Intelligent Street Light System
Automated Street Lights Based on Vehicle Detection

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Abstract—Sensors have become a day-to-day feature in our lives. Nowadays most mobile phones are equipped with fingerprint sensors, motion sensors & the newly arrived iris scanners. These sensors are provided as a form of biometrics to the device. But sensors can have a lot of other applications. One such application is to control various electronic gadgets according to the need of the user. Controlling street lights on detection of a vehicle where the traffic density is low is a great example of it. Sensor based system to detect a vehicle & turning on the respective street lights can help save a lot of city's electricity budget. The main aspect of this project is to perform timely functionalities as soon as the sensor detects the vehicle. So, on detection of a vehicle the system triggers the next few street lights to turn on in an orderly sequence. As soon as the vehicle passes by, the street lights are turned off after a certain amount of time & a lot of energy is saved.

Keywords*-IR Sensors, Microcontroller, LEDs.*

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I. INTRODUCTION

For the past years, environmental issues have gained a lot of attention. Various government organizations are working to create technologies which can be environment friendly or finding newer different ways for reducing the damage done to the environment. Energy-efficiency is the motto for every new brand that is launched in the market.

Amongst various problems, arises the problem of electricity consumption. We might have noticed that sometimes in vacant college campuses or on rural highways, a large number of street lights are kept on even though there is no one to utilize those resources. It may also happen that the administrator might forget to turn off the street lights during the day & result in a tremendous loss of energy. Usually, these street lights are attached with High Pressure Sodium (HPS) bulbs which consume a lot of power. HPS bulbs have a choke coil which consumes a bit of energy other than the original consumption of the power assigned to the bulb.

A solution to this is to replace all the HPS bulbs with Light Emitting Diodes (LEDs). LEDs consume far less power & have a long life compared to HPS bulbs. Just a mere replacement of the bulbs will contribute to a lot of energy-efficiency. As a matter of fact, our proposed system doesn't stop by just replacing HPS bulbs by LEDs. Here we plan tocontrol the street lights depending on the need of the hour. If a few IR sensors are installed to detect the vehicle & turn on the street lights sequentiallyaccordingto the position & direction of the car with the help of microcontrollers. This system can be installed in places where the traffic density is low compared to the dense traffic which we find on city streets. The system can be completely automatic so the need to turn on the power supply manually is alsoeliminated.

Implementing this system will save hours of energy daily which can be used for other purposes or can be supplied to villages where there are frequent power cuts or no power at all. Sensor based technology is the future & can be beneficial for a developing country like India to make a landmark in the world where nowadays technology is the 4th basic need of human life.

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II. DESIGN

This design gives us a simple prospect as to how the system works. As explained before, on detection of the vehicle, the next few street lights are turned onin succession while the rest are offtill the vehicle arrives at that particular sensor. Not only the street lights which are ahead of the vehicle can be turned on but the lights, which when the car passes by were turned on can be kept lit for a fixed duration of time. This is done so that there won't be complete darkness behind the car when it passes by. A particular delay is set so as to turn the street lights off when the car passesby to a considerable amount of distance. (The delay can be adjusted as per the user needs). So even if a few cars follow each other in succession then the entire system is synchronous. This continues up until the vehicle is in the system & exits it.

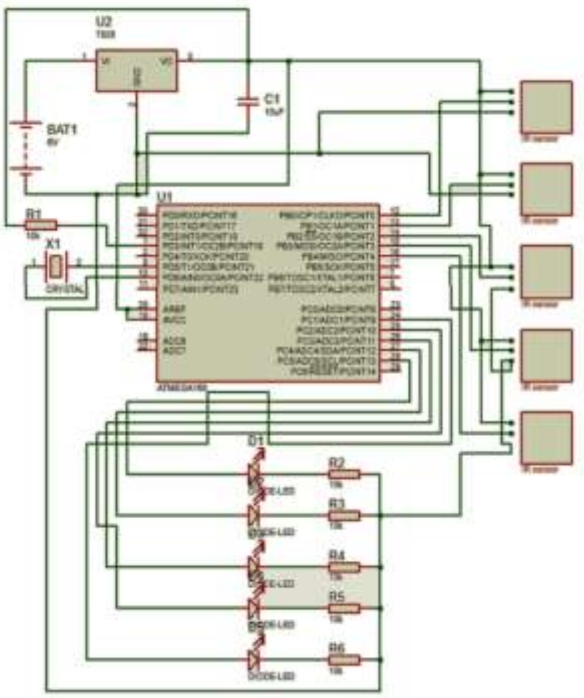
III. METHODOLOGY

Algorithm:

