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Water Pump Control in Field using Solar Energy

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***Abstract*: This paper focuses on the design and implementation of water pump control in the field using solar energy. This works on the principle of photovoltaicity. Solar panel converts the solar energy into electrical energy which is stored in the lead-acid battery. The embed board LPC 2148 is used for programming, which intern controls the switching of the motors. The solar water pump operates as a soft real time system, where the response time of the system is not crucial. The dc motors turn on or off at different time intervals. A toggle/push button switch will turn on or off of the system which reduces the manual effort of the user. The field can be divided into different slots based on the requirement of the user. Quantity of water supplied to the crops can be varied based on the different type of crops. The power generated by solar panels is used to draw water from the tank. This tequinique can be used for irrigation in fields.**

Keywords – Water pump, photovoltaicity motor, solar panel, lead-acid battery, real time, toggle, irrigation

1.INTRODUCTION

Agriculture is an important part of Indian economy. The rapid growth in agriculture has helped Indian agriculture mark its presence at global level. India is one among top countries in terms of production of various agricultural commodities like paddy, wheat, vegetables, fruits etc. In India more than 60% of the population earns their livelihood from agriculture.

As we approach a new millennium, there are growing concerns and repetitive warnings of water scarcity. With increasing demand for food and competing use within irrigation professionals to manage water effectively. Irrigation plays a master role in the following scenarios like: reduced rainfall, uneven distribution of rain fall, development of agriculture in desert area etc. Irrigation has some of the advantages like: increase food production, optimum benefits of domestic water supply etc. Meanwhile some of the
drawbacks of irrigation include: water-logging, dampness in weather, loss of valuable lands etc. In order to overcome the drawbacks of irrigation user can make use of the automatic solar water pump. In solar water pump control a farmer can reduce his manual efforts.
Solar powered water pumps can deliver drinking water as well as water for livestock or irrigation purposes. Solar photovoltaicity is been widely used in different applications. Despite of various limitations of several energy sources, one of the most appropriate and simplest uses of photovoltaicity is water pumping [1]. Solar water pumps may be useful in small scale or community based irrigation. As large scale irrigation requires large volumes of water that in turn require a large solar panel and batteries for storage purpose.

2.LITERATURE SURVEY

This section deals with the summary of alternate solutions to the problems existing with the present irrigation system. The solutions are as follows:

Paper 1- PV system is the best solution for remote agriculture and for need such as water pumping for crops[1]. Zigbee technology that uses wireless transmission can enhance the security of the PV system. Zigbee technology is a wireless communication technology to connect local wireless nodes [1].It can be fixed in ambient environment which can be monitored in control room. The components used to build this system are solar panel, sensor, inverter, solar pumping motor, zigbee module[1].

Paper 2- Photovoltaic water pumping system involves the technique in which the energy produced by the panel is fed to the motor trough a converter with two power stages: a DC/DC stage to boost the voltage of the panels and a DC/AC three-phase inverter to convert the DC voltage to three phase AC voltage set[2]. The three phase induction motor has a high degree of robustness, low cost, higher efficiency and lower maintenance cost compared to other types of motors and hence it is used. It uses a single PV panel which is used to drive low powered water pumps.

Paper 3 - Another alternative is vector control of induction motor coupled with a centrifugal hydraulic pump, powered by a photovoltaic array. As shown in fig.2.1 the centrifugal pump is driven by an induction motor and fed by a voltage-source inverter[3].It uses a induction motor which has lower maintainance compared to dc motor.

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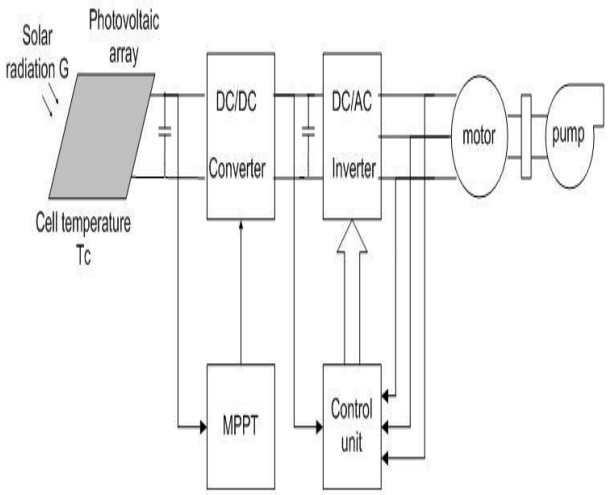

Fig. 2.1. Photovoltaic pumping system

The idea proposed in this paper is cost effective and is easy to use compared to the other alternate solutions discussed above because of use of dc motor. This idea can be of easy use to the farmers . Although zigbee is an advanced technology it is difficult for the user to implement and maintain it efficiently.

3.METHODOLOGY

The methodology adapted in implementation of this idea involves applying the simple concept of photovoltaicity to run the motors at different intervals of time. The applied methodology can be divided into three phases as follows:

Phase 1 - In this phase the attributes of the projects are listed and some of the attributes that are meant to be fulfilled are listed as objectives. The list of objectives is again shortened to pruned objectives. These pruned objectives are chosen keeping in mind user demands and designer constraints. The system is designed to meet all these objectives. Some of the important objectives that the system should meet are safety, productivity, ease of use etc. Also the various constraints are taken into consideration like size and efficiency.

