A SELF-REGULATING STREET LIGHTNING TECHNIQUE USING IOT

[1]Y Srilatha, [2]N V S Sowjanya, [3]B Preethi Devi, [4]A Rasi Deepika
[1]Assistant Professor, [2] Assistant Professor, [3] Assistant Professor, [4] Research Scholar
[1,2,3,4]Department of Information Technology,
[1,2,3,4]Pragati Engineering College, Surampalem, India

Abstract: The main consideration in the present field technologies are Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as the source of the power (Thermal, Hydro etc.) are getting diminished due to various reasons. As we all know that energy consumption has increased a lot and sources of energy are limited so in order to meet the increasing demand of energy use of renewable sources of energy is a must. This paper aims to describe a method for modifying street light illumination by using sensors at minimum electrical energy consumption. When presence is detected, all surrounding street lights glow at their brightest mode, else they stay in the dim mode. LED bulbs are used as they are better than conventional incandescent bulbs in every way. This will reduce heat emissions, power consumption, maintenance and replacement costs and carbon dioxide emissions. Coupled with SSSLS (Solar Smart Street Light System), massive energy-savings are envisioned. Also, a demonstration with a real-time proto type model involving costs and implementation procedure has been developed using internet of things (IoT) to visualize the real time updates of street processing and notifying the changes occur.

Keywords: LED, Arduino, IoT, IR Sensor

1. INTRODUCTION

Nowadays, human has become too busy, and is unable to find time to switch the lights wherever not necessary. The present system is like the lights will be switched on in the evening before the sun sets and they are switched off the next day morning after there is enough light on the outside. With this, the power will be wasted up to some extent. But the actual timing for these lights to be switched on are when there is absolute darkness.

This paper gives the best solution for electrical power wastage. Also, the manual operation of the lighting system is eliminated. The energy consumption in entire world is increasing at the fastest rates due to population growth and economic development and the availability of energy sources remains woefully constrained. Resource augmentation and growth in energy supply has not kept pace with increasing demand and, therefore, continues to face serious energy shortages.

Streetlights are an integral part of any developing locality. They are present on all major road- ways and in the suburbs too. Every day, streetlights are powered from sunset to sunrise at full strength, even when there is no one around. On a global scale, millions of dollars are spent each day on these street lights to provide the required electrical energy. The maintenance and replacement costs of conventional incandescent bulbs are immense. They consume a lot of electric power to function and their heat emissions are also quite high. All of this contributes to greater demand of electricity production and consequently, more carbon dioxide emissions from powerhouses.

This paper aims at harvesting the energy from renewable energy sources like sun and to effectively use the harvested energy for the benefit of mainly the remote villages (villagers) facing the serious power problems. The main aim of this paper is to provide a IoT based Automatic Street Lightning System powered with solar energy during night time. We use the word smart because the system not only provide power to the street lights but also helps in detecting the direction of movement of the pedestrian and helps him by means of illuminating the path of movement till the near next street light. By integrating the entire street lights with Smart street light system it is possible to systematically help the pedestrian to reach the destination in the remote rural areas which are facing serious electric power supply problem. The same system can also be used in metropolitan cities as well. A simple and effective solution to this would be dimming the lights during off peak hours. Whenever presence is detected, the lights around it will glow at the normal (bright) mode. This would save a lot of energy and reduce cost of operation of the streetlights. We can check the status of street light on internet using IOT (Internet of things) from anywhere in real time and solve the issues if happen during the processing.

2. RESEARCH METHODOLOGY

2.1. Functional Description:

The present system employs power delivery via a single-phase line to the streetlight. The proposed system involves five more components to regulate the power delivery. An Infra-Red Proximity Sensor at the base of the street light detects presence in

a small area around the street light. The data from the sensor is sent to the Arduino which forms brain of the circuit. The Arduino then commands to switch between dim and bright modes depending upon the requirement and thus controls the brightness of the street light. A battery eliminator, also powered by the single-phase line, is used to supply 5V inputs to the sensors and Arduino.

The design basically includes three working modes:

- OFF mode: When there is enough natural light in the surrounding i.e. during the daytime, the entire system is switched off and the batteries are charging.
- Active mode: When the natural light drops below a certain level the system automatically turns on and the motion sensors are powered.
- ON mode: On the presence of pedestrians, the sensors turn on which in turn switcheson the LED lights. These lights turn off after a period.

