries. The goal has been to build a solar tracking and windmill driven water pump and Battery charging along with the utilisation of solar energy and to design a small-scale irrigation system for farms in India. The purpose was to demonstrate and spread knowledge about these techniques to farmers in the region.

In 2007, two students from Halmstad University conducted a field study and found that many farmers lack clean and running water. Back in Sweden they constructed a prototype of a windmill that employs wind energy to pump water using a semi-rotary pump. The intention is that local farmers should be able to build their own windmill, and thus have running water in their household.

The windmill construction in this report is based on the prototype, but the original drawings were changed to fit the specific situation in Karnataka, India better. Importance throughout the project has been to minimise cost and to only use material that local farmers can get hold of. Building and assembling of the windmill were then performed by the authors of this project. The windmill drives a pump that pumps water from a well to a tank for further use in irrigation.

Calculations have been made on the energy available in the wind and an energy analysis was then performed to see what wind speed is required for the system to work. If wind speed is low, the windmill can be adjusted by placing the connecting rod closer to the rotation centre where it requires less work to function. As a result of that, the volume of water per stroke will decrease and it will take longer time to fill the tank. The windmill has not been tested during optimal wind speed conditions. The tests that have been performed during the circumstances at the time showed that the performance of the windmill is consistent with the theoretical calculations.

1. Introduction

As we come across many technologies with respect to irrigation from planting to crop cutting machines. For this activity farmers are spending amount in a large extent and for growing crop, we need water. For this many farmers have undergone for adaptation of bore well, pumping the water through the fossil fuel pump etc. Again they have to pay amount for this. So it becomes burden to get profit in irrigation when the expenses are deducted. To overcome this we are implementing wind pump to drag the water from bore well to the irrigation field. And there is also power generated by windmill also. By studying over this cases the main aim of our project come into picturise that the use of wind energy for pumping the water. So

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far this project we say 'Reciprocating pump using wind mill".

1.1 Working principle

In this the solar tracking and wind energy is used to pump the water and also it is used to generate the electrical power. The blade rotates with the help of wind; another source of power is solar energy. AC current is also used to run the pump for pumping the water for the irrigation purpose.

1.2 Reasons to adapt this technology

- It is renewable, inexhaustible and environmental pollution free
- To overcome the lack of power
- This system provides power supply continuously for 24hrs
- Can pump the water through wind mill.

1.3 Advantages

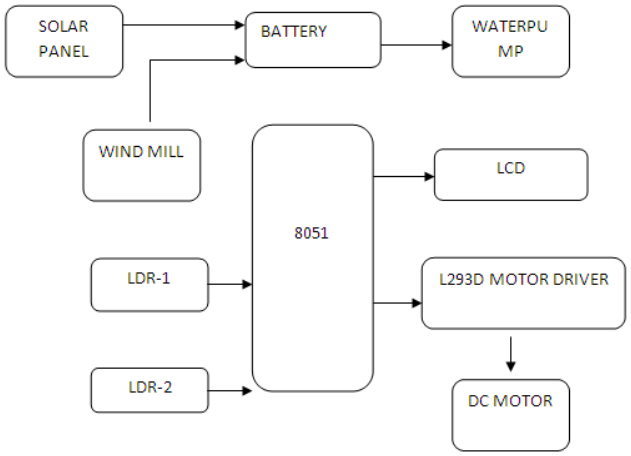
- Efficient and low cost design
- Easy to operate
- Clean and green energy
- Low maintenance

1.4 Applications

- Used in agricultural purpose
- Modified and used as electricity generator

3. HARDWARE IMPLEMENTATION

Block diagram:



Battery:

A rechargeable battery, storage battery, secondary cell, or accumulator is a type of electrical battery which can be charged, discharged into a load, and recharged many times, while a non-rechargeable or primary battery is supplied fully charged, and discarded once discharged. It is composed of one or more electrochemical cells.

3.2 LCD Interfacing

This section describes the operation modes of LCDs, then describes how to program and interface an LCD to art .8051 using Assembly and C.

Solar panel:

Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating.

Modules electrical connections are made in series to achieve a desired output voltage and/or in parallel to provide a desired current capability. The conducting wires that take the current off the modules may contain silver, copper or other non-magnetic conductive [transition metals]. Bypass diodes may be incorporated

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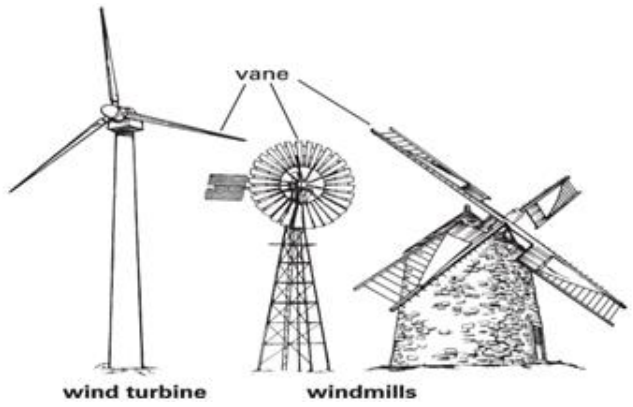
or used externally, in case of partial module shading, to maximize the output of module sections still illuminated.

