Smart Street Light Powered by Sun

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Abstract

Our manuscript aims to develop a system which will lead to energy conservation. The proposed work is accomplished by using Arduino microcontroller and sensors that will control the electricity based on the shortage of light and object's detection. Meanwhile, we will use a moveable solar panel which have a sensor and that sensor helps the solar panel to move where it found maximum amount of sunlight. Moreover, a counter is set that will count the number of objects passed through the road. The beauty of the proposed work is that the wastage of unused electricity can be reduced, lifetime of the streetlights gets enhance because the lights do not stay ON during the whole night. We are confident that the proposed idea will be beneficial in the future applications of microcontrollers and sensors etc.

Introduction

Automation systems are being preferred over the manual mode because it reduces the use of energy to saves energy. These automation systems play an essential role in making our daily life more comfortable and facilitate users from ceiling fans to washing machines and in other applications. Among all exciting applications, street lights play a vital role in our environment and also plays a critical role in providing light for safety during night-time travel. In this scenario, when the street lights are in working functionality over the whole night that consumes a lot of energy and reduces the lifetime of the electrical equipment such as electric bulb etc. Especially in cities' streetlights, it is a severe power consuming factor and also the most significant energy expenses for a city. In this regard, an intelligent lighting control system can decrease street lighting costs up to 70% and increase the durability of the equipment.

The traditional lighting system has been limited to two options ON and OFF only, and it is not efficient because this kind of operations meant power loss due to continuing working on maximum voltage. Hence, wastage of power from street lights is one of the noticeable power loss, but with the use of automation, it leads to many new methods of energy and money saving. In this regard, controlling lighting system using Light Dependent Resistor (LDR), IR obstacle detector sensor and Arduino together is proposed in the past. In the meanwhile, the importance of smart light system has motivated a lot of studies and the series of research work has been done. Sun tracking sensors are also utilized to power OFF the street lights by the detection of the sunlight luminance. Furthermore, to save more electricity we added a moveable solar panel which will charge the battery so no extra electricity needed. Distinguished from turning ON/OFF the electricity, another approach is introduced to dim the light in fewer traffic hours that might be useful to reduce the power consumption, but the electric bulbs are in continuous usage condition. To the best of our knowledge, a need is still existed to design a system that controls the dim light, connect the power ON/OFF with the vehicle's motion detection, calculate the total number of vehicles passed through the road, and control the entrance gate at night to reduce criminal activities.

The most natural solution is to control the street lights according to the outside lighting condition. This is what our paper is aiming for in smart lighting system in which the street lights will be turned OFF when there are no motion detections or day-time, otherwise the lights will be remained Dim/ON. Our proposed design is aimed at efficiently replacing any light systems that are manually controlled, and this is accomplished with the properly arrangements of microcontroller Arduino Uno, IR obstacle avoidance sensor, LDR(5), Solar panel and Servo motor(2).

In this scenario, when the intensity of sunlight impinges with LDR, street lights can be further controlled as per the desired requirement, automatically. Most importantly, a counter is set to count the number of vehicles/objects passing through the road, which will be displayed on the serial monitor of Arduino IDE. Moreover, the high-intensity discharge street bulbs are replaced with LEDs to further reduce the power consumption. An automatic street light system does not help us in reducing the power consumption only, but also to reduce accidents, criminal activities and maintenance costs.

Components	Specification
1. LDR [5]	Voltage: DC 3-5V, 5mm, 1.8 gm.
2. Arduino	22 pins, operating voltage 6-20V
3. Servo Motor [2]	
4. IR obstacle avoidance sensor	Voltage: DC 3-5V, Range 2-30cm, Angle 35
5. Solar panel	
6. LED	5 mm , operating voltage 5V

