Smart Portable Economical Solar System (SPESS)

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***Abstract*: In this project we have make some improvements on the currently used conventional method for the extraction of electrical energy from solar PV rays and we did some research and found that instead of working in efficiency, we have focused on the cost factor for generating electrical energy from solar PV. Thus came the idea of Smart Portable Economical Solar System (SPESS). SPESS provides an economical way for generating electrical energy directly from solar PV. Our research also indicates that this type of solar system is self-sustaining and has the capability of operating itself and protecting itself from harsh weather conditions without needing any aid from anybody. This system is also very suitable for mini power plants required for backup and storing of electrical energy in residential and commercial applications as it is portable and supports the need for moving or relocating it. This system also helps the cause for producing a pollution free source of economical energy. This system consists of rigid structure housed in a container underground but it also provides flexibility as when need be the system can automatically assemble itself above ground to fulfill the desired energy requirement. The overall system when fully assembled gives an appealing look which proves to be a soothing scenario to human eyes.**

I. Introduction

1. In everyday life we see that the need for renewable energy generation system is increasing due to the world energy crisis and the harm afflicted to environment by the current energy generation system, but the current technology does not provide an efficient and more economical system for energy generation.

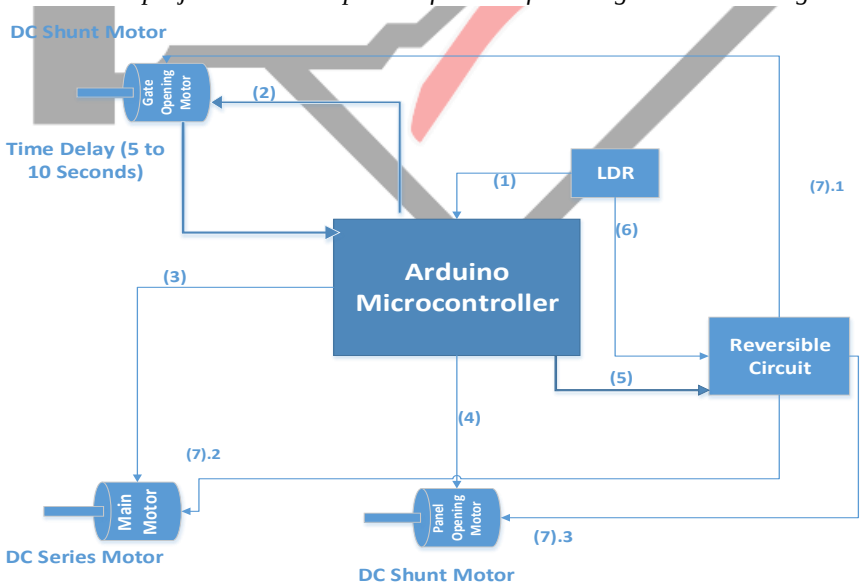
2. So, as an engineer our first priority is to create something that is both economical and environment friendly. So, we decided to do something about it and came up with Smart Portable Economical Solar System also known as "SPESS"

3. SPESS is equipped with smart sensing and tracking technology which helps in monitoring the intensity of sun rays and at the same time provides safety against factors which damage the equipment. The operation of SPESS is totally unmanned; therefore it eliminates the need of any skilled operator. Due to its light weight, it is easy to carry, hence it is portable. It also serves the aim of providing clean energy which will be a compulsion in the future, as it can be used as a charging station for electrically operated vehicles.

I. METHODOLOGY

Basic Block diagram –

The brief method as to how this project works is explained from the following basic block diagram:-



From the above block diagram the basic operation of this project can be observed. The numbering shown in the above block diagram shows the turning ON and OFF sequence of different equipment used in this project. The Straight forward procedure of operation of this project is as follows:-

1. Firstly LDR will detect bright light from the sun and will send a signal to Arduino.
2. After receiving signal from the LDR, the Arduino will turn ON the Gate Opening Motor which will open the gate of an undergrounded container which houses the whole assembly.
3. As soon as the gate is fully opened, the Main Motor is turned ON which will lift the whole assembly above the ground.

