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Solar Based Smart Corridor System

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Abstract: This paper presents a Solar Based Smart Corridor System. The system provides an automated lighting system and charging circuit. This detection is based on the motion sensor. The whole system is automated by ESP32 microcontroller. Admin can control the lighting system remotely as the controller has a wi-fi module. The goal of a microcontroller is to interface with sub-systemsand provide suitable decisions for efficient working of the system. The system will use solar energy from solar panels to perform its work.

In the absence or failure of it, the system will work on a battery which is charged with the help of solar power. In failure of these both the system will work on traditional state electricity supply. This system is made to work on hybrid mode of power supply.

To get this system to work efficiently, we have prepared a set of rules. So that entire system will work according to the algorithm developed. So this system uses eco-friendly energy sources with good efficiency. Also, as the system is robust, scaling of the system based on the need of energy required is relatively easy.

Keywords: Solar panel, IOT, Mobile charging, Inverter, ESP32, Motion sensor

I. INTRODUCTION

The scarcity of conventional energy resources is the major issue the whole world is facing currently. The major solution to reduce the use of conventional energy especially for electricity is the use of Solar energy as it is available in tremendous unending amounts. To use solar energy in our day to day life we consider places like big organization terraces of houses, corridors, etc which will give us the large surface area to have more solar panels to create more energy. But with the current system for corridor lights for educational campuses or big organizations the wastage of electricity is considerable. The lights and other electric appliances are working even if there is no necessity.

So the proposed smart corridor system uses solar energy but we need to design a system which will make efficient use of the energy provided to it using solar. The main purpose of this system will be to control the corridor lights effectively and to provide ports to charge smartphones. Use of a microcontroller to control these devices can help to increase efficiency and the system can be made more robust.

Our system will have two main facilities –

1) Smart Control of Lighting System
2) Availability of Mobile Charger Port

The controlling of these parts will be done by microcontroller. The primary supply for the Lighting System as well as the Smartphone charger port will be solar energy. Battery will be used to store the excess solar energy in case the system is off. Design of the system will be hybrid, it will be able to run both on solar, as well as, conventional sources of energy provided by electricity providers. Also, the system should be hybrid enough to accommodate old devices. Most LEDs run on AC power supply while DC is supplied by Solar Panel.

With the inclusion of devices such as inverters, we can make sure that the system runs on conventional power supply as well as solar power supply. Modern smartphones have become an integral part of a person’s daily life. As the use of smartphones increases, the need for charging facilities for them also increases. Thus, our system also includes a mobile charging port to give users the ability to use renewable and eco-friendly sources for daily life, thus, overall, helping nature. This kind of system can have a wide variety of applications.

From malls to railway stations, from industrial areas to academic campuses, we can use this system to use eco-friendly energy sources with good efficiency. Also, as the system is robust, scaling of the system based on the need of energy required is relatively easy.