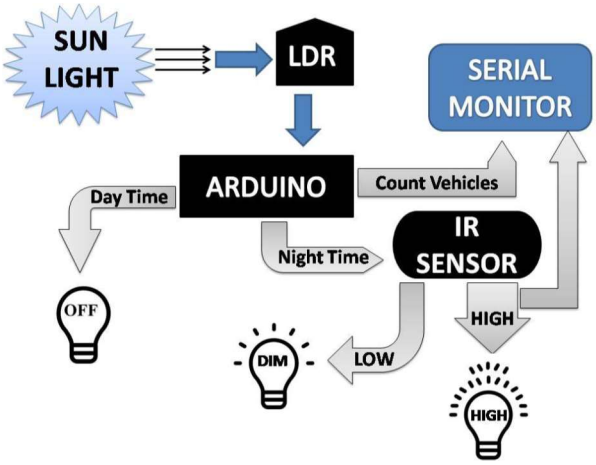


Figure: The architecture design of automatic street light control system.

For the simplicity of discussion, Fig. 1 illustrates the overall working mechanism and the features of the proposed lighting concept. Firstly, LDR will sense the intensity value of sunlight and send it to Arduino. Arduino will judge if the received value is above the threshold level (which is set independently by the user from the discrete value: 0-2023), then it will consider it as day-time and LEDs will remain OFF, or if the received value below the threshold level, Arduino will consider it as a night-time. In the night-time, if the value of IR obstacle detector sensor is LOW and detects no object, then DIM LEDs (half of its maximum voltage) will glow, or if IR obstacle detector value is HIGH and detects any object, then HIGH LEDs (full of its maximum voltage) will glow. Arduino will also count the total number of vehicles that crossed the street in the night-time with the help of IR obstacle detection sensor and will demonstrate it to the serial monitor. Moreover, we will use some LDR in the solar panel so that the solar panel will move to the maximum sunlight and by that we will get maximum amount of sun energy.

Multiple electronic components are used for building electronic circuits. Our proposed circuit designs contain these components that are described below in table 1:

Table: Specification of electronic components used in to design the proposed system.

Literature Review

Street light is an essential thing for every countries and every cities. That's why there are several projects on street lights. As we are entering the decades of technology where everything is smart and automated, street lights are also included in that. One the other hand, Electricity is also one of the most expensive and needed thing in our life. Moreover, every country's govt. taking every necessary steps to save electricity. In this case, automatic or SMART street lights will be very great full as in we can save a lot of electricity. If we look in our country's current situation, here street lights are only on and off for a fixed time either it's needed or not. That's why it is high time to change this seen and look for a better solution.

From the several street lights project, we are going to talk about some which helped and inspired us to do this project. First of all the project from the different universities' student,

Zain Mumtaz, Saleem Ullah, Hamza Ahmad Madni , Naila Aslamand, Zeeshan Ilyas from Khwaja Fareed University of Engineering & Information Technology, Shuo Liu and Jehangir Arshad Meo from Department of Electrical Engineering, COMSATS University Islamaba Pakistan,

There project is on "Automatic Streetlights that Glow on Detecting Night and Object" which is also our main concept. There main goal was to save energy which is our one of the goal. They also used the same basic equipment we used for our project. They did not mention any cost of

their project but as the equipment are all same so our cost will be far same. The second project is form the students of Green University of Bangladesh,

Omit Debnath, Md. Abdul Wahhab and Md. Tanvir Hossain from the DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING FACULTY OF SCIENCE AND ENGINEERING GREEN UNIVERSITY OF BANGLADESH.

"Vehicle Motion Based Auto Street Light and Speed Detector with Alarm System" was there project which also helps us to understand more about detecting vehicle. The used less amount of sensors as their project was just to detect vehicle so that their project cost is lower than our one approximately.

The last one is from, RAUNAK KR SINGH, ANIKESH KUNDU, CHANDAN KUMAR RAM and SUSITA SAHA from the Department of Electronics & Communication Engineering, RCC INSTITUTE OF INFORMATION TECHNOLOGY. There project is also same as the previous project “VEHICLE MOVEMENT STREET LIGHT WITH AUTOMATIC LIGHT SENSING”. They also same sensors and equipment to build the projects, so we can say that the cost is same as previous one as they also did not mention any cost.