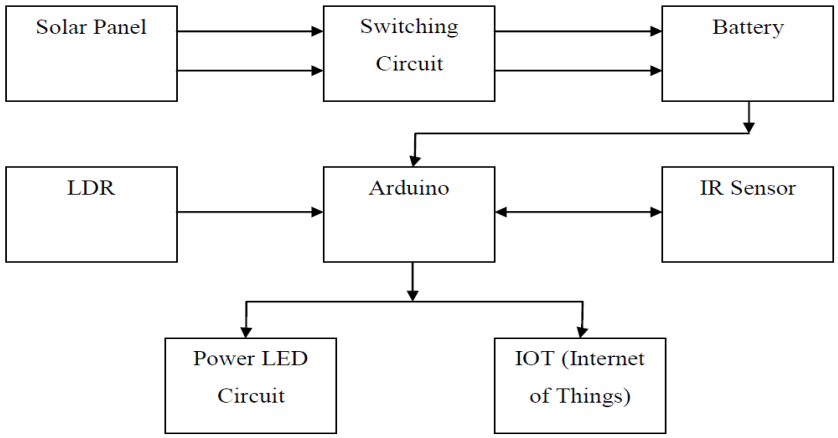

Figure 2.1: Block Diagram

This block diagram describes the working of "A Self-Regulating Street Lightning Technique using IoT":

- Solar panel of 10Watt is used here with will converts the incoming sunlight into electrical energy and used to charge the battery using switching circuit which converts the varying voltage into stable voltage.
- Now this charged battery is used as a supply source to rest of the system.
- Through battery we will provide supply to Arduino which is controlling the functioning of LDR and IR sensor as per the presence of vehicle.
- Then according to the changed occur in IR sensor and LDR the Arduino controls the power LED circuit.
- The serial monitor data of Arduino is now displayed on web browser using IoT.