Phase 2 – This phase includes finalizing the best suitable solutions from the number of solutions obtained from the morphological chart. The morph chart in table 3.1 shows all the possible alternate solutions with the best ones being highlighted. The highlighted solutions are considered to be the best as well as suitable from the designer's point of view. The morph chart shows the highlighted solutions like solar as source of energy, toggle button to turn on and off the system for user comfort , arm , Keil , embedded C as technical parts of system development, field and dc motors for betterment of product design.

Phase 3 – The inputs and the outputs of the system are identified and they are applied to the black box. The fig 3.2. shows the black box having Solar energy and Push button at the inputs side . They are identified as the inputs to the system .Also the outputs are identified as Operation of pump, Flow of water to field area and sound . Though sound is an irrelevant output it is included in the fig 3.2 to give a clear idea of all the possible outputs.

Phase 4 – It involves the developing of the overall flow of the project .In this phase the components for the system development are listed taking their specifications into consideration. The detailed description of the components used is discussed in the implementation phase. The interconnectivity of the components is clearly shown in the fig .1.3.This fig. 3.is called transparent box as it uncovers the black box which shows all the components involved in the system development

Table 3.1 : Morphological Chart highlighting the best solution

Means / Functions	Mean 1	Mean 2	Mean 3	Mean 4	Mean 5
Inputs	Relay switch	**Push button**	Toggle switch	Proximity switch	____
Source of energy	Electrical	Hydraulic	Mechanical	**Solar**	Wind
Hardware	Plc	**Arm**	Microcontroller	Arduino	FPGA
Software	**Keil**	Turbo C	Xilinx	CoDeSys	____
Programming language	Ladder diagram	**Embedded C**	Assembly language	____	____
Implementation	**Field**	Industry	Home	____	____
Motor	Stepper Motor	**DC Motor**	Electrical Motor	Synchronous Motor	

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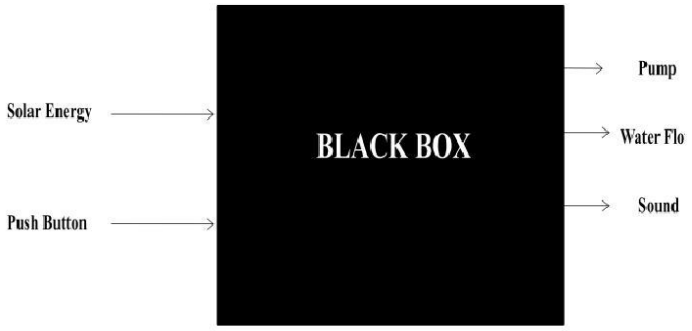

Fig. 3.2 . Black Box showing inputs and outputs.

The methodology followed helps in betterment of the system design and development as includes listing of all the objectives that are to be meet by the system. Also the morph chart gives clear idea about the number of alternatives present for a particular design. Thus the designer can choose the best design as per the requirement.

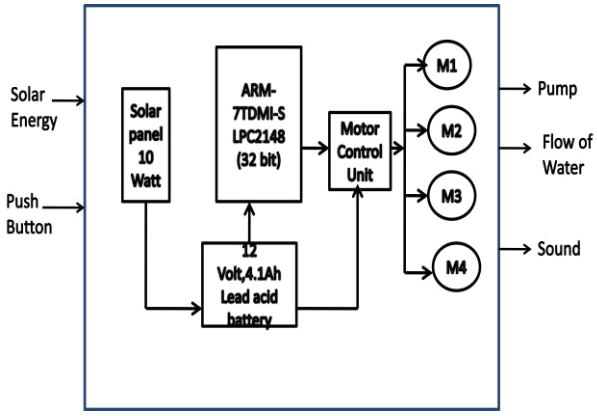

Fig .3.3.Transparent Box showing various components in system development.

4.IMPLEMENTATION

This section deals with the specification of each and every component of the system.Fig.1.4. gives the flow of design of the system.

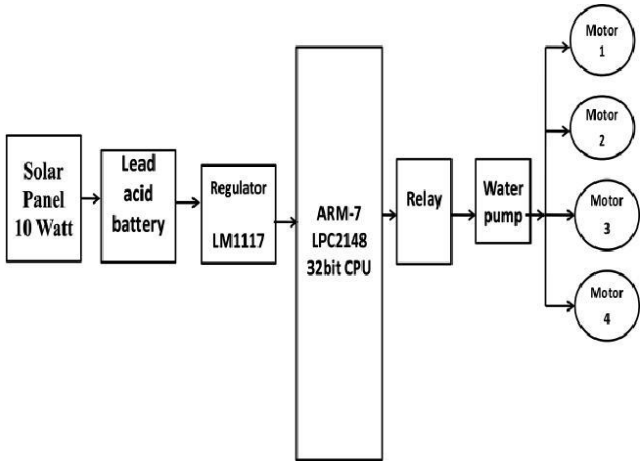

Fig.4.1Block diagram of solar water pump

a)Solar Panel: Solar energy is used as source of energy that is obtained from solar panel. A 10 Watt solar panel is used in this system. The size of the panel depends on the size of pump. A typical solar panel is show in fig.4.2.