After all of these projects inspection we have tried to build our project more efficiently and more user friendly. We also thought about some security alert system of streets and also to save more electricity we added a moveable solar panel which will charge the battery so no extra electricity needed and we can give more lights to urban area. So, after all of that we can proudly say that our project will be more efficient and best for our country.

Methodology

The system is designed in such a way that firstly it takes data as input from the LDR (Light Dependent Resistor) according to the time that the sensor in and then passes the data to the Arduino. LDR is a Light Dependent Resistor whose resistance is dependent on the light impinging on it. The resistance offered by the sensor decreases with the increase in light strength and increases with the decrease in light strength. This device is used for detection of day-time and night-time because when sunlight falls on it, it will consider as day-time, and when there is no sunlight falls on it, it will be regarded as a night. These are very beneficial, especially in light/dark sensor circuits and help in automatically switching ON /OFF the street lights. During day time the whole system will be turned off automatically.

During night time for any sort of movement the IR obstacle avoidance Sensor will receive data as input. An obstacle avoidance sensor consists of an infrared-transmitter, an infrared-receiver and a potentiometer for adjusting the distance. Whenever an object passes in front of a sensor, the emitted rays hit the surface of an object and reflect to the receiver of the sensor so it will consider this as a motion. It is a heat sensitive sensor and used for detection of motion. The IR sensor will be placed in a height of 3.5 feet, so that it can avoid any kind of disturbance from the animal like dog, cat, mouse etc. At night whenever the IR sensor sense any kind of motion it passes the data to the microcontroller so that it can turn on the light. The system will be designed in such a way that the light once turned on the light will be on for 3 minutes. After 3 minutes the light will be turned off automatically.

Additionally the whole system will be powered by a battery rather than electricity from the gridline. For this purpose we will use solar panel to charge the battery. Basically the solar panel is fixed with an absolute structure that cannot move. In our project we will servo motors to move the structure with solar panel according to the position of the sun. The circuit design of solar tracker is simple but setting up the system must be done carefully. Four LDRs and Four 100KΩ resistors are connected in a voltage divider fashion and the output is given to 4 Analog input pins of Arduino. The PWM inputs of two servos are given from digital pins 9 and 10 of Arduino. LDRs are used as the main light sensors. Two servo motors are fixed to the structure that holds the solar panel. The program for Arduino is uploaded to the microcontroller. The working of the project is as follows. LDRs sense the amount of sunlight falling on them. Four LDRs are divided into top, bottom, left and right. For east – west tracking, the analog values from two top LDRs and two bottom LDRs are compared and if the top set of LDRs receive more light, the vertical servo will move in that direction.