II. PROPOSED SYSTEM ARCHITECTURE

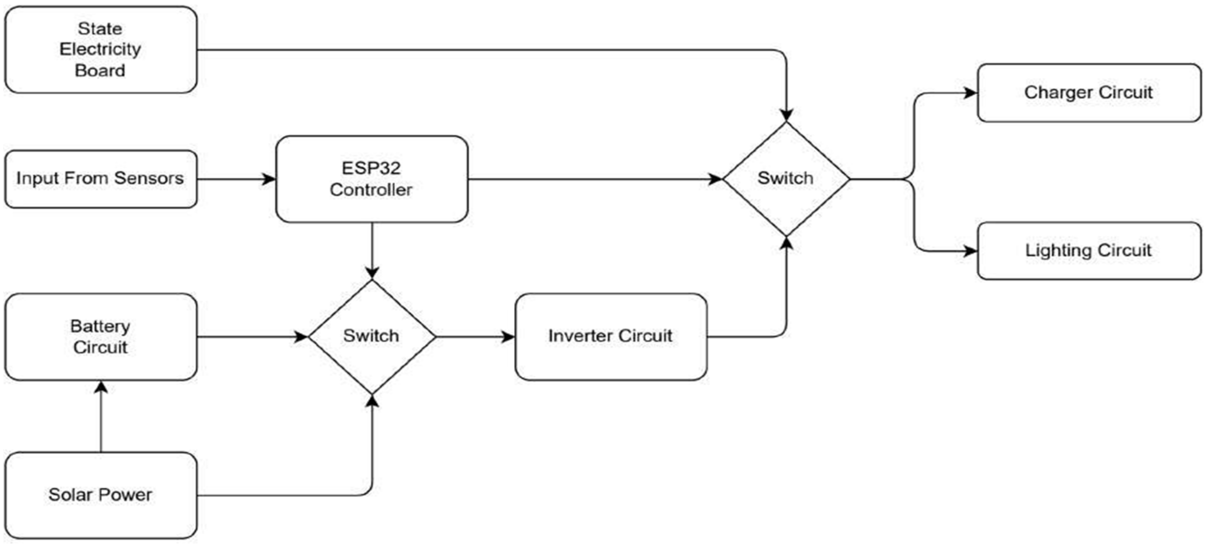

Fig. 1 System Block Diagram For Solar Based Smart Corridor System

The above figure shows the overall system block diagram which consists of three main parts – Solar power generation and storage Circuit, Power Circuit, Controlling Circuit. Solar Power generation and storage Circuit consists of Solar Panel and Battery, Panel provides the necessary energy and Battery is used to store that energy. The main component of Power Circuit is Inverter. This is the integral part which converts DC given by Solar into AC. Also, furthermore Relays are also used to control LEDs connected using Microcontroller. Mobile Charger Port is provided at the output. The Controlling Circuit consists of all the switches, Input from sensors such as motion sensors and also the heart of the circuit – Microcontroller. Here, we use ESP32 for controlling as it can handle IOT functionalities quite easily. All the switches i.e.Turning ON and OFF of different components is handled by microcontrollers with use of sensors.

Initially, preference is given to Solar Panel for direct supply. In case it does not provide sufficient power, then stored power from the battery will be used to provide necessary supply. Finally, if any of the options, direct power from solar or battery, is not sufficient then conventional State Electricity Board supply will be used to provide necessary power. Focusing on the ESP32, it handles checking of all the sensors and performs respective functions depending on values given by sensors. To provide further ease of access, we configure ESP32 in such a way that an authoritative person can turn ON or OFF the whole system just by using his smartphone. In this manner, the system will work in real time to ensure efficient use of energy and ease of access from the perspective of the user all the while implementing technology which uses eco-friendly and renewable sources of energy for its working.

1) ESP32

Fig. 2 ESP32

ESP 32 is a combo chip with a highly integrated solution for Wi-Fi and Bluetooth IOT applications. This chip is designed to achieve best power, RF performance and reliability in more varieties of applications. ESP32 integrates an antenna switch, low noise receiver amplifier. filters and also power management modules.

2) CPU and Memory of ESP32

- Single/Dual core 32 bit LX6 Microprocessor
- It has two Cores
- 448KB ROM
- 520KB SRAM and 16 KB SRAM in RTCAdvanced Peripheral Interfaces:
- 34 programmable GPIOs
- 12 bit SAR ADC up to 18 channels
- 4 x SPI, 2 x I2S, 2 x I2C
- 3 x UART
- Motor PWM
- LED PWM up to 16 channels

3) Solar Panel

Fig. 3 Solar Panel

Solar energy is a fairly unlimited source of energy. The advantage of solar energy is that it is free, reachable to common people and available in large quantities of supply compared to that of the price of various fossil fuels and oils in the past many years. Solar panels use sunlight as a source of energy to generate electricity. We used a solar panel of 50W, 12V. Theway of utilization of solar energy is explained in system operation.

4) PIR Sensor:

Fig. 4 PIR Sensor

PIR is nothing but Passive Infrared motion sensor. Here it uses a pair of pyroelectric sensors to detect if the person is present in the corridor or not. Detection range for indoor PIR is 25cm to 20m and for outdoor PIR detection range is 10m to 150m. It has three terminals such as input, usually 5V, output and ground.