4. As soon as the whole assembly is above the ground, the Panel Opening Motor is turned ON which will unpack the solar panels mounted on top of one another.
5. The arrangement of solar panels is done in such a way that when the panel is fully opened, it will look like a circular disc which gives this project a stable and appealing look.
6. And then finally the system will become functional and start converting solar energy in to electrical energy.
7. A Battery is provided which will store the energy produced by the system which will provide backup supply and supply required for initialization.
8. This system is also very flexible as it detects the position of the sun based on the intensity of the sun rays and re-positions itself for providing optimum efficiency possible.
9. The top most disc part is flexible and moves itself depending on the maximum intensity of the sun rays.
10. Again as the LDR senses bright light, it sends a signal to Arduino which will operate the reversible circuit and the whole process is again carried out in a backward fashion.
11. The opening and closing of each motor with respective time delay is done through effective programming of Arduino microcontroller.

Following are the materials and the ways as to how they fit in our need and contribute in successful completion of this project:-

1. ARDUINO KIT:-

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally. Its products are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

Our project uses an Arduino with Atmel (8bit) as it's CPU with SRAM as memory and EEPROM as storage for receiving signals from LDR and providing controlling signals to relays and motors for operation.

A simple connection diagram of Arduino used in our project is as shown below:

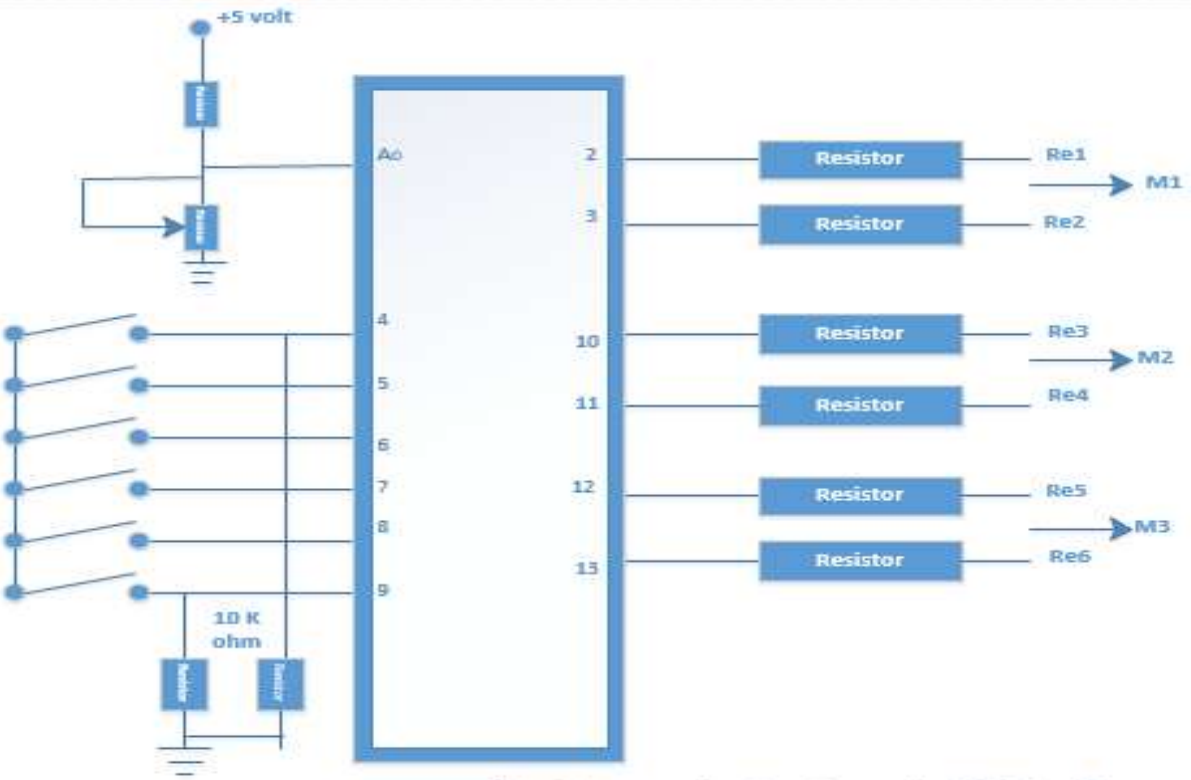


Fig : Microcontroller Port Connection With Aurdino

Above figure shows the microcontroller port connection with Arduino which controls the motors to perform various functions as desired by the user.