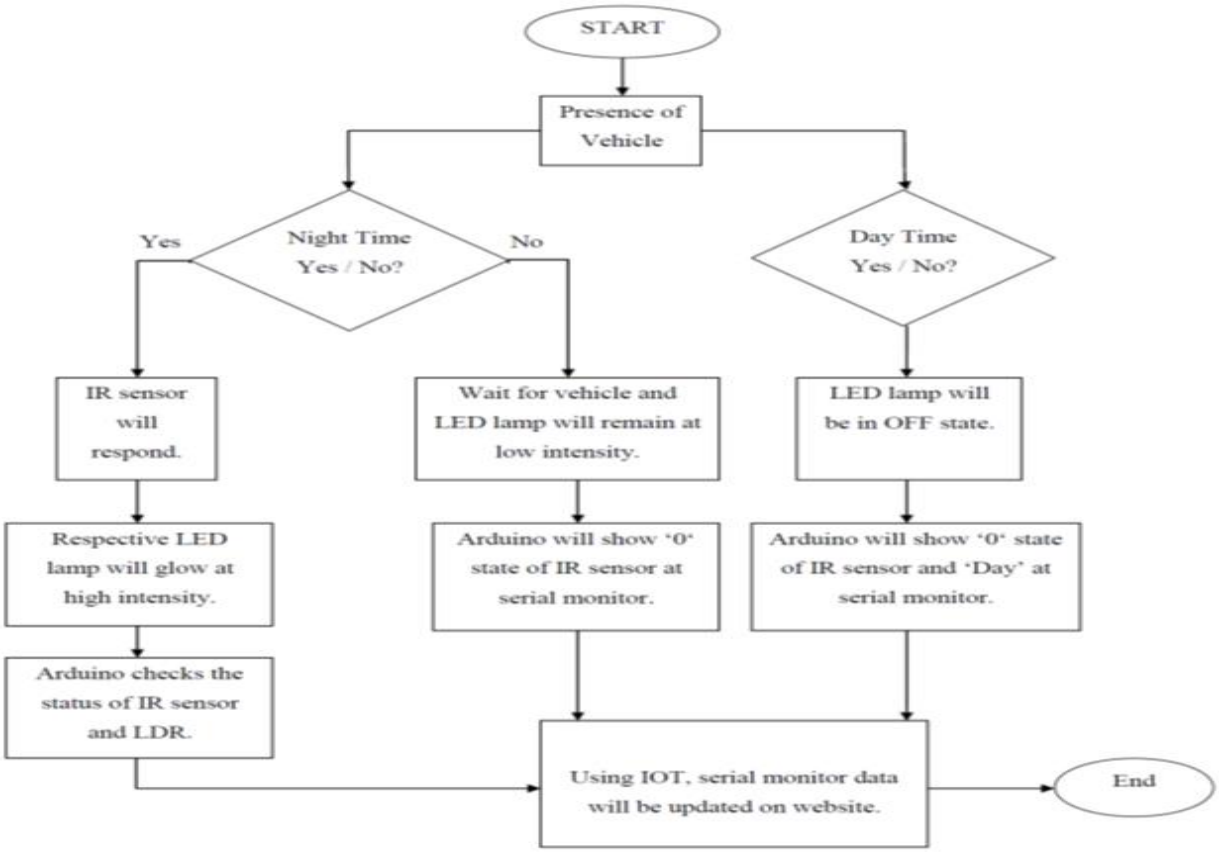

Figure 2.2: Flow Chart

3. HARDWARE DESCRIPTION:

3.1. Solar Panel

Solar panels are active solar devices that convert sunlight into electricity. They come in a variety of rectangular shapes and are usually installed in combination to produce electricity. A solar panel or module is a series of interconnected silicon cells joined together to form a circuit. In greater numbers the amount of power produced by these interconnected cells can be increased and used as an electricity production system. At the present time about 80% of all solar panels are made from crystalline silicon (i.e. monocrystalline, polycrystalline, amorphous silicon or hybrids) solar cells. Typically, the solar cells are laid out in a grid pattern – with perhaps as many as 72 different solar cells. The solar panels after being hermetically sealed to protect them, are covered in a non-reflective glass to protect the solar cells from environmental damage and placed into a rigid frame.

Figure 3.1: Solar Panel

3.2. IR Sensors

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. It is also capable of measuring heat of an object and detecting motion. Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation is the region having wavelengths longer than visible light wavelengths, but shorter than microwaves. The infrared region is approximately demarcated from 0.75

to 1000µm. Infrared technology is found in many of our everyday products. For example, a television has an IR detector for interpreting the signal from the remote control. Key benefits of infrared sensors include low power requirements, simple circuitry and their portable feature.

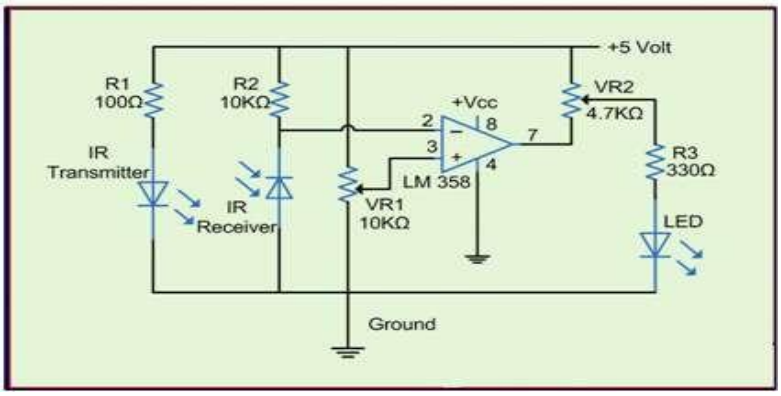

Figure 3.2: IR Sensor

3.3 Arduino

Arduino is a single-board microcontroller, intended to make the application of interactive objects or environments more accessible. The hardware consists of an open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. Current models feature a USB interface, 6 analog input pins, as well as 14 digital I/O pins which allows the user to attach various extension boards. The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The Diecimila, Duemilanove, and current Uno provide 14 digital I/O pins, six of which can produce pulse width modulated signals, and six analog inputs.

Figure 3.3: Arduino

3.4 Light Dependent Resistor (LDR)

An 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. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy is incident on the device more & more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased.

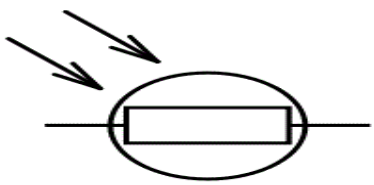

Figure 3.4: Symbol of LDR and LDR

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity (hence resistivity) reduces when light is absorbed by the material. LDR's are light dependent devices whose resistance decreases when light falls on them and increases in the dark. When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as dark resistance. It can be as high as 1012 Ω. And if the device is allowed to absorb light its resistance will decrease drastically. If a constant voltage is applied to it and intensity of light is increased the current starts increasing.

