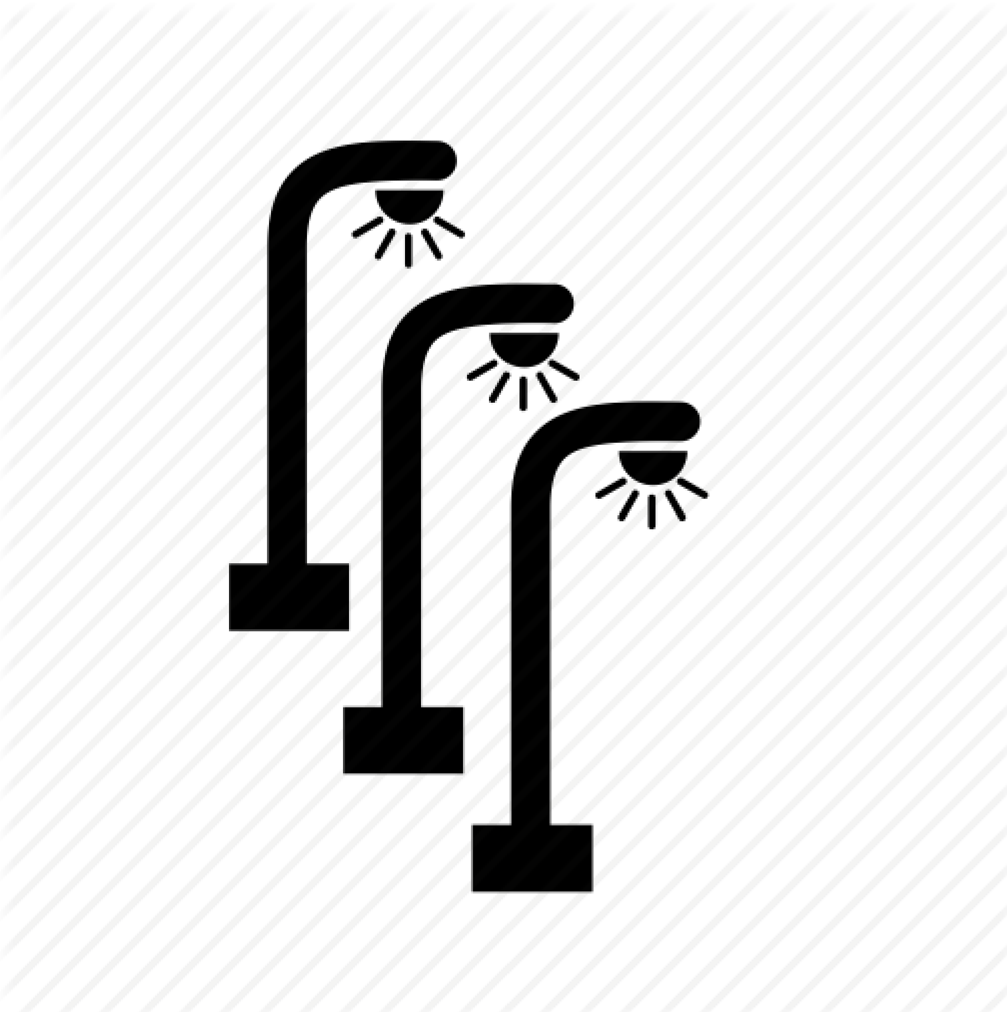

[SMART STREET LIGHT]

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Design and implementation
Of
Smart-street light system
Using
ARDUINO UNO

A thesis submitted for the partial fulfillment

Of the necessities for the award of degree of

Bachelor of Technology

In

Electrical Engineering

By

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Under the guidance of

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May, 2015

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May 10, 2015

Certificate

This is to certify that the project entitled "**Design and implementation of Smart Street Light system using Arduino Uno"** submitted by **Swadhin Meher(Roll No:111ee0218)** is an authentic work applied by him beneath my oversight and steerage for the partial fulfillment of the wants for the award of **Bachelor of Technology Degree** in **Electrical Engineering** at **National Institute of Technology Rourkela.**

To the most effective of my information, the matter embodied within the project has not been submitted to the other University / Institute for the award of any Degree or certification.

Date – 10/05/2015

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Prof. Dr. Sandip Ghosh

(National Institute of Technology Rourkela)

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Abstract:

Smart Street Light spotlights on different restriction and difficulties identified with traditional and old street lights that are confronted now days and the answer for the deal with those issues by embracing the vision of a smart street light. The noteworthiness of this vision is "a completely mechanized bidirectional force conveyance of power and information between the road lights and all the directions in the middle". Smart street lights are vitality effective as well as extremely dependable.

The primary thought in the present field advances are computerizations, power utilization, and expense adequacy. Automation is implied for the decrease of labor as the human has gotten to be excessively occupied and even incapable, making it impossible to discover time to switch the lights. Presently a day's everybody are mindful of the availability of limited power sources like coal, biomass, and hydro and so on. Unnecessary wastage of power in the street lights is one of the noticeable power loss.