Purpose:-

Arduino is responsible for turning ON and OFF various equipment through effective programming and is considered as the HEART of this project.

2. TRANSFORMER:-

A transformer is a static electrical device that transfers electrical energy between two or more circuit, a varying current in one coil of the transformer produces a varying magnetic flux, which in turn, induces varying electromotive cross the second coil wound around the same core.

Electrical energy can be transferred between the two coils, without a metallic connection between the two circuits. Transformer is used for increasing or decreasing the alternating voltage in electrical power applications, and for coupling the stage of single processing circuit. For research purpose we have used a step down transformer. The specifications of the transformer used in this research are as follows:-

Secondary voltage: 18V
Rating
Power Rating: 6VA
Primary voltage: 115V ac, 230V ac
Rating
Number of Outputs: 2
Dimensions: 53 x 22.6 x 44mm
Weight: 175g
Mounting Type: Through Hole
Operating Frequency: 50Hz

Purpose:-

The main purpose of the transformer used in this project is to step down the supply voltage to be used by the circuit.

3. Relays:-

A relay is an electromagnetic switch, it is used in application to turn on and of a circuit by low power signal 24V, or several circuits must be controlled by one signal. Relays can be used to control several circuits by one signal. A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). You can think of a relay as a kind of electric lever: switch it on with a tiny current and it switches on ("leverages") another appliance using a much bigger current. Why is that useful? As the name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents. Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off) or as amplifiers (converting small currents into larger ones).
A simple circuit diagram of relay used as electromagnet switch is as shown below:-

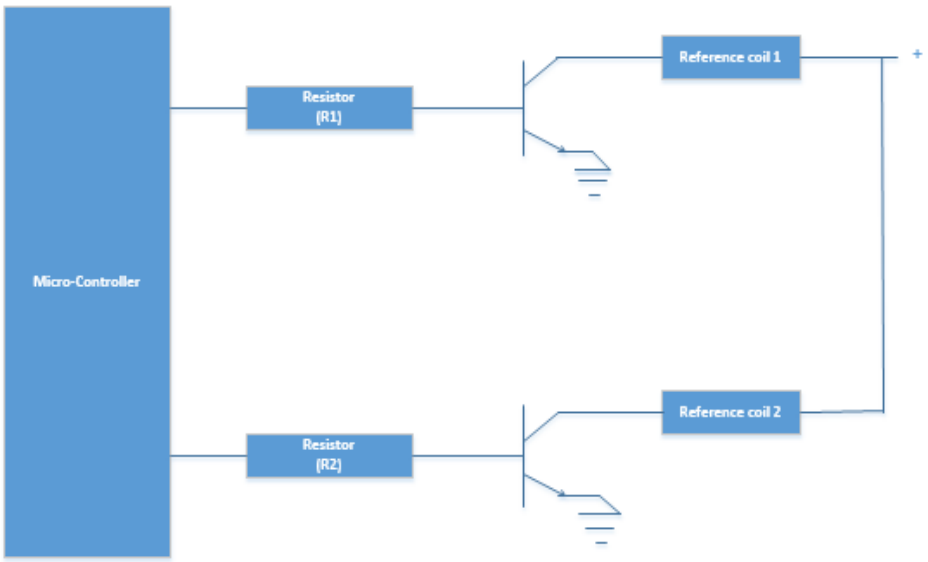
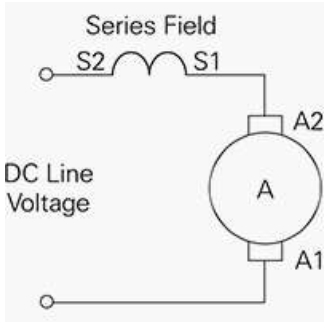


Fig : Relay
Electromagnetic Switch

Purpose:-

In this project relays come in to action during reversing of whole operation when LDR senses dark light and then sends a signal to microcontroller then reversing circuit activates and through relay the motors operate in reverse direction.

4. DC Series Motor:-



A DC series motor converts electrical energy to mechanical energy. Its principle of operation is based on a simple electromagnetic law that states that when a magnetic field is created around current carrying conductor and interacts with an external field, rotational motion is generated. Series motors once started will offer maximum speed and torque but gradually, with an increase in speed, its torque will come down because of its reduced current.