LDR's have low cost and simple structure. They are often used as light sensors. LDR's have low cost and simple structure. They are often used as light sensors. They are used when there is a need to detect absences or presences of light like in a camera light meter. Used in street lamps, alarm clock, burglar alarm circuits, light intensity meters, for counting the packages moving on a conveyor belt, etc.

3.5 Power Light Emitting Diode (LED)

A high-power LED light source is a single LED power higher than 0.5W. At present, many manufacturers use low power LED, but it need use a lot of LED, and lower power LED with higher light decay. So its trend to use high power LED source in commercial lighting.

High power LED is a light emitting diode with high rated current. Low LED power is generally 0.1W, operating current is 20mA, but high-power LED can reach 1W, 2W, or even tens of watts, operating current can be range from tens of mA to several hundred mA. Due to the constraints of flux conversion efficiency and cost, it decides high-power mainly used in some special lighting areas in short-term and long-term goal is the general lighting.

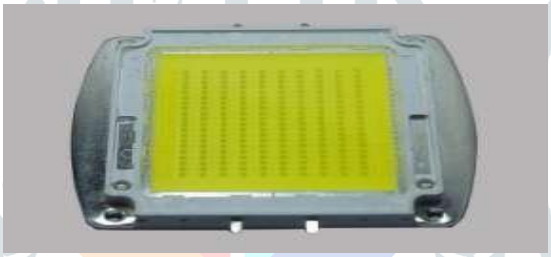

Figure 3.5: Power LED

3.6 Resistors

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor. All other factors being equal, in a direct-current (DC) circuit, the current through a resistor is inversely proportional to its resistance, and directly proportional to the voltage across it. This is the well-known Ohm's Law.

In alternating-current (AC) circuits, this rule also applies if the resistor does not contain inductance or capacitance. Resistors can be fabricated in a variety of ways. The most common type in electronic devices and systems is the carbon-composition resistor.

Fine granulated carbon (graphite) is mixed with clay and hardened. The resistance depends on the proportion of carbon to clay; the higher this ratio, the lower the resistance.Another type of resistor is made from winding Nichrome or similar wire on an insulating form. This component, called a wire wound resistor, can handle higher currents than a carbon- composition resistor of the same physical size.

However, because the wire is wound into a coil, the component acts as an inductor as well as exhibiting resistance. This does not affect performance in DC circuits but can have an adverse effect in AC circuits because inductance renders the device sensitive to changes in frequency.

Figure 3.6: Resistor

3.7 Capacitors

Capacitor is a passive component used to store charge. The charge (q) stored in a capacitor is the product of its capacitance (C) value and the voltage (V) applied to it. Capacitors offer infinite reactance to zero frequency, so they are used for blocking DC components or bypassing the AC signals. The capacitor undergoes through a recursive cycle of charging and discharging in AC circuits where the voltage and current across it depends on the RC time constant. For this reason, capacitors are used for smoothing power supply variations. Other uses include, coupling the various stages of audio system, tuning in radio circuits etc. These are used to store energy like in a camera flash.

Capacitors may be non-polarized/polarized and fixed/variable. Electrolytic capacitors are polarized while ceramic and paper capacitors are examples of non-polarized capacitors. Since capacitors store charge, they must be carefully discharged before troubleshooting the circuits. The maximum voltage rating of the capacitors used must always be greater than the supply voltage.

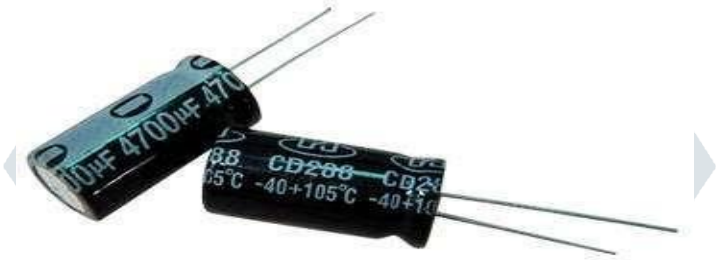

Figure 3.7: Capacitor

3.8 Solar Battery Charging Circuit

Solar concept is not new for us. We all know the importance of solar energy. Solar gadgets are increasing day by day. As non-renewable energy sources are decreasing, usage of solar energy is increased. This solar energy is not only used on the Earth but also used in space stations where no electrical power is available.