Two sensors viz. The light dependent resistor (LDR) and object sensor which are utilized as a part of the smart street light framework to recognize day and light and distinguish the movement of walker and vehicle separately.

The LDR identifies the vicinity of daylight and naturally turn off the street lights in the day time and turn it on without daylight which decrease the issue of manual switching of road lights. The object sensors identifies the movement of any object and offer command to the microcontroller to glow the road lights with 100% intensity and without any movement in the street give command to the microcontroller to glow with 10% of its maximum intensity.

Here I have utilized an Arduino Uno to control all the command from LDR and Object Sensor and execute them legitimately. Fundamentally it acts as the mind of the entire framework.

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Chapter-1

Introduction:

The thought of outlining a new framework for the street lights that don't devour immense measure of power and light up vast zone with high intensity. Smart Street lights framework is an essential piece of the smart city which represents 10-40% of aggregate power utilizations which is a discriminating attentiveness toward general society powers. So a vital and productive vitality advancements are to be executed for monetary and social security.

Background of Study:

The present framework is similar to, the road lights will be exchanged on in the night prior to the sun sets and they are exchanged off the following day morning after there are adequate lights on the streets. The hindrance of the framework is that we require manual operation of the road light which needs labor.

In sunny and rainy days, ON and OFF time differ discernibly which is one of the significant hindrances of the present street lights systems.

Conventional street lighting systems are online most of the day without purpose. The consequence is that a large amount of power is wasted meaninglessly.

With the wide accessibility of adaptable lighting innovation like light transmitting diode (LED) lights and all over accessible remote web association, quick responding, dependable working, and power moderating street lighting frameworks get to be reality. The reason for this work is to portray the Smart Street Lighting framework, a first way to deal with perform the interest for adaptable smart lighting frameworks. The goal of this undertaking is to plan an automated lighting framework which focuses on the saving of power; to construct a vitally energy efficient smart lighting framework with integrated sensors and controllers; to outline a smart lighting framework with particular methodology plan, which makes the framework adaptability and expandability and configuration a smart lighting framework which similarity and versatility with other commercial products and mechanized automated system, which may incorporate more than lighting frameworks.

Chapter-2

Problem Statement:

Statement [1]: Street lights are on in the presence of sun light.

Statement [2]: Street lights are on in the absence of any vehicle and pedestrian.

Disadvantages of Classical Street Light:

- Street lights are remain on when there is a visible spectrum of light.
- These street lights need a manual switching operation.
- It also needs man power.
- These street lights are unnecessarily glowing with its full intensity in the absence of any activities in the street.
- High power consumption and waste of energy.
- Less reliable.
- Manual hectic operation due to change in season and climate.

To face the various problem mentioned above in the conventional lighting system we need a lighting system that is well equipped with recent inventions and technology. As it is well known to everyone is that the natural sources to generate power is limited and we are wasting so much of energy meaninglessly.

So if we can use automation in this particular case so that all the street lights can be switch on and off automatically when it is really necessary. And if we can use controller circuits to implement a model so that all the street lights can only glow with its maximum intensity when there is activity in its region otherwise it should glow at a minimum given intensity. So that we can save a huge amount of power.

With the inventions of light emitting diodes which has a small amount of power consumptions and high efficiency; we should use light emitting diodes instead of all classical fuse bulbs.

With the help of all these sensor available in the market; we should have 100% control over the street for the safety and security of lives in the streets along with a flexible transportation system.

Chapter-3

Development of LDR:

It is said that "*On the Flintstones, a small bird sits inside the light and turns it on every night before he goes to bed*". But in 21st century that small bird's duty is done by a small photo sensitive resister. Light Dependent Resister (LDR) is made up of light sensing material called Cadmium Sulphide i.e. Cds.

LDR is a Cadmium Sulphide photo resister that changes its resister according to the spectrum of light falls on it. Its resistance is 1MΩ in the absence of sunlight and 5kΩ in the presence of sunlight. So when there is complete darkness it conducts electricity very poorly due to high resistance and when there is a visible spectrum of light it conducts electricity very well.

So according to problem statement (1) the classical street lights

- Are remain switched on in the presence of sunlight.
- Need manual switching.
- Need man power.
- Face variable On-period due to change in seasons.
- Less reliable.
- Waste of huge amount of energy unnecessarily.

To overcome this problem we can connect a relay in series with all the street lights which will receives the signals from LDR where to switch the street lights on or off. By using this concept we can develop an automatic street light.

Automatic Street Lights:

Automatic Street light is the bird from Flintstones which will turn on all the street lights in the absence of sunlight and switch it off in the presence of sunlight.

To implement it on practical circuits we need

[1]Opamp CA3140