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5) *Level Shifter:* As its name suggests, Level Shifter is used to shift the voltage. Here we used I2C Bi-Directional Logic Level Converter of 4 Channels - BSS138. It is used for mutual transformation between 5V TTL to 3.3V TTL. ESP 32 provides 3.3V on GPIO pins so Level shifter is used to convert 3.3V to 5V which is required for PIR sensor and relays.
6) *Voltage Sensor:* To detect the voltage, a Voltage Sensor is used. We used a Voltage Detection Sensor Module 25V. It has input voltagerange 0 - 25V DC and voltage detection range is 0.2445V to 25V and voltage analog resolution is 0.00489 V. We used a voltage sensor to detect the voltage of the solar panel and battery.
7) *Relay:* A 5V relay is used as a switch. Relay has 5 pins such as Coil 1, Coil2, Common, Normally Close (NC) and Normally Open (NO). Two coils are used to trigger the relay, normally one is connected to 5V and one is connected to ground. Load is connected to either NO or NC depending on application. If load is connected to NC then load remains connected before trigger and if load is connected to NO then load remains disconnected before trigger.

A. *Inverter Proteus Circuit*

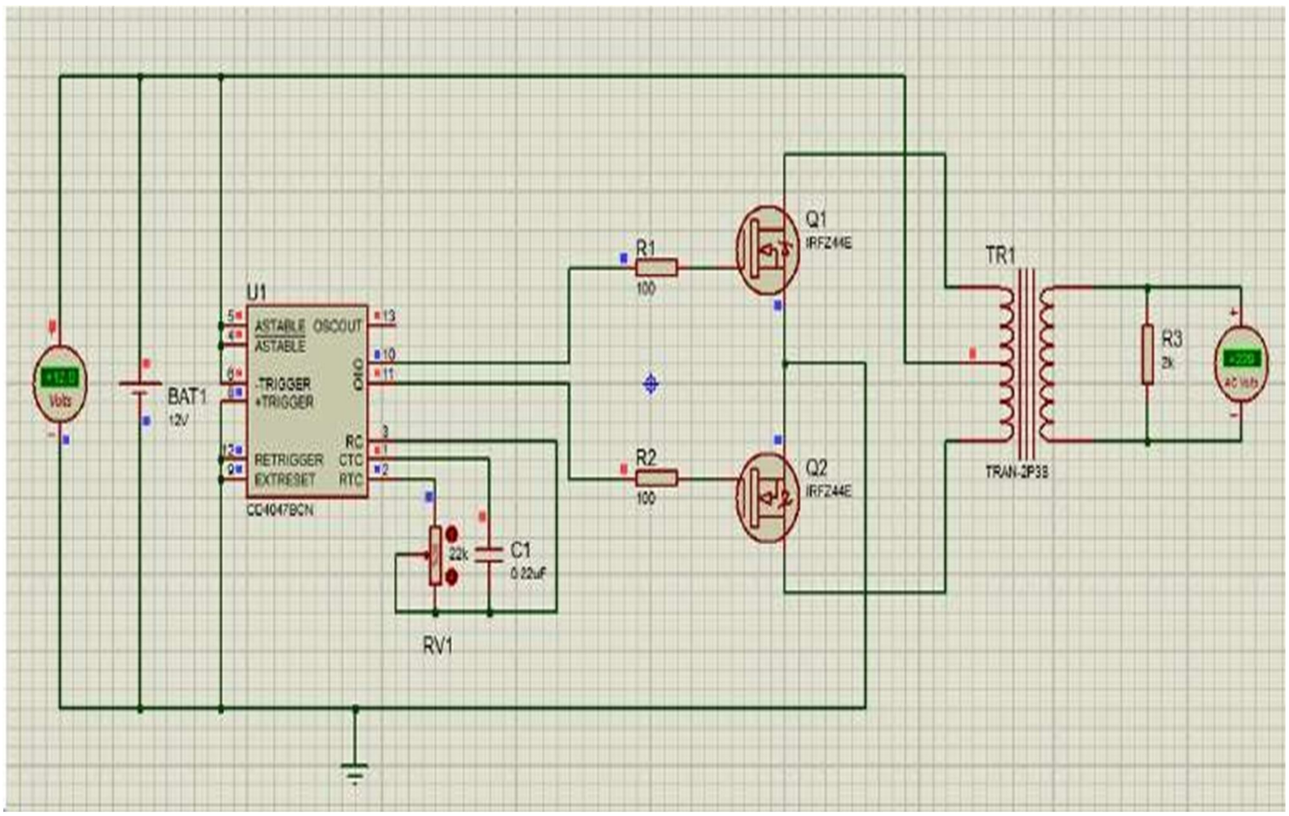

Fig. 5 Inverter Circuit In Proteus

Inverter circuit is used to convert 12V DC supply to 230V AC supply. It mainly contains following sub parts:
1) *Astable Multivibrator:* IC CD4047 is used which acts as a switching pulse oscillating device used in astable multivibrator mode. In CD4047,potentiometer and capacitor is used.As it is configured in astable mode, by varying potentiometer, we can change output pulses at Q and Q' pins(See Fig.5) of CD4047.
2) *MOSFETs:* IRFZ44n is an n-channel power MOSFET which is used as a switch and also it is used for driving output power. and its drain pins are connected with secondary pins of the transformer. Source pins of both MOSFETs are connected to the negative terminal of the battery and the common pin in the secondary winding is connected to the positive terminal of the battery. MOSFET switches to ON when the alternate square pulse from Q and Q' (See Fig-5) drives it.
3) *Transformer:* 12-0-12/1A secondary transformer used as a step-up transformer to convert low AC to high AC. Due to the generation of alternating square wave pulses on Q and Q' (See Fig-5), the secondary winding is forced to induce an alternate magnetic field. This magnetic field produces high AC voltage which is approximately 230V.