Fig. 4.2. A Solar Panel

- Power (Pmax) :This is the maximum wattage the panel is capable of producing, under absolutely ideal conditions.
- Cell Type & Efficiency **:**Solar panels are made up of solar cells wired together. Within the cells sunlight is converted into electricity.The very best commercially available solar cells are still less than 25% efficient at this process, with 15% to 18% efficiency being much more common. In general monocrystalline cells are more efficient than polycrystalline cells, and they are both much more efficient than amorphous silicon thin film cells.
- Voltage at Maximum Power Point (Vmpp) & Current at Maximum Power Point (Impp) :These are the key numbers for any solar panel, and describe the electrical point at which the panel is operating at peak efficiency – the maximum power point. Voltage times current gives the user wattage, so (Vmpp x Impp) should always gives Pmax. The “Maximum Power Point” is at the knee of thecurve, Voc is at the bottom right, and Isc is at the top left as shown in fig.4.3

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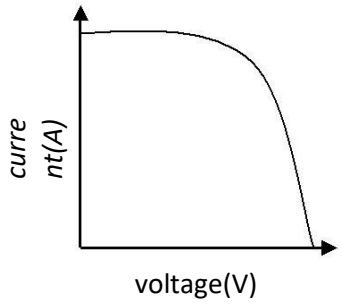

Fig.4.3. Voltage v/s Current graph

b)Lead Acid battery: A lead acid battery of 12 Volt,4.1Ah is used as store electrical energy .

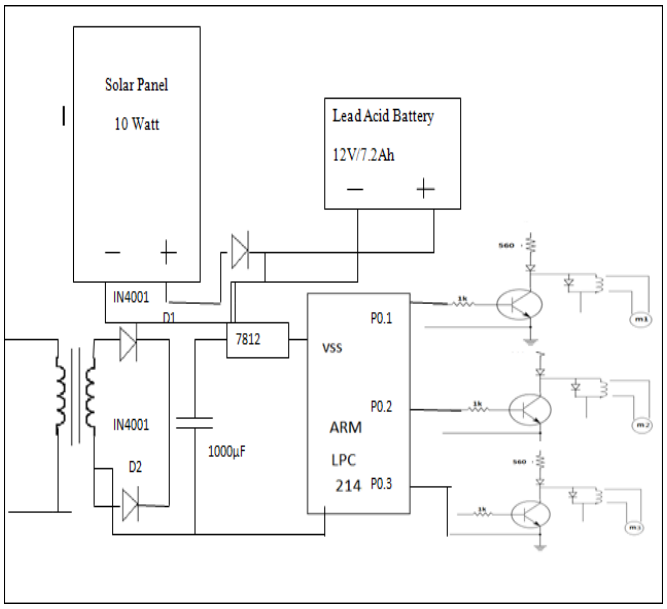

Fig. 4.4. Circiut Diagram

c)Regulator: LM1117 is regulator that is being used. It is used to maintain a constant voltage level. It is available in an adjustable version, which can set the output voltage from 1.25V to 13.8V with only two external resistors. It is a high efficiency linear regulator. Its temperature range is 0°C to 125°C.

d)Control unit:Arm-7 LPC2148 is control unit used. Since the proposed idea deals with four motor for four different slot, the control unit automatically switches between the four motor. By this efficiently large area of field can be divided into four slots further water can be supplied to each slot. This results in efficient time management along with savage of water. User can program the timing for each slot.

e)Relay: This is a mediator between control unit and four motor. A single pole single throw relay is being used. The program that is dumped into arm kit controls the relay. The proposed idea uses four relay that switches between each other.

f)Motor: It is an actuator that is being used to driver water from overhead tank. Four 12V dc motor are used each at a time.

The circuit diagram for the single relay switching is shown in fig.4.4. The shows the complete circuit of the project .

Modes of Operation : - The circuit shown in fig 4.4 operates in 3 modes. They are as follows
i) Solar Mode - In this mode system works on solar enery only and the battery is charged through solar panel.
ii) Battery Mode - In this mode system draws energy from the battery that is charged through solar panel. Here the battery is in discharging mode.
iii) Power Supply Mode - In this mode system works on energy drawn from 230 volts ac supply. This is stepped down using a 12 volt step down transformer as shown in fig.4.4.

The second and the third mode are alternatives to the first mode. During extreme conditions ie. during rainy season the panel will not charge and the system can work in second or the third mode.

5. CONCLUSION

In this paper, we have presented water pumping technique using solar energy. The principle used is photovoltaicity. A solar panel is used that converts solar into electrical energy that is used to drive the water from the tank to the fields.The embed board is used for programming which controls the motors. In order to optimize the use of energy solar cell is used. It is shown that the water can be managed efficiently. Finally we can conclude that this project is user-friendly and can be operated on use of solar energy. The future scope is to include a level sensor that will indicate the level of water in the tank .

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