Advantage:

1. Used very high starting torque required.
2. Series motor draws less current and power from the source compared to a shunt or compound motor.
3. Series motor offers the lowest starting current at a given torque.

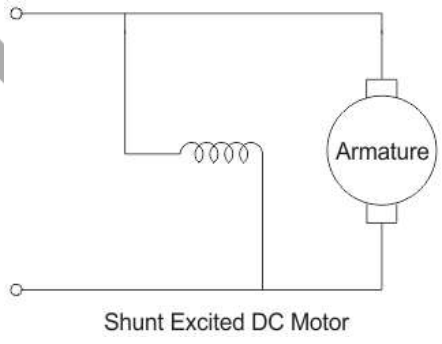
Disadvantage:

1. Speed regulation in the series motor is quite poor. With the increase in the load, speed of the machine decreases.
2. If speed decreases torque will decrease.
3. DC series motor should always require being loaded before starting the motor, hence not suitable for all type of applications.

Purpose:-

As DC series motor provides high starting torque, we have used it a gate opening motor and to lift the assembly above the ground as soon as the microcontroller receives signal LDR.

5. DC Shunt motor:-



Shunt Excited DC Motor

Basically motor consists of one rotating and one stationary part. In case of DC shunt motor,

Armature is rotating one (supplied with DC supply)-When current carrying armature conductors placed in main field then force acts on it. This force on each conductor gets added and results into rotating torque.

field winding is stationary(supplied with DC supply)- To induce main flux

Now, Armature winding and field winding are connected in parallel to each other.

When armature and field winding is supplied with DC, then by the electromagnetic induction principle, rotating torque generates which ,makes rotor to rotate as per given above.

Advantage:-

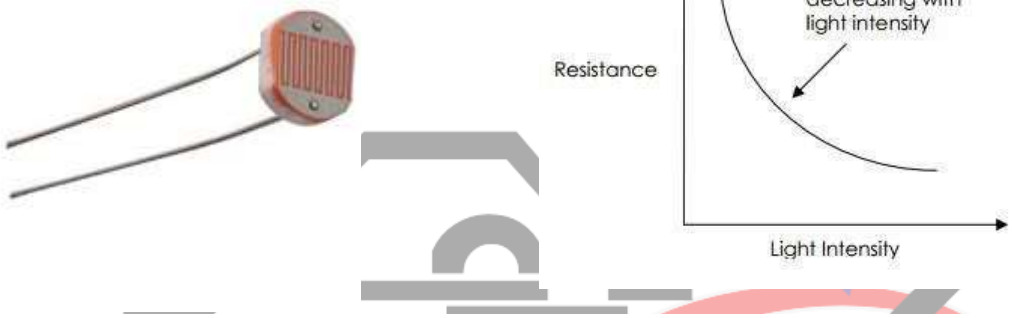
1. Constant Speed characteristics
2. Simple speed control methods

Disadvantages:-

1. Requires commutator which lead to sparking at brushes.
2. For variable speed drive, we can't use it.

Purpose:- In this project dc shunt motor is used at the top most part where solar panels are mounted and is used and pack and unpack the panels adjusted on top of one another during forwarding and reversing.

6. *LDR (photo light dependent resistor)*:-



An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.
The most common type of LDR has a resistance that falls with an increase in the light intensity falling upon the device (as shown in the image above). The resistance of an LDR may typically have the following resistances:

Daylight
= 5000Ω
Dark
= 20000000Ω

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap. Extrinsic devices have impurities, also called dopants, and added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

Purpose:-
In this project the role of LDR is very important as it senses bright light and gives the signal to microcontroller which causes all the motors to operate and the whole assembly becomes functional and when the LDR senses dark light again it sends a signal to microcontroller which causes all the motors to operate in reverse direction unpacking and bringing down the whole assembly underground.