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III. SYSTEM OPERATION

A. Physical System Circuit

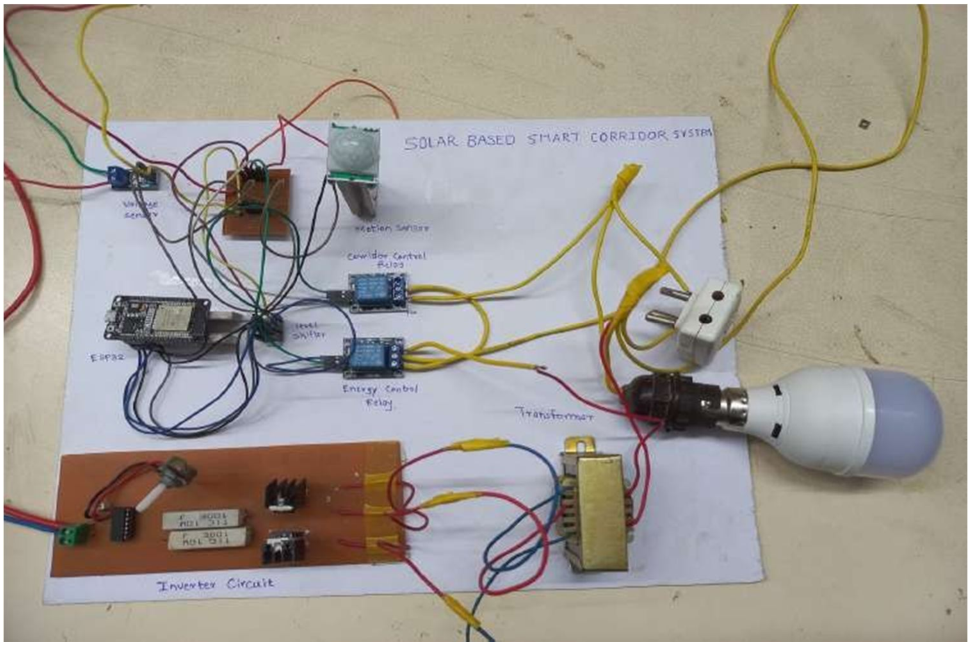

Fig. 6 Physical System Circuit

B. Algorithm Flowchart

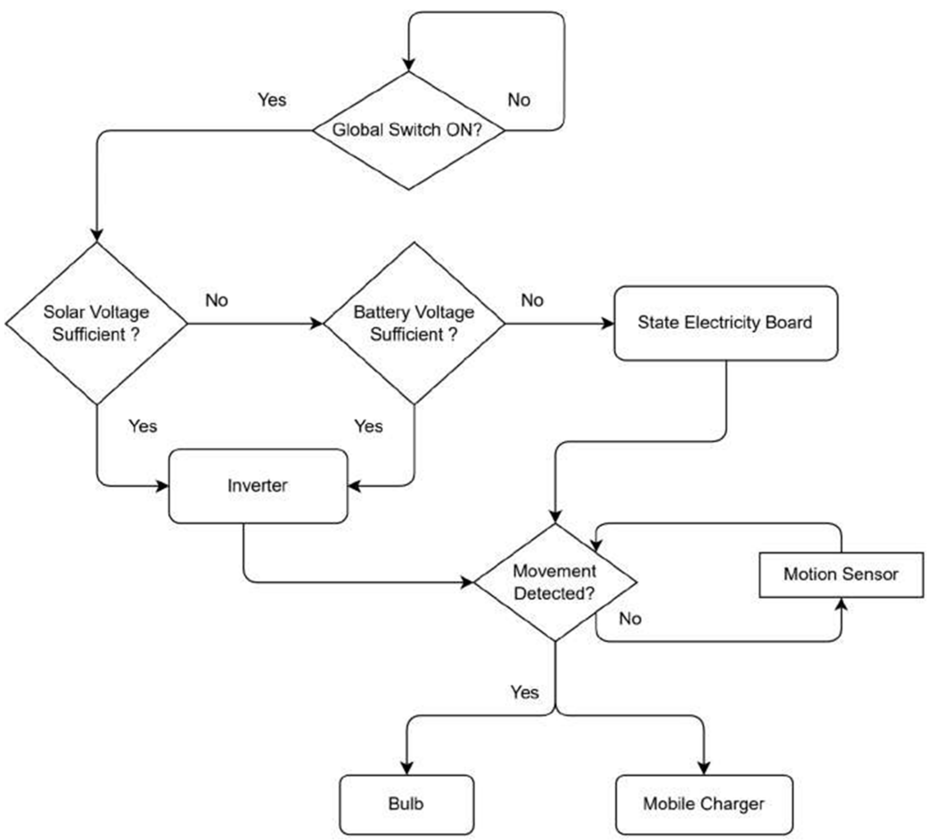

Fig. 7 Algorithm Flowchart

At the beginning we check if the global switch is ON, the system will work only if it is ON. As ESP32 is dual core we take advantage of each core. One core runs Corridor Control Subsystem while the other core runs Energy Control Subsystem.

In the Energy Control Subsystem, we periodically check if energy provided by the Solar Panel is sufficient to drive the load, if it is not, then we move towards our battery where solar energy is stored. In case even Battery also does not have sufficient power we move towards conventional State Electricity Board power supply.

In the Corridor Control Subsystem, we periodically check if a person is detected by motion sensors. If the motion sensor detects a person, then the respective LED turns ON. And also, the mobile charging port is turned ON. As the person moves away, the LED and mobile charging port will automatically turn OFF.

Both of these subsystems run in parallel making efficient use of the dual core architecture of ESP32.