Here is the simple circuit to charge rechargeable Lead-acid battery from the solar panel. This solar charger has current and voltage regulation and has over voltage cutoff facilities. This circuit may also be used to charge any battery at constant voltage because output voltage is adjustable.

Solar Battery Charger Circuit Principle: Here the solar panel produces 12V DC. The charging current passes to LM317 voltage regulator through the diode D1. The output voltage and current are regulated by adjusting the adjust pin of LM317 voltage regulator.

Solar Battery Charger Circuit Design: The circuit uses a 12V solar panel and an adjustable voltage regulator LM317. Solar panel consists of 1.2V rated solar cells. Pot RV1 is used to set the output voltage to the battery. Diode D2 prevents the discharge of battery.

Power Dissipation: In this, power is limited because of the thermal resistance of LM317 voltage regulator and the heat sink. To keep the temperature below 125 degree Celsius, the power must be limited to 10W. LM317 voltage regulator internally has temperature limiting circuit so that if it gets too hot, it shuts down automatically.

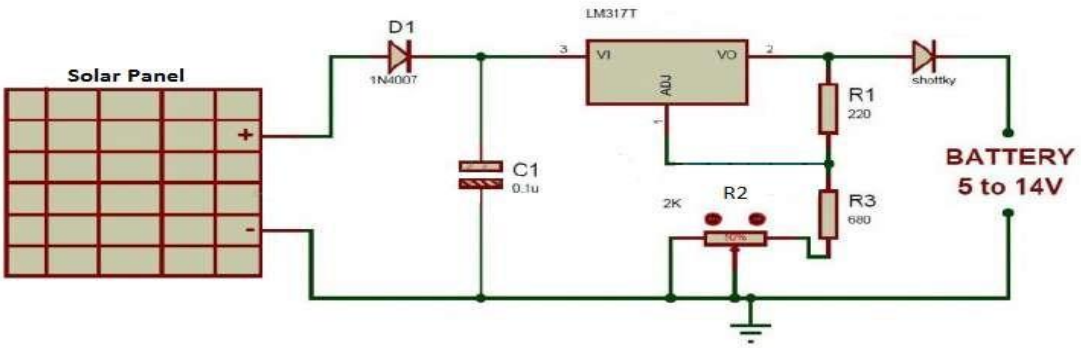

Figure 3.8: Battery Charging Circuit through Solar Panel

3.9 Input Module Working

In this input module of the project, we used 4 IR sensors which are interfaced with Arduino and work individually with respective to each other. In this we are connecting the output pins of IR sensor to pins 2,4,7,8 of Arduino to give status of IR sensor. IR sensor senses the presence of a vehicle or a pedestrian on the road and increases the intensity of LED street lamps on the road through output module. All IR sensor works on 5V and Arduino is working on less than 5V supply (Battery or Laptop USB driver).

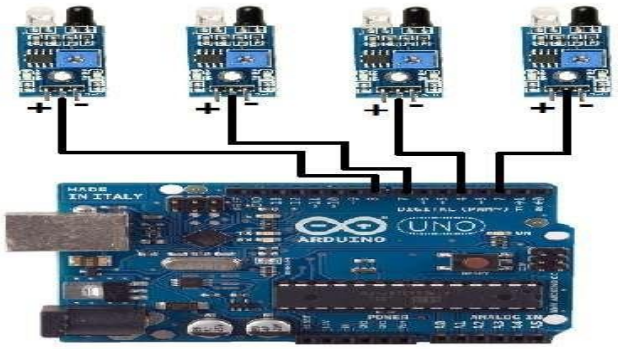

Figure 3.9: Input Module Diagram

3.10 Output Module Working

In this output module of project, the digital output pins 6,9,10,11 of arduino are taken as a input to ULN2003a driver which works as a switching circuit. This ULN2003a output is connected to LED street lamps and increases the light intensity when required. LDR is connected to analog pin A0 of arduino and helps in switching between day,evening and night time modes. In this, ULN2003a is working on 9V supply with is used to give to LED lamps.