Arduino Code

```
<Servo.h>

Servo servohori;
int servoh = 0;
int servohLimitHigh = 160;
int servohLimitLow = 20;

Servo servoverti;
int servov = 0;
int servovLimitHigh = 160;
int servovLimitLow = 20;

int ldrtopl = 2;
int ldrtopr = 1;
int ldrbotl = 3;
int ldrbotr = 0;
void setup ()
 {
```

```
 servohori.attach(10);
 servohori.write(0);
 servoverti.attach(9);
 servoverti.write(0);
 delay(500);
}

void loop()
{
 servoh = servohori.read();
 servov = servoverti.read();

 int topl = analogRead(ldrtopl);
 int topr = analogRead(ldrtopr);
 int botl = analogRead(ldrbotl);
 int botr = analogRead(ldrbotr);

 int avgtop = (topl + topr) / 2;
 int avgbot = (botl + botr) / 2;
 int avgleft = (topl + botl) / 2;
 int avgright = (topr + botr) / 2;

 if (avgtop < avgbot)
 {
  servoverti.write(servov +1);
  if (servov > servovLimitHigh)
   {
    servov = servovLimitHigh;
   }
  delay(10);
 }
 else if (avgbot < avgtop)
 {
  servoverti.write(servov -1);
  if (servov < servovLimitLow)
 {
  servov = servovLimitLow;
 }
  delay(10);
 }
 else
 {
  servoverti.write(servov);
 }

 if (avgleft > avgright)
 {
  servohori.write(servoh +1);
  if (servoh > servohLimitHigh)
  {
  servoh = servohLimitHigh;
  }
  delay(10);
 }
 else if (avgright > avgleft)
 {
  servohori.write(servoh -1);
  if (servoh < servohLimitLow)
   {
    servoh = servohLimitLow;
   }
  delay(10);
 }
 else
 {
  servohori.write(servoh);
 }
 delay(50);
}

int led = 11;
int led1 = 10;
int led2 = 9;
int led3 = 6;
int led4 = 5;
int ldr = A0;
int x1, x2, x3, x4,x5;
void setup(){
Serial.begin (9600);
pinMode (led,OUTPUT);
pinMode (led1,OUTPUT);
pinMode (led2,OUTPUT);
pinMode (led3,OUTPUT);
pinMode (led4,OUTPUT);
pinMode (ldr,INPUT);
}
void loop(){
28
int ldrStatus = analogRead (ldr);
if (ldrStatus <=300){
if (analogRead(A1)<500) {
x1=0;
x2=1;
digitalWrite(led,HIGH);
digitalWrite(led1,HIGH);
delay(100);
}
else{
if(x1==0){
digitalWrite(led,HIGH);
analogWrite(led,255/5);
delay(50);
}
if(x2==1){
digitalWrite(led1,HIGH);
analogWrite(led1,255/5);
delay(50);
29
}}
if (analogRead(A2)<500) {
x2=0;
x3=1;
digitalWrite(led1,HIGH);
digitalWrite(led2,HIGH);
delay(100);
}
else{
if(x2==0){
digitalWrite(led1,HIGH);
analogWrite(led1,255/5);
delay(50);
}
if(x3==1){
digitalWrite(led2,HIGH);
```

```
analogWrite(led2,255/5);
delay(50);
30
}}
if (analogRead(A3)<500){
x3=0;
x4=1;
digitalWrite(led2,HIGH);
digitalWrite(led3,HIGH);
delay(100);
}
else{
if(x3==0){
digitalWrite(led2,HIGH);
analogWrite(led2,255/5);
delay(50);
}
if(x4==1){
digitalWrite(led3,HIGH);
analogWrite(led3,255/5);
delay(50);
31
}}
if (analogRead(A4)<500) {
x4=0;
x5=1;
digitalWrite(led3,HIGH);
digitalWrite(led4,HIGH);
delay(100);
}
else{
if(x4==0){
digitalWrite(led3,HIGH);
analogWrite(led3,255/5);
delay(50);
}
if(x5==1){
digitalWrite(led4,HIGH);
analogWrite(led4,255/5);
delay(50);
}}
32
if (analogRead(A5)<500) {
x5=0;
digitalWrite(led4,HIGH);
delay(100);
}
else{
if(x5==0){
digitalWrite(led4,HIGH);
analogWrite(led4,255/5);
delay(50);
}}}
else{
digitalWrite(led, LOW);
digitalWrite(led1, LOW);
digitalWrite(led2, LOW);
digitalWrite(led3, LOW);
digitalWrite(led4, LOW);
}
}
```