IV. EXPERIMENTAL RESULTS

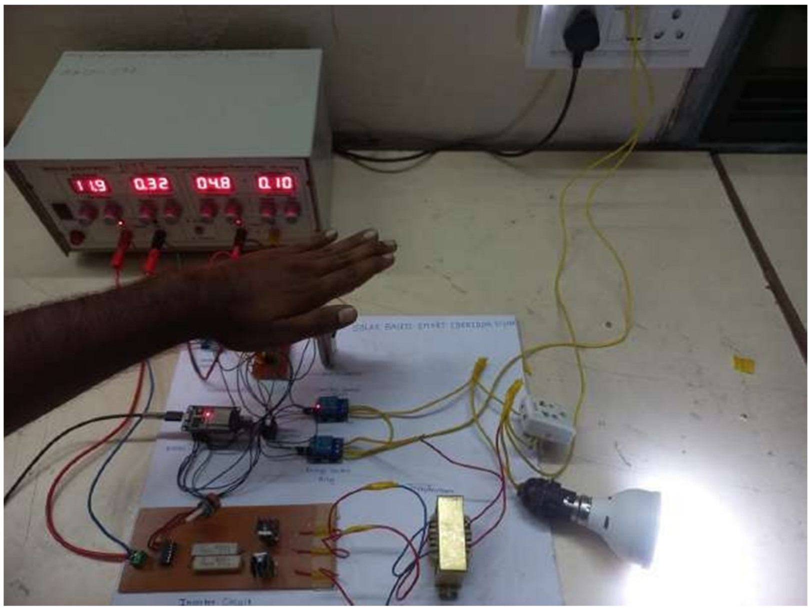

Fig. 8 Inverter ON, LED ON

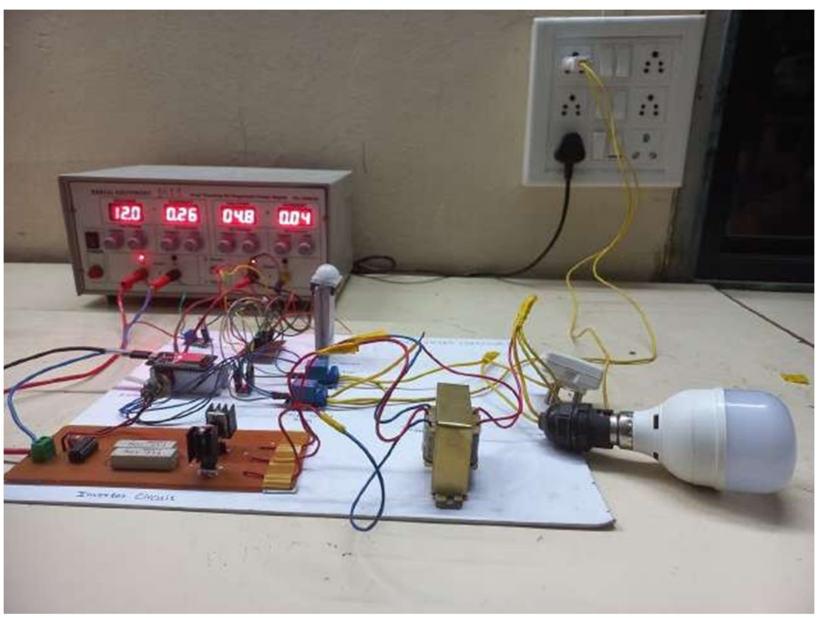

Fig. 9 Inverter ON, LED OFF

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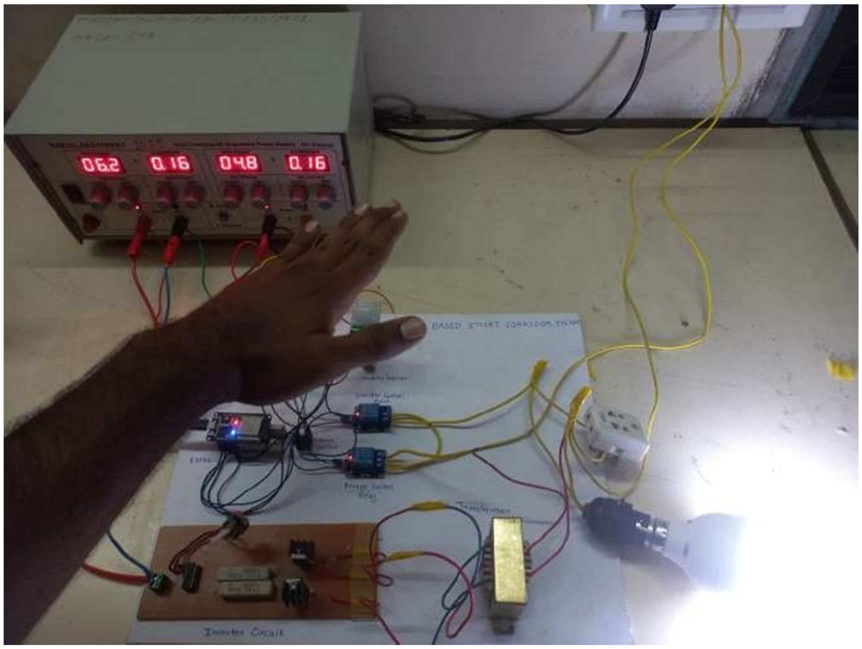