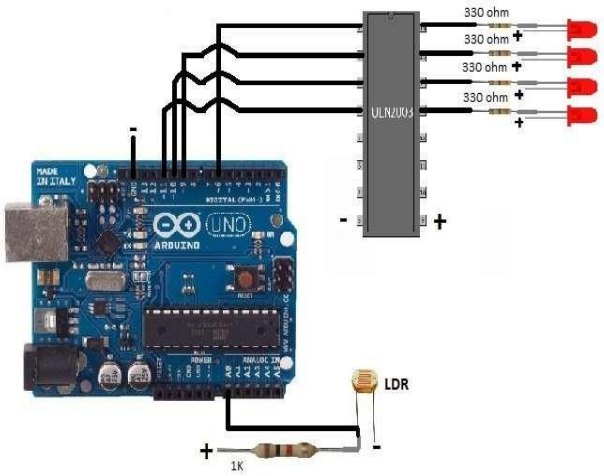

Figure 3.10: Output Module Diagram

4. Internet of Things (IoT)

The Internet of Things is an emerging topic of technical, social, and economic significance. Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025.

5. Area of applications

It can be used in some clocks, alarms, and other electronic devices that are dependent on sunlight.

We can used it outside of house, corridors or industry area, which helps to save power.

- It can be used as a street light.
- In sea off-shore side we can use it as a dangerous sign.
- Photo resistors have many uses, most of which involve detecting the presence of light.
- Street lights use photo resistors to detect whether it is day or night and turn the light on or off accordingly.

- Photo resistors are also used in digital cameras to detect how much light camera sees and adjust the picture quality accordingly.
- Smoke detection.
- Automatic lighting control.
- Burglar alarm systems.
- Camera (electronic shutter).
- Strobe (color temperature reading).

6. Advantages

- Solar street light is independent of grid as a result of this operating cost is much low.
- Maintenance cost is much low compared to conventional street light.
- Intensity of LED can be controlled effectively without changes in its light color.
- Risk of accidents is very low.
- It is environmentally friendly, no harmful emissions.
- Longer life compared to conventional street lights.
- Power consumption is much lower.
- LDRs are sensitive, inexpensive and readily available devices. They have good power and voltage handling capabilities, similar to those of a conventional resistor.

7. Disadvantages

- Initial investment is very high.
- Rechargeable batteries have to be replaced from time to time.
- Non-availability of sunlight during rainy and winter seasons is a problem.
- Dust accumulation on the surface of panel creates a problem.
- It is sensitive to ambient light and require careful shielding.
- Can be more complicated to align detector pairs.
- Photo resistors are only sensitive to light and no other force can power it without risking damage.
- Also, they are unable to detect low light levels and may take a few seconds to deliver a charge while their electrons build up momentum.

8. References

[1] http://www.ehow.com/how-does_5561845_do-ir-sensors-work.html#ixzz310syLD6I
[2] http://homepages.which.net/~paul.hills/Emc/BecBody.html
[3] http://en.wikipedia.org/wiki/Arduino
[4] http://www.galco.com/comp/prod/sensor.htm
[5] http://www.passmyexams.co.uk/GCSE/physics/LM324.html
[6] https://en.wikipedia.org/wiki/Internet_of_Things
[7] http://www.internetsociety.org/doc/IoT-overview
[8] https://www.firebase.com
[9] https://en.wikipedia.org/wiki/Firebase
[10] http://www.main.org/polycosmos/glxywest/vimanas.htm-Indian Flying Machines
[11] http://www.electronicsforyou.com
[12] http://www.triplepundit.com/2011/08/solar-farming-potential-india/-SolarFarming
[13] http://en.wikipedia.org/wiki/Solar_cell
[14] http://www.planetarypower.com.au/solar_panels.htm
[15] http://www.icreateproject.info/uncategorized/arduino-display-data-over-local-network/
[16] http://www.electronicshub.org/solar-battery-charger-circuit/
[17]http://www.instructables.com/id/How-to-communicate-with-Arduino-using-HTML Chrome/step5/The-end/.
[18] https://github.com/whichlight/Arduino-Serial-to-Browser
[19] https://en.wikipedia.org/wiki/Solar_panel
[20] http://www.engineersgarage.com/electronic-components/capacitors
[21] http://www.engineersgarage.com/electronic-components/resistors
[22] https://www.arduino.cc/
[23] https://en.wikipedia.org/wiki/Arduino
[24] https://en.wikipedia.org/wiki/Operational_amplifier
[25] http://www.ti.com/lit/ds/symlink/lm741.pdf
[26] https://en.wikipedia.org/wiki/ULN2003A
[27] http://www.efxkits.com/arduino-based-auto-intensity-control-of-street-lights