Circuit Diagram

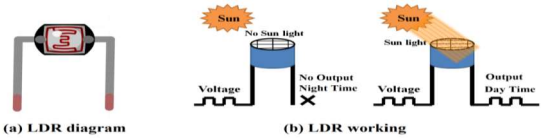


Figure: LDR symbol and its working phenomenon

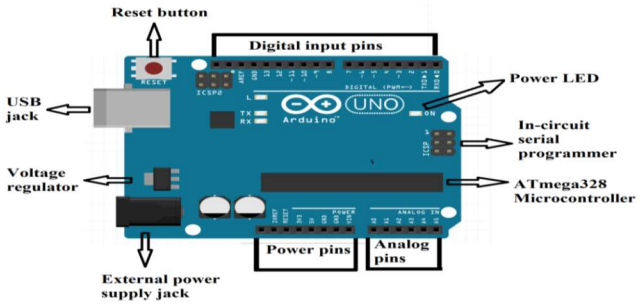


Figure: Arduino Uno board description

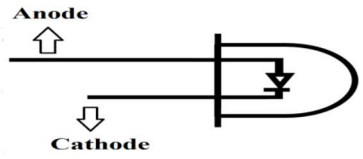


Figure: LED circuit diagram

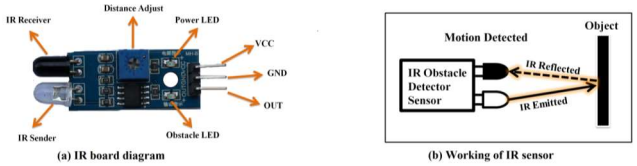


Figure: IR obstacle detector sensor diagram and working.

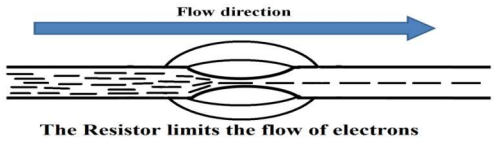
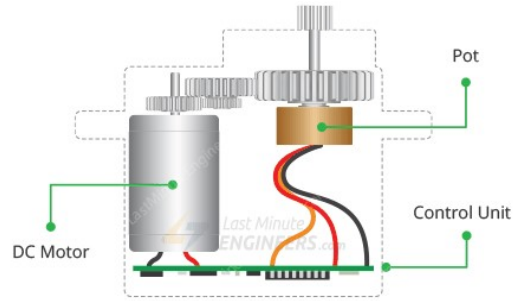


Figure: Working principle of resistor



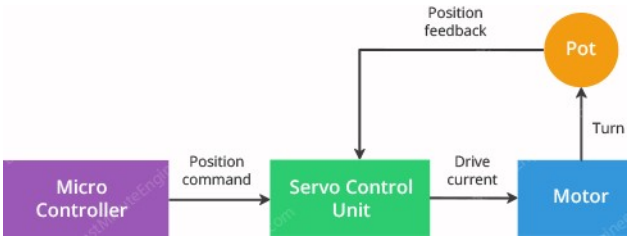


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Figure: Working principle of Servo motor.

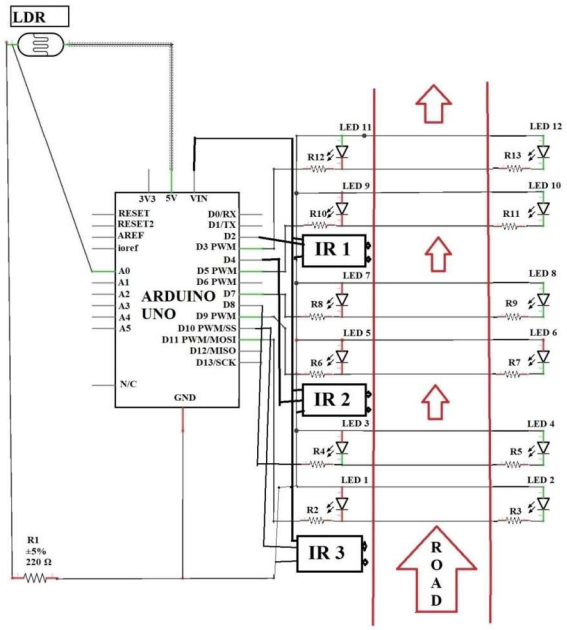

Figure: Circuit design of automatic street light control system with the Dim light capability.