Fig. 10 MSEB ON, LED ON

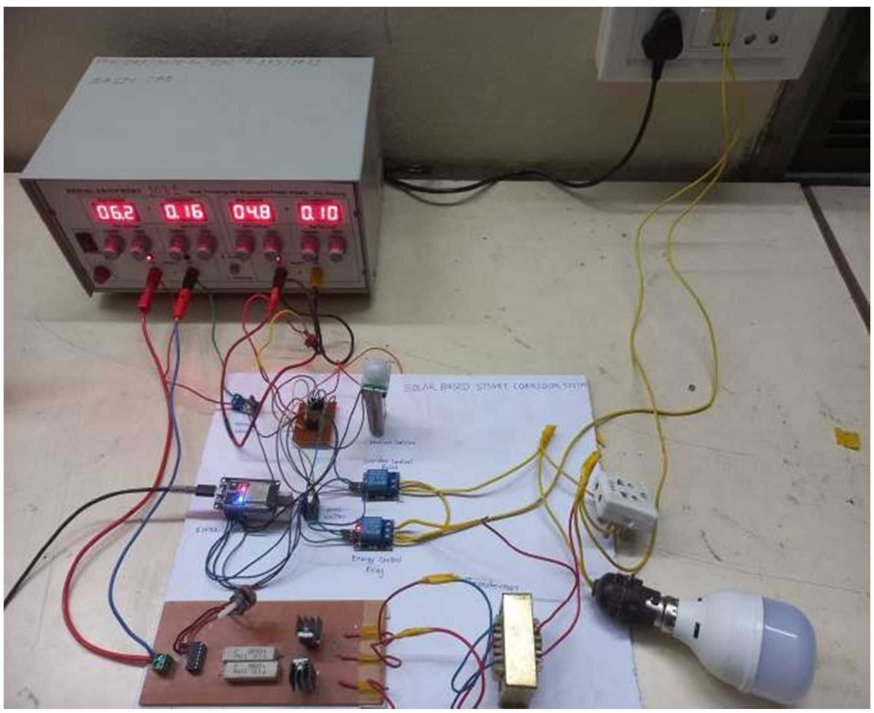

Fig. 11 MSEB ON, LED OFF

1) LED tubes powered by solar energy work on the sensors interfaced with the microcontroller. In protoFigure 11. MSEB ON, LED OFF type consisting one motion sensor and one LED, The motion was detected by the motion sensor and the LED was turned on when the motion was detected. This control is achieved by the program in ESP32.
2) Failure of solar energy or storage batteries is resolved by using the relay which will power the LED and mobile charging ports through the supply from the state electricity board in case our system cannot deliver the necessary amount of energy.
3) The mobile charging ports with adapter outputs are provided in the corridor and the system is designed in such a way that if the person is present in the corridor then only the charging ports will be activated.

V. CONCLUSIONS

This paper describes the Solar Based Smart Corridor System. In this we have used ESP32 as a controller to integrate with sub-systems. Bi-directional Level shifter is used to change voltage from 3.3v to 5v and vice versa. PIR sensor is used as a motion sensor which is used to detect presence of a person. The system works on hybrid mode which is either solar energy through solar panel or battery or traditional state electricity power supply. System provides a smart lighting system as well as charging ports for mobile. System is controllable remotely with the help of a *Blynk* app through the wi-fi module on the ESP32. It will minimize human intervention.

VI. ACKNOWLEDGMENT

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