Windmill:

A windmill is a mill that converts the energy of wind into rotational energy by means of vanes called sails or blades. Centuries ago, windmills usually were used to mill grain, pump water, or both. Thus they often were gristmills, windpumps, or both. The majority of modern windmills take the form of wind turbines used to generate electricity, or windpumps used to pump water, either for land drainage or to extract groundwater.



Light Dependent Resistor:

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it.

DC Motor:

A DC motor is any of a class of rotary electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

4.4 Submersible pump

A submersible pump (or sub pump, electric submersible pump (ESP)) is a device which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between pump and the fluid surface. Submersible pumps push fluid to the surface as opposed to jet pumps having to pull fluids. Submersibles are more efficient than jet pumps.

4.5 Dynamo

A dynamo is an electrical generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. Today, the simpler alternator dominates large scale power generation, for efficiency, reliability and cost reasons. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (vacuum tube or more recently solid state) is effective and usually economic.

4. SOLAR TRACKING INTRODUCTION

One of the most promising renewable energy sources characterized by a huge potential of conversion into electrical power is the solar energy. The conversion of solar radiation into electrical energy by Photo-Voltaic (PV) effect is a very promising technology, being clean, silent and reliable, with very small maintenance costs and small ecological impact. The interest in the Photo Voltaic conversion systems is visibly reflected by the exponential increase of sales in this market

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segment with a strong growth projection for the next decades. According to recent market research reports carried out by European Photovoltaic Industry Association (EPIA), the total installed power of PV conversion equipment increased from about 1 GW in 2001up to nearly 23 GW in 2009.

The major components of this system are as follows.

- Light dependent resistor
- Microcontroller.
- Output mechanical transducer (stepper motor)

5.2.1Block Diagram

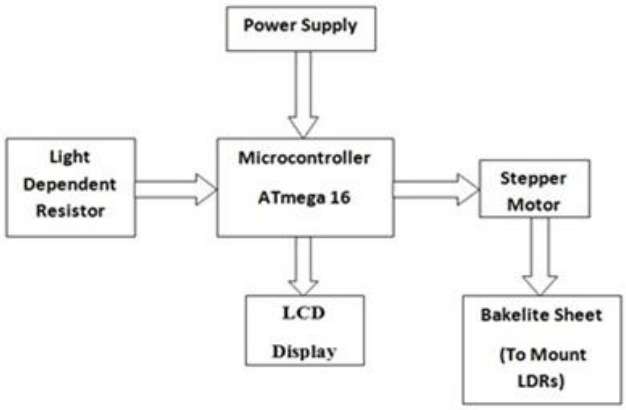

Fig 3.1 Block Diagram of Project

5.3 Track layout design

The first step is to draw the track layout on the plain copper clad board, according to the circuit to be implemented which turns on an LED when the push-button is pressed. The lines joining different components will form the track layout on the PCB. Each component is inserted from the non-copper side of the board and its leads appear on the copper side. For example, when viewing the component side, the base of the BC109 transistor appears to the right of the collector, while from the track side, it appears at the left of the collector.

5.4 Components Description

5.4.1 Solar Tracker

Solar Tracker is basically a device onto which solar panels are fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. After finding the sunlight, the tracker will try to navigate through the path ensuring the best sunlight is detected. The design of the Solar Tracker requires many components. The design and construction of it could be divided into six main parts that would need to work together harmoniously to achieve a smooth run for the Solar Tracker, each with their main function. They are:

- Methods of Tracker Mount
- Methods of Drives
- Sensor and Sensor Controller
- Motor and Motor Controller
- Tracker Solving Algorithm
- Data Acquisition/Interface Card

5.4 Sensors

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.

1. Light Dependent Resistor

Light Dependent Resistor is made of a high-resistance semiconductor. It can also be referred to as a photoconductor. If light falling on the device is of the high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron conducts electricity, thereby lowering resistance. Hence, Light Dependent Resistors is very useful in light sensor circuits. LDR is very high-resistance, sometimes as high as 10MΩ, when they are illuminated with light resistance drops dramatically.

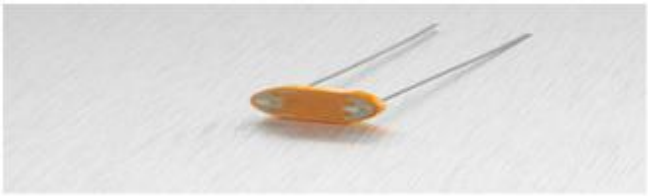

Fig 4.1 Light Dependent Resistor

2. Photodiode

Photodiode is a light sensor which has a high speed and high sensitive silicon PIN photodiode in a miniature flat plastic package. A photodiode is

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
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designed to be responsive to optical input. Due to its water clear epoxy the device is sensitive to visible and infrared radiation. The large active area combined with a flat case gives a high sensitivity at a wide viewing angle. Photodiodes can be used in either zero bias or reverse bias. In zero bias, light falling on the diode causes a voltage to develop across the device, leading to a current in the forward bias direction.

