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Solar Street Lights Control Using PIR Sensors

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***Abstract:** This project is based on the idea of maintaining maximum utilization and minimum loss of available energy. The plenty of solar energy available during the day time is stored in a solar cell and the stored energy is used to glow the street lights during the whole night. Also, the system provides a power saving mode of operation by adapting the method of automation. A dark sensor and a light sensor provide the automatic "ON"/" OFF" facility to the street lights, so that it will glow automatically when it is required (i.e., when the surrounding will be dark) and it will be turned "OFF" automatically if sufficient light is available in the surrounding. Again, the auto intensity control mechanism has been applied by the help of a microcontroller to control the light intensity of the luminaries as per the requirement. Hence the loss of energy due to unnecessary glow of the street lights can be avoided.*

I. INTRODUCTION

Concerns over global climate change, local air pollution & resource scarcity make the alternative and renewable sources of energy attractive worldwide. The sources of energy that are inexhaustible as they are replaced by nature and can be replenished in short time period are known as renewable energy resources. Sunlight, wind, biomass, water, geothermal, and so on, which can be harnessed continuously, are termed as renewable energy sources. The earth is blessed with enormous amount of solar energy that it receives every morning with the rise of the sun.The Sun is an in-exhaustive, reliable & non-polluting source of power. Solar energy experienced by us as heat and light, can be used through two routes:

1) First, the thermal route uses the heat for water heating, cooking, drying, water purification, power generation, and other applications.
2) Second, the photovoltaic route converts the solar energyinto electricity, which can then be used for a number of purposes such as lighting, pumping, communication,and power supply in un-electrified areas.

Solar energy is obtained through the use of Solar cells.The Solar cells convert sunlight into electrical energy, based on the principle of photovoltaic effect. The electricity so obtained can directly be used to charge the batteries used forvarious appliances. Solar energy has a wide range of applications in Indian Railways especially at remote or hilly places where grid supply is not available round the clock or not available at all. The solar energy can be well utilized for lighting purpose. Solar powered outdoor lighting system is ideal for lighting the area in remote locations where the electricity is unavailable or erratic. It can also be used to illuminate the surroundings of the buildings for security & safety.

II. METHODS & MATERIALS

A. *Existing System*

The first, without any doubt, is the high consumption. Each year, in the world, several trillion kWh are expended on street lighting. A high consumption means a high amount of generated energy, which in turn translates into a high level of noxious emissions. Secondly, there are difficulties related to the maintenance of the system. How does the lighting network operator find out that a certain lamp or a component of a street-light came out of action and needs to be repaired or replaced. Third, but no less important, is the problem related to the billing of the street lighting energy consumption. Another name for street lighting is "unmetered load" – the bills the municipalities have to pay are imprecise and are based on calculations (parameterized consumption vs working hours).

B. *Proposed System*

Solar street lights are raised light sources which are powered by solar panels generally mounted on the lighting structure or integrated into the pole itself. The solar panels charge a rechargeable battery, which powers a fluorescent or LED lamp during the night. Most solar lights turn on and turn off automatically by sensing outdoor light using solar panel voltage. Solar streetlights are designed to work throughout the night.

Many can stay lit for more than one night if the sun is not in the sky for an extended period of time. Older models included lamps that were not fluorescent or LED. Solar lights installed in windy regions are generally equipped with flat panels to better cope with the winds. Modern designs use wireless technology and fuzzy control theory for battery management. The street lights using this technology can operate as a network with each light having the capability of performing the turning on and off of the network.

C. Hardware

Components used are as follows:

1) Solar Panel

The solar panel is one of the most important parts of a solar street light, as the solar panel can convert solar energy into electricity that the lamps can use. There are two types of solar panels commonly used in solar street lights: monocrystalline and polycrystalline. The conversion rate of mono-crystalline solar panels is much higher than their poly-crystalline counterparts. Solar panels also vary in wattage systems.

Fig: Solar Panel

2) Lighting Fixture

LEDs are usually used as the primary lighting source of modern solar street lights, as the LED will provide much higher luminosity with lower energy consumption. The energy consumption of an LED fixture is at least 50% lower than the HPS fixture counterpart which is widely used as the lighting source in traditional street lights. A lack of warm-up time in LEDs also allows for use of motion detectors for additional efficiency gains.