1. Sensor 1 detects the vehicle approaching.
2. Microcontroller triggers street lights 1 & 2 to turn on.
3. Sensor 2 now detects the passing vehicle.
4. Microcontroller triggers street light 3 to do the same.
5. Once the vehicle is detected at sensor 3, microcontroller turns on street light 4 & correspondingly turns off street light 1.
6. This process repeats for the entire system till the vehicle exits it.

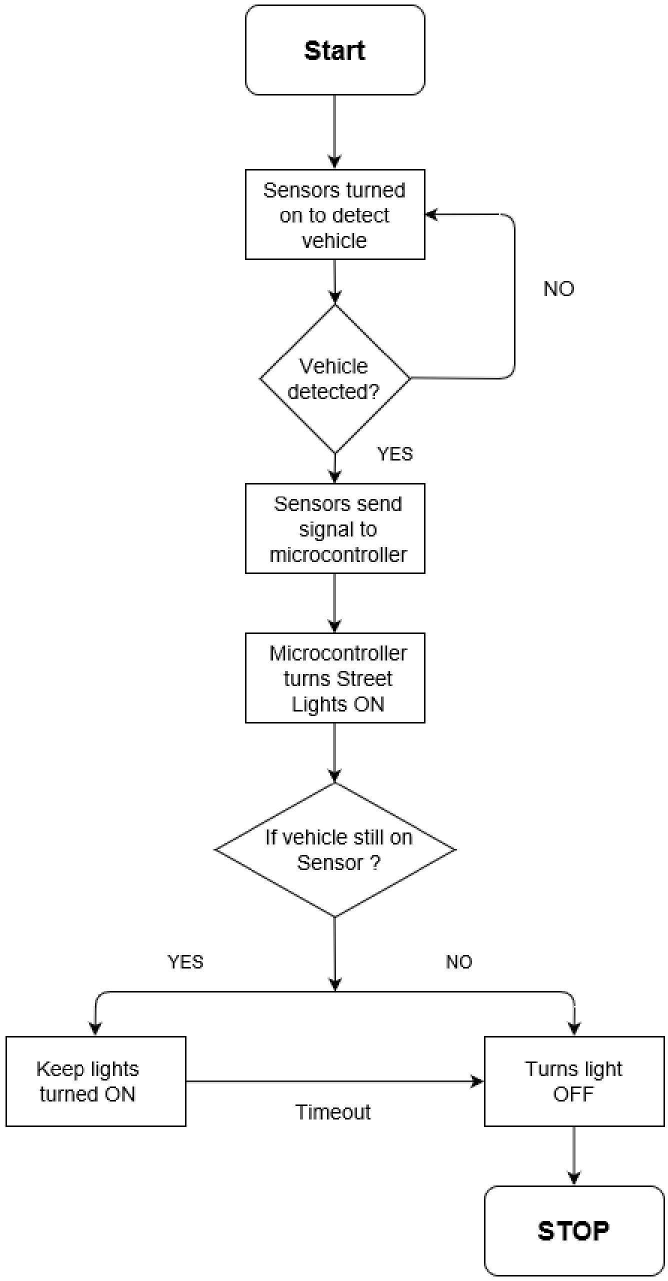
The proposed system would have maximum load between 6.00 pm to 10.00 pm as the traffic would be a bit dense, then after 1.00 am. So, the system would have maximum utilization between the peak hours. As for the next few hours from 10.00 pm to 6.00 am, the utilization would be far too less & the energy efficiency would be maximum as the lights won't be working unnecessarily at times when the need is absolutely none

Circuit Diagram:



The above figure shows the circuit diagram of the given system. It consists of 5 LEDs along with 5 IR sensors. The power to this system is provided by a 6 V battery& the microcontroller used is ATMega 168.The 10 μF capacitor filters the unwanted AC signals.