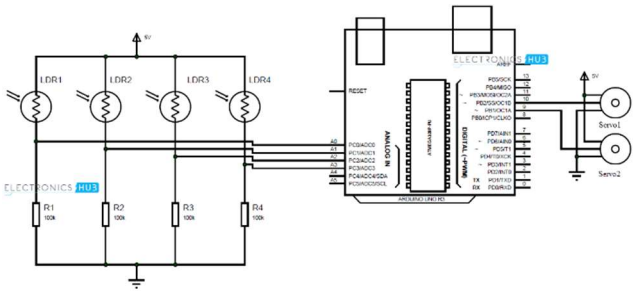

Figure: Circuit design of Arduino solar tracker with 4 LDR.

Conclusion

This paper explains the plan and development of a control circuit for consequently ON/OFF the road light dissemination framework. By utilizing Smart Street light, one can spare surplus measure of vitality which is finished by supplanting sodium fume lights by LED and including an extra component for security purposes. It forestalls pointless wastage of power, caused because of manual exchanging of streetlights when it's not required. It gives an effective and brilliant programmed streetlight control framework with the assistance of IR sensors. It can decrease the vitality utilization and keeps up the expense. The framework is flexible, extendable and absolutely movable to client needs.

1. The framework is currently utilized distinctly for one route traffic in parkways.

2. Continuous employments of LDR and IR sensors even in day time.

3. Not turned on before the nightfall.

The Smart light framework can be additionally stretched out to make the present framework in two ways rush hour gridlock, making the framework increasingly adaptable if there should be an occurrence of blustery days and presentation of ways to control the lights through GSM based help. Moreover, solar power is being used in this framework instead of electricity. Additionally, the frame is designed such way that it can rotate to consume the solar power where it is available. Thus, by using this framework, solar power can be used in human welfare and electricity shortage can be removed.

Future Impact

- Works of this task thought is splendid as it is an actual existence sparing device and there is nothing more significant than human life.
- In future each vehicle will have such kind of framework that will decrease number of lethal mishaps.
- This framework can build it has similarity by utilizing ultra-sonic sensors.
- This framework will to help decline our capacity misfortune.
- Ultra-sonic sensors can distinguish any obstacles on street, for example, breakers, structures and so on.
- The framework with ultra-sonic sensor will be extremely powerful while driving in uneven regions where sharp turns causes issues particularly in night.
- This framework will likewise decrease vehicle blend on street while over-taking or going with rapid as it will recognize vehicle in-front and naturally looks after safe separation and speed.
- We can improve this gadget by utilizing sun oriented boards.
- Water verification coat can be plan over the circuit. So can that it can give productive bring about stormy season. We can likewise make it by remote controller use counters.
- For pragmatic applications, the sensor can be appended with the wheel of a vehicle to get the wheel vibration, which can be utilized for estimating vehicle speed.
- Multiple sensors can be put next to the street to quantify the vehicle speed. For model, two sensors can be set up out and about with a known separation separated. Two most noteworthy vibration pinnacles can be seen while the vehicle will be at the closest position of the sensors. At that point the time between the appearances of the two pinnacles can be determined. Along these lines speed can be controlled by the isolating the separation between two sensors with the determined time.
- A GPS framework can be added to decide the specific speed infringement area of vehicles as a component of indistinguishable evidences of the guilty parties.
- The information can be prepared continuously however the present framework can't do that.
- The sensor has restricted access to send information from the server PC to the customer PC continuously. In future, the sensor availability can be created to oversee information totally continuously mode.
- A remote printer can be incorporated with this framework to produce printed copy of report naturally. That may lessen the manual work for printing the reports of speeding vehicles physically.
- The graphical UI can be additionally evolved to make it more easy to understand by including new highlights.
- In this task, there is specific identification go for the sensors past that extend the sensors may neglect to recognize the deterrent. Utilizing increasingly remote innovation this issue can be survived.
- The solar power system that is being used in this project can be used in other fields. By using solar power system, electricity shortage can be removed.

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