II. Programming Code for Arduino

```
#define NUM_SAMPLES 10
int sum = 0;                    // sum of samples taken
unsigned char sample_count = 0; // current sample number
float voltage = 0.0;            // calculated voltage
const int sw1 = 4;
const int sw2 = 5;
const int sw3 = 6;
const int sw4 = 7;
const int sw5 = 8;
const int sw6 = 9;
const int relay1=2;
const int relay2=3;
const int relay3=10;
const int relay4=11;
const int relay5=12;
const int relay6=13;
int buttonState = 0;
int buttonState1 = 0;
int buttonState2 = 0;
int buttonState3 = 0;
int buttonState4 = 0;
int buttonState5 = 0;

void setup() {
// put your setup code here, to run once:
 Serial.begin(9600);
 //lcd.begin(16,2);
 //lcd.clear();
 pinMode(sw1, INPUT);
 pinMode(sw2, INPUT);
 pinMode(sw3, INPUT);
 pinMode(sw4, INPUT);
 pinMode(sw5, INPUT);
 pinMode(sw6, INPUT);
 pinMode(relay1, OUTPUT);
 pinMode(relay2, OUTPUT);
 pinMode(relay3, OUTPUT);
 pinMode(relay4, OUTPUT);
 pinMode(relay5, OUTPUT);
 pinMode(relay6, OUTPUT);

}

void loop()
{
 buttonState = digitalRead(sw1);
 buttonState1 = digitalRead(sw2);
 buttonState2 = digitalRead(sw3);
 buttonState3 = digitalRead(sw4);
 buttonState4 = digitalRead(sw5);
 buttonState5 = digitalRead(sw6);
 int voltage_value0 = analogRead(A0);
 voltage_value0 = voltage_value0/26;
 Serial.print(voltage_value0 * 0.132);

 delay(100);
  if(voltage_value0 > 3)
  {
    digitalWrite(relay1, HIGH);
  }
   if(buttonState == HIGH )
   {
```

```
   digitalWrite(relay1, LOW);
   delay(5000);
   digitalWrite(relay3, HIGH);
  }

  if(buttonState1 == HIGH)
  {
   digitalWrite(relay3, LOW);
   delay(5000);
   digitalWrite(relay5, HIGH);
  }
  if(buttonState2 == HIGH)
  {
   digitalWrite(relay5, LOW);
   delay(5000);
  }
  ////////////////////////////////////////
  if(voltage_value0 < 3)
   {
     digitalWrite(relay6, HIGH);

   }
  if(buttonState3 == HIGH)
  {
   digitalWrite(relay6, LOW);
   delay(5000);
   digitalWrite(relay4, HIGH);
  }
  if(buttonState4 == HIGH)
  {
   digitalWrite(relay4, LOW);
   delay(5000);
   digitalWrite(relay2, HIGH);
  }
  if(buttonState5 == HIGH)
  {
   digitalWrite(relay2, LOW);

  }

 delay(1000);

}
```

IV. Future Scope

The scope or extent or the expansions that can be done in future with this project are as follows:-

1. Rain sensors and compatible automatic rain covers can be added if this system is to be used in the places with heavy rainfall or the places where weather is subject to change frequently.
2. Wind sensors can be added if this system is to be used in the hilly or windy areas where wind blows heavily which will cause the system to protect itself smartly during harmful situation.
3. Automatic dust cleansers can be added which will keep the system clean and will also help in reducing the need for maintenance.
4. Solar intensity magnifiers can also be used for increasing efficiency.
5. Gear system is used or research purpose but hydraulic system can also be used in it's place.
6. This system can be used as charging stations for electrically operated vehicles during day time.
7. By excluding the underground part and constructing this project above the ground can charge the electrically operated vehicles during night time.

V. Conclusion

1. Following are some key points that we have concluded by conducting this research:
2. An economical source of clean energy can be created which will help in maintaining sustainable environment.
3. Estimation of energy production and energy payback time off the PV system in four regions is done.
4. The impact of system parameter such as temperature, solar irradiation and load changes on the voltage stability is found out.

5. The continuity of supply even in adverse conditions can be maintained and successful storage of electrical energy is obtained.
6. The overall cost of a typical solar system can be reduced by implementing the schemes shown and provided in this research.
7. A smart system can be created which will be totally unmanned and protect itself from harmful conditions such as dust, rain, wind, etc. without needing the aid of any human.
8. A portable system can be created which has wide applications in residential compact solar power and backup systems as in cases of residential applications moving and relocations are very common, so, a portable system is preferred.

REFERENCES

Following the references of different research papers and books that we have referred during the research which provides worthwhile contribution to this research:

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4. D. Pavithra, R. Balakrishnan, "IoT based monitoring and control system for home automation. In Communication Technologies (GCCT)", 2015 Global Conference, pp. 169-173, 2015, April.