Flowchart:



As shown in the flowchart, the system will activate as soon as the sensor detects the reflection of the vehicle. On detection, the sensor will send a signal to the microcontroller which in turn, turns on the LEDs of the next few programmed streetlights. The lights will be on as long as the vehicle is in the proximity of the sensor. So even if a car breaks down on the highway, there won't be complete darkness for the driver. As soon as the vehicle passes by, the microcontroller turns off the LEDs after a particular time delay. (The street lights can be dimmed instead of turning off depending on the needs of the environment the system is installed in).

IV. FEASIBILITY STUDY

A case study of replacing 1000 High Pressure Sodium (HPS) street lights by LED lights with smart street light:
Let us assume 1000 HPS lamps of 400w, working from 6p.m to 6a.m.

Loss in the choke coil = 20 watts (average/1hps bulb).
Total energy consumed by choke:
20 w * 1000 bulbs * 12 hours = 240 kWh
Total power consumed by 1000 HPS Bulbs.
400 w * 1000 bulbs * 12 hours = 4800 kWh
Total energy consumed/day: 4800 + 240 = 5,040 kWh
If 1 kWh costs at an average Rs. 5,
5,040 units * 5 Rs * 365 days = Rs. 91,98,000.

Replacement by LEDs
Power consumed by 1 LED: 200 watts
Total energy consumed by LED:
200 w * 1000 bulbs * 12 hours = 2400 kWh.

Energy Saved/Day
5,040 kWh (HPS Bulbs) – 2400 kWh (LEDs) = 2,640 kWh

Financial Saving/Year
2,640 kWh * 5 Rs * 365 days = Rs. 48,18,000.

Savings if no activity
If there is no vehicle detected, lights can be dimmed with the help of a dimmer or can be completely turned off.
If turned off, the power this system consumes is literally negligible as the lights are merely turned on for seconds when a vehicle passes by.
If dimmers are used in the system, then we can reduce the power consumption of 200 w to 100 w which in turn saves a lot of power.
Suppose a dimmer of 2000 watts is used. It can be connected with as many LEDs as long as the overall power remains less than the given 2000 watts.
So, for LEDs of 200 watts, we would assume we can add as many as 10 LEDs. But the actual wattage initially going through the dimmer is much higher. A good approximation is to allow an additional 200 w more than for each LED fixture, so in this case, the 2000 w dimmer can handle only 5 LEDs.

Overall cost for dimming system
1000 bulbs (overall bulbs) / 5 bulbs (number of bulbs a dimmer can handle) = 200 dimmers would be required.
Cost of 1 dimming system: Rs. 5,500 (approximately).
Cost for 200 dimming systems: Rs. 11,00,000.
Here the power consumed would be approximately half the power consumed.

Power consumed by Dimming system from 6.00 am to 6.00 pm.
100 watts * 5 Rs * 365 days = Rs. 21,90,000
We can assume approximate amount around Rs. 25,00,000 since the lights would be turned on for a few seconds for the vehicles to pass by & also by the power consumed by the dimmer if installed.

Total investment
Cost of 1 LED system: Rs. 11,000.
For 1000 units: Rs. 1,10,00,000
Cost of 1 IR sensor: Rs. 600.
For 1000 units: Rs. 6,00,000.
Labor cost: Rs. 10,00,000
Total investment: Rs. 1,10,00,000 + Rs. 6,00,000 + Rs. 10,00,000 = Rs. 1,26,00,000
Payback time: Total investment/Annual Savings
1,26,00,000/48,18,000 = 2.615 years.
Savings after 10 years: Rs. 48,18,000 * 10 years = Rs. 4,81,80,000.
Profit: Rs. 4,81,80,000 – Rs. 1,26,00,000 = Rs. 3,55,80,000

In short, the overall profit after 10 years would be Rs. 3,55,80,000 for 1000 street lights.

V. CONCLUSION

In this paper, the design of intelligent street light system is put forward to make efficient use of the technology available & reduce the power consumption of street lights in areas where the density is quite low. Thus, contributing to the savings of the city’s budget of electricity. This system provides faster, efficient output & looks similar to a normal street lighting system. If it is implemented on every rural highway or college campus, the amount of power saved would be tremendous. This system embraces the latest trend of sensor based technologies to implement it in our daily lives according to the need of the user.

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