Fig: Light fixture

3) Rechargeable Battery

Batteries will store the electricity generated by the solar panel during the day and provide energy to the fixture during the night. The life cycle of the battery is very important to the lifetime of the light and the capacity of the battery will affect the backup days of the lights. There are two types of batteries commonly used in solar-powered street lights- gel cell deep cycle batteries as well as lead acid batteries. Lithium-ion batteries are also popular due to their compact size. The storage battery bank has enough capacity to keep the system going on without break down when the weather is not favorable for generation of electricity due to cloudy days and rains.

Fig: Rechargeable Batteries.

4) Pole

Strong poles are necessary to all street lights, especially to solar street lights as there are often components mounted on the top of the pole: fixtures, panels and sometimes batteries. However, in some newer designs, the PV panels and all electronics are integrated in the pole itself. Wind resistance is also a factor.


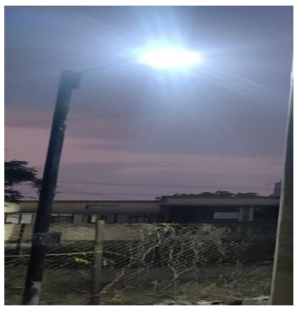

Fig: Poles.

III. BLOCK DIAGRAM & INSTALLATION

A. Block Diagram

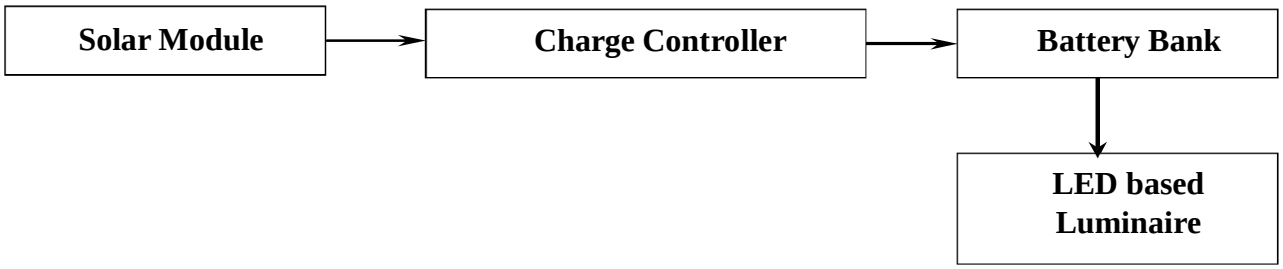

Fig: Block Diagram of solar street light.

B. Solar Module

An assembly of suitable inter-connected crystalline silicon solar cells. The solar cells are provided with surface anti- reflective coating to help to absorb more light in all weather conditions. Toughened, high transmissivity glass in front side of the module for improved visibility & protection against environmental hazards, such as, rain, hail & storm and weather proof TEDLAR/POLYSTER back sheet. The transparency of toughened glass used is > 91%, when measured in actual sunlight by placingthe glass plate perpendicular to the sun's rays through an air mass of 1.5.

C. Charge Controller

Charge controller has automatic dusk-dawn circuit for switching on/off the street light without manual intervention. It is capable of handling 120% of the module's rated current for one hour duration. When battery discharges more at the end of autonomy days, in such a situation charge controller automatically boost charge the battery. On availability of sun shine (after autonomy days), the night load energy is delivered by the battery through the solar charge controller.

D. Battery Bank

The Sun is not always available and it is not regular. However, lights are to be fed daily. Therefore power should be stored in a battery bank. The storage battery bank have enough capacity to keep the system going on without break down when the weather is not favorable for generation of electricity due to cloudy days and rains. LMLA or VRLA battery which are specially designed to be charged & discharged frequently and can handle heavy discharges time after time with minimum charging efficiency of 90%.

E. Installtion

While mounting the solar modules, following points should be considered for getting maximum output from the solar modules:

1) Modules should be oriented south facing to receive maximum sunlight.

2) The Modules produce more power at low temperature and full sun.

The Solar panels are generally installed in such a way that they can receive maximum direct sunlight without shade from any building/trees nearby falling on them at any part of the day. As we know that the Sun rises in the East and sets in the West as a result of Earth's rotation around its own axis. Also, the Earth revolves around the Sun. Due to these two movements there is variation in the angle at which the Sun's rays fall on Earth's surface over a year. At any particular place on Earth this variation in angle in one year may be up to45 degrees. Considering these facts, the following guidelines are to be kept in mind while installing solar panels.

a) Solar panels should be installed South facing in the Northern hemisphere and north facing in the Southern hemisphere. Since India is in the Northern hemisphere, Solar panels will be installed always- South facing in ourcountry.

b) The rule of thumb for fixed (never adjusted) is to set thempointing south at an angle = latitude. If it is to be adjusted twice in a year, winter is latitude + 15 deg and summer is latitude - 15 deg.

c) For the angle for "now", point them so that a stick perpendicular to the panel casts no shadow at solar noon (when the sun is at it's peak -- close to noon standard time).

d) Any obstruction (such as tree or building) should be avoided in East, West or South of the place of installation. The following is the criteria:

e) East or West: The distance between solar panel and obstruction should be more than double the height of obstruction.

f) South: The distance should be more than half the height of obstruction.

The support for the Solar panel needs to be a robust one and should not be accessible to general public. It should be so installed that rainwater, bird dropping, leaves etc. do not accumulate and the top surface can be cleaned easily.

Latitude, usually denoted by the Greek letter phi (φ) gives the location of a place on Earth (or other planetary body) north or south of the equator. Lines of Latitude are the imaginary horizontal lines shown running east-to-west (or west to east) on maps (particularly so in the Mercator projection) that run either north or south of the equator.

Technically, latitude is an angular measurement in degrees (marked with °) ranging from 0° at the equator (low latitude) to 90° at the poles (90° N or +90° for the North Pole and 90° Sor −90° for the South Pole). The latitude is approximately the angle between straight up at the surface (the zenith) and the sun at an equinox.

IV. RESULT

Fig: Solar Street Light.

V. ADVANTAGES

1) Fuel source for solar panel is direct and endless so noexternal fuels required.
2) Sunlight - free of cost.
3) Long life of solar modules, fast response and highreliability.
4) Can operate under high temperature and in open.
5) Inherently short circuit protected and safe under any loadcondition.
6) Pollution free.
7) Minimum maintenance.
8) Independent working.
9) Noise-free as there are no moving parts.
10) No AC to DC conversion losses as DC is produceddirectly.
11) No transmission losses as installed in the vicinity of theload.
12) Suitable for remote, isolated and hilly places.
13) Suitable for moving loads/objects.
14) Since it is in modular form, provision of future expansionof capacity is available.
15) It can be used almost everywhere from small electronicdevice to large scale MW power generation station.
16) It can be installed and mounted easily with minimum cost.

VI. DISADVANTAGES

1) Initial cost is high.
2) Dependent on sunlight.
3) Additional cost for storage battery.
4) Climatic condition, location, latitude, longitude, altitude, tilt angle, ageing, dent, bird dropping, etc. affect the output.
5) It has no self-storage capacity.
6) Manufacturing is very complicated process.
7) To install solar panel large area is required.

VII. APPLICATION

1) Airport lighting.
2) Highway and roadway lighting.
3) Park and playground lighting.
4) Industrial and commercial lighting.
5) Outdoor security lighting.

VIII. CONCLUSION

This paper of SOLAR STREET LIGHTING SYSTEM is cost efficient, practical and eco-friendly and very safe way to save energy. It very efficiently tackles with two main problems of today: saving of energy and disposal of incandescent lamps. Energy consumed by the highways now-a-days can also be saved that is the electrical energy by replacing it with solar energy. So far from the discussion, the effectiveness of the proposed street light model can be considered as a best proposal from energy saving point of view. It is not only the way to save energy but also an idea to make a proper utilization of available solar energy which is radiating every day without being used. Though the initial investment is very high, still it can be considered as to be economic if we will think about a long-term period, because we are using here the solar energy, which is available free of cost. Hence after the installation no more payment is to be given regarding electricity. Also, the automatic solar street light system is completely Noiseless, Smoke-free and free from fire hazards. Hence it will not only save the electricity bill but also will illuminate the path in an eco-friendly way.

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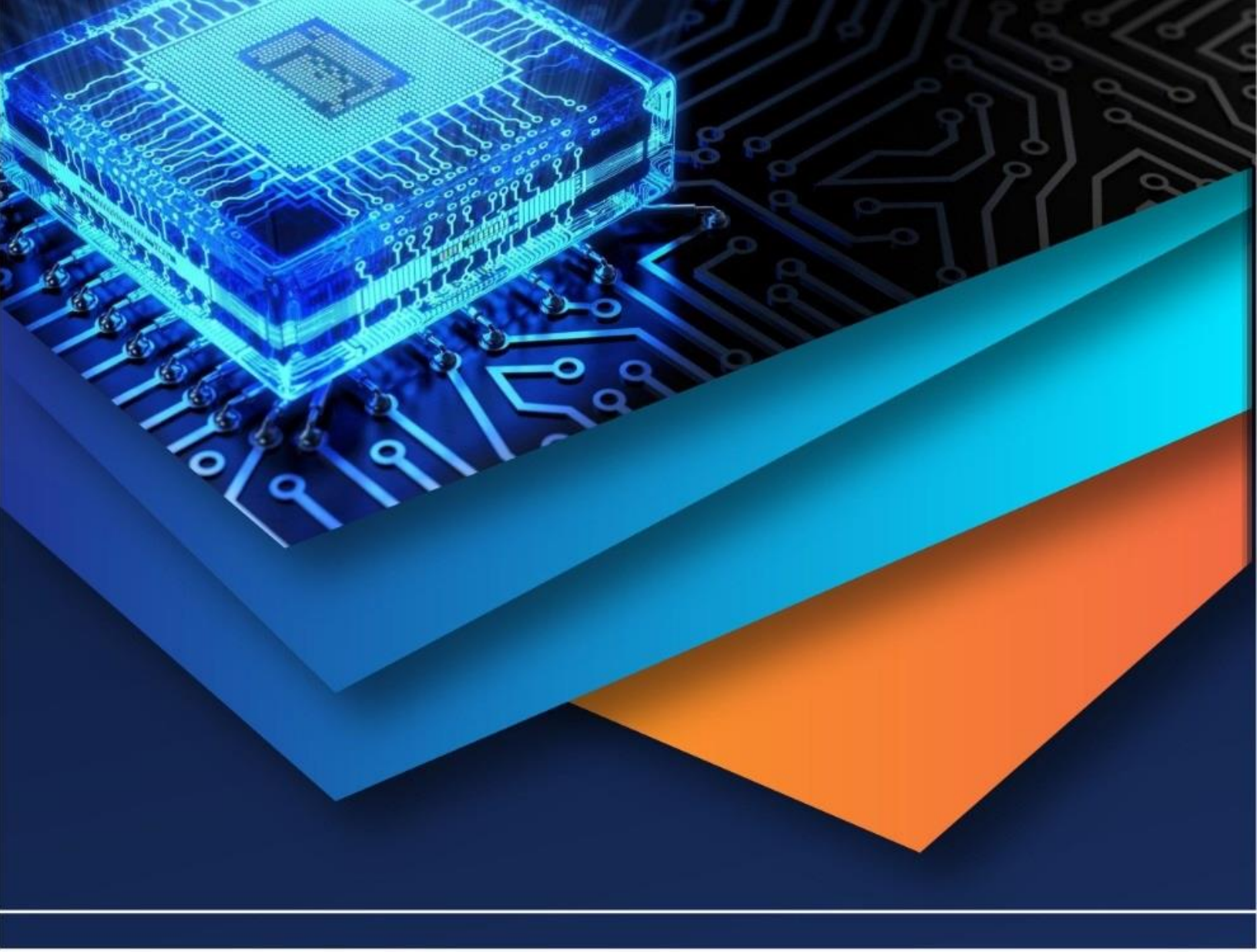

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