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Ingenious Automated Street Lamp Network using PLC

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***Abstract*: As we all know that energy consumption has increased a lot and sources of energy are limited, it has become mandatory to conserve power. Energy crisis is one of the critical issues. The street lighting is one of the largest energy expenses for the city, accounting for upwards of 35-45% of a municipality's utility budget. An intelligent lighting control system can reduce municipal street lighting costs as much as 70%. The main aim of the proposed system is the intelligent gleam control of street lights using PIR sensor to optimize the problem of power consumption. Street lights are being replaced by LED's and controlled by Programmable Logic controller (Siemens S7-200 PLC). The main difference from other controllers is that PLC's are toughened for severe conditions and have the feature for extensive input/output (I/O) arrangements. This system can save a large amount of electricity compared to the existing one.**

***Keywords*: FBD, LED, PIR sensor, Siemens S7-200 PLC, Power consumption**

1. Introduction

The street lighting might prevent vehicle accidents and injuries. However unwanted usage of street lights leads to large power consumption. It's a well-known fact that our country suffers from lack of energy for electricity. The main purpose of the street lights is to provide the lights during the nights in roads, highways streets etc. But due to the continuous functioning of the street lights there is a huge loss of electricity. If a street light consumes 1000 W (approximately) of electricity in an hour and it runs for 2 hours extra every day, the 1000 X 2 = 2000 Wh = 2 KWh. For a road of 2 km length (at 2 lights fixed with a single post at 10m centre to centre distance), 400 lights are in place. 2 KWh X 400 = 800 KWh is wasted in all areas every day, so we can imagine the wastage of fossil fuel, water, man, time etc. to produce the electricity which is not benefiting anybody, that's why an initiative has to be taken to save the power wastage due to street lights .Well without the street lights it is difficult for the vehicles to run at night in highway and roads so we can't stop their functioning. The ingenious Street Lights are the one that detects the vehicle from a certain radius and glows till the vehicle crosses a particular radius. By this way we can conserve high amount of electrical energy which are wasted by normal street lights. The proposed system uses LEDs instead of incandescent lamps. The system is multipurpose, extendable and totally variable to user needs. Around 30% of the revenue of a nation is required in the lighting of streets and avenues. The maintenance cost is too high and if the light is wasted like they are generally glowing in the night when there is no vehicle nearby or even in the morning when there is no need of light, it will eventually affect the economy of our country. On an average the street lights are working for more than 13 hours a day which is more than the actual required amount of time. So by using smart lights we can not only save electricity and reduce the working time of the lights but we can improve our economy.

2. Proposed system

The aim of ingenious street lights is to save energy and to save cost. Each smart street light can be installed one by one to the network of smart street light systems by setting the parameters. The system is autonomous-distributed controlled. The proposed system mainly operates based on three modes:

Ample mode:
Criteria: Sunlight intensity > 250 lux
Action: OFF state
Timing: 6am – 6pm
Night mode:
Criteria: Sunlight intensity < 250 lux
Action: ON status
Timing: 6pm -10pm
Late night mode:

Our system mainly focuses on late night mode where necessity of street light is less. The system is designed in such a way that the lamp glows only when a pedestrian or a vehicle movement is sensed by the sensor. The entry and exit light of the ingenious network is always in ON state for safety purpose. Based on the information received from sensor consecutive three lights glow and the process repeats as the movement is detected based on the commands from the logic controller.

3. Block diagram

The circuit consists of PIR sensor for which a power supply of 5v is given. The sensor detects vehicle and pedestrian movement. It is covered with Fresnel lenses that create a wide angle of detection. The operating voltage range is 3.6v-5v. Sensitivity range is 5 to 12m.Once the sensor detects a

pedestrian and vehicle movement, it gives an output of 3.3v which is triggered using a relay. The relay output is given to the PLC which operates on 24v dc. The required logical conditions are programmed in the controller. In our system we use Function Block Diagram. Based on the logical conditions it switches to the appropriate mode (auto/manual). The lamp status is decided depending on the mode. Our design mainly revolves around the late night mode during which the lamp glows depending on the sensor signals.

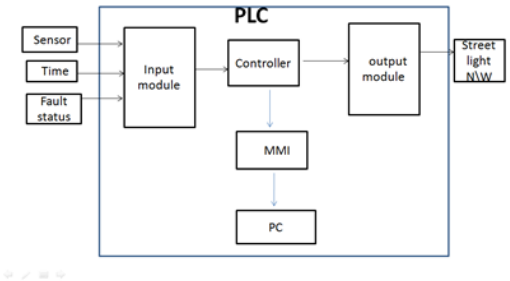

Fig. 1. Block diagram

4. Programmable Logic Controller

Programmable Logic Controller is usually located in the field close to the processing unit. PLCs are small and operator interface may be simple as button switch. In second generation PLC suppliers have added analog to digital conversion capability and provided sufficient logic to configure simple control loops. SIMATIC S7-200 stands for a reliable, fast and flexible controller in the micro automation area with a broad scale of modules. Programming was based on the easy to learn engineering software STEP 7 Micro/WIN.

There are five basic components in a PLC system:

- The PLC processor, or controller
- I/O (Input /Output) modules
- Chassis or backplane
- Power supply
- Programming software

Fig. 2. PLC

PLC is easily expandable and do support different communication protocols, e.g. TCP/IP, Modbus, profibus etc. over serial RS232, USB, Ethernet. PLC I/O cards contain relays which can save main controller from over current and come for different voltage levels: 24VDC, 120VAC, 240AC etc.

Programming Software:

Step 7 Micro WIN Smart

5. Functional block diagram

Functional block is a means of writing programs which can then be converted into machine code by some software for use by the PLC. The term function block diagram (FBD) is used for PLC programs described in terms of graphical blocks. It is described as being a graphical language for depicting signal and data flows through blocks, these being reusable software elements. A function block is a program instruction unit which, when executed, yields one or more output values.

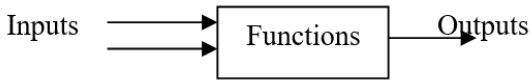

Fig. 3. Functional block diagram

A function block is depicted as a rectangular block with inputs entering from the left and outputs emerging from the right. Names of function block inputs are shown within the block at the appropriate input and output points. Cross diagram connectors are used to indicate where graphical lines would be difficult to draw without cluttering up or complicating a diagram and show where an output at one point is used as an input at another. Function blocks can have standard functions, such as those of the logic gates or counters or times, or have functions defined by the user.

Advantages of proposed system

- PLC is used to control the operation automatically.
- PLC can communicate in different protocols.
- Failure possibilities of PLC are less.
- Usage of sensor and LED maximizes the system efficiency
- 60% of power is conserved when compared with the conventional method.

A. LED vs. Incandescent bulb

Table 1
LED vs. Incandescent bulb

Lumens	Incandescent light bulb (watts)	Fluorescent / LED (watts)
375 lm	25 W	6.23 W
600 lm	40 W	10 W
900 lm	60 W	15 W
1125 lm	75 W	18.75 W
1500 lm	100 W	25 W
2250 lm	150 W	37.5 W
3000 lm	200 W	50 W

6. Conclusion

In the existing system manual operation is required for switching on and off purpose. The pressure sensors used are not economical. Switching losses are more. LDR sensors have the ability to sense only the vehicles with headlight. The above said

drawbacks in the existing system are rectified in the proposed system. Thus the energy consumption is low, resulting in conservation of energy. This also raises the Indian economy.

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