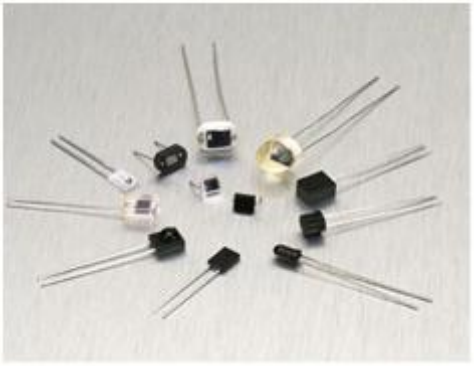

Fig 4.2 different type of photo diodes

5.5 Motor

Motor is use to drive the Solar Tracker to the best angle of exposure of light. For this section, we are using stepper motor.

Stepper Motor

Features

- Linear speed control of stepper motor
- Control of acceleration, deceleration, max speed and number of steps to move
- Driven by one timer interrupt
- Full - or half-stepping driving mode
- Supports all AVR devices with 16bit timer

5. Result and Discussion

A windmill driven water pump at the rural area reduces the need for a diesel driven pump. A diesel pump fills the water tank quickly, but a windmill will instead produce a continuous flow of water, as long as it is windy, and does not need fuel. It is therefore a more eco-friendly solution.

Under the construction and assembly of the windmill, some problems and set backs were encountered. The foundation, which is the most expensive part of this project, was not planned for initially. Local farmers will probably not make a concrete foundation due to the high cost. In this case, it was needed because of the wind and ground conditions.

Pipes and metal plates had to be bought in big quantities, i.e. pipes of 6 metres length only, or plates of 2x2 metres. Metal Workshop that were hired to do all metal work, such as cutting, drilling and welding, could also make the small parts for the construction from waste material.

6.1Recommendations

- Wind conditions are important to consider when planning for a windmill.
- Some kind of cover for the bearings can be constructed in order to protect the grease from rain and dust.
- A plastic bottle with holes in should be put over the inlet of the pipes to prevent the small filter from clogging too fast.
- Last but not least, if there is water left in the tank after irrigation, it can be used for livestock farming.

7. Scope for Future Study

Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. The earth’s surface is made of different types of land and water. These surfaces absorb the sun’s heat at different rates, giving rise to the differences in temperature and subsequently to winds. During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water. In the same way, the large atmospheric winds flow for many purposes: sailing boats, pumping water, grinding mills and also generating electricity. Wind turbines convert the kinetic energy of the moving wind into electricity.

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7.1.1 Advantages

- Can be used for both distributed generation or grid interactive power generation using on-shore or off shore technologies.
- Ranges of power producing turbines are available. Micro-turbines are capable of producing 300W to 1MW and large wind turbines have typical size of 35kW-3MW.
- Wind turbine is suitable to install in remote rural area, water pumping and grinding mills
- Average capacity factor can be close or higher than 30%.

7.1.2 Disadvantages

- The total cost can be cheaper than solar system but more expensive than hydro.
- Electricity production depends on- wind speed, location, season and air temperature. Hence various monitoring systems are needed and may cost expensive.
- High percentage of the hardware cost (for large WT) is mostly spent on the tower designed to support the turbine.

8. CONCLUSION

From the above results and analysis we have found out that a wind/solar hybrid system can be put up in most areas of Kenya with mean wind speeds of about 3 m/s since the average solar irradiation in the country is adequate due to its geographical position. Through this system, we can supply water to the larger part of the 65% rural Kenya lacking access to piped water. Using the engineering design principles of setting up a water pumping system with all factors involved under consideration, we can use these natural energy resources to supply water as well as, depending on output and demand, supply electrical energy. These hybrid systems are also eco friendly and seek to preserve the environment by reducing pollution levels by a considerable amount when compared to diesel, for example, as an alternative. The solar / hybrid systems require a lot of starting capital but looking at the long term benefits, the systems are feasible. The maintenance procedures are also not complex though proper education is required in order not to mismanage or inappropriately use of the system e.g. overcharging of the battery and overloading of the system. The demand in Kenya for such systems is on the rise both for water pumping and electricity generation since both these amenities, water and electricity, are under a lot of pressure with an increasing consumption rate every year.

From the design of experimental set up with Micro Controller Based Solar Tracking System Using Stepper Motor If we compare Tracking by the use of LDR with Fixed Solar Panel System we found that the efficiency of Micro Controller Based Solar Tracking System is improved by 30-45% and it was found that all the parts of the experimental setup are giving good results. The required Power is used to run the motor by using Step-Down T/F by using 220V AC. Moreover, this tracking system does track the sun in a continuous manner. And this system is more efficient and cost effective in long run. From the results it is found that, by automatic tracking system, there is 30 % gain in increase of efficiency when compared with non-tracking system. The solar tracker can be still enhanced additional features like rain protection and wind protection which can be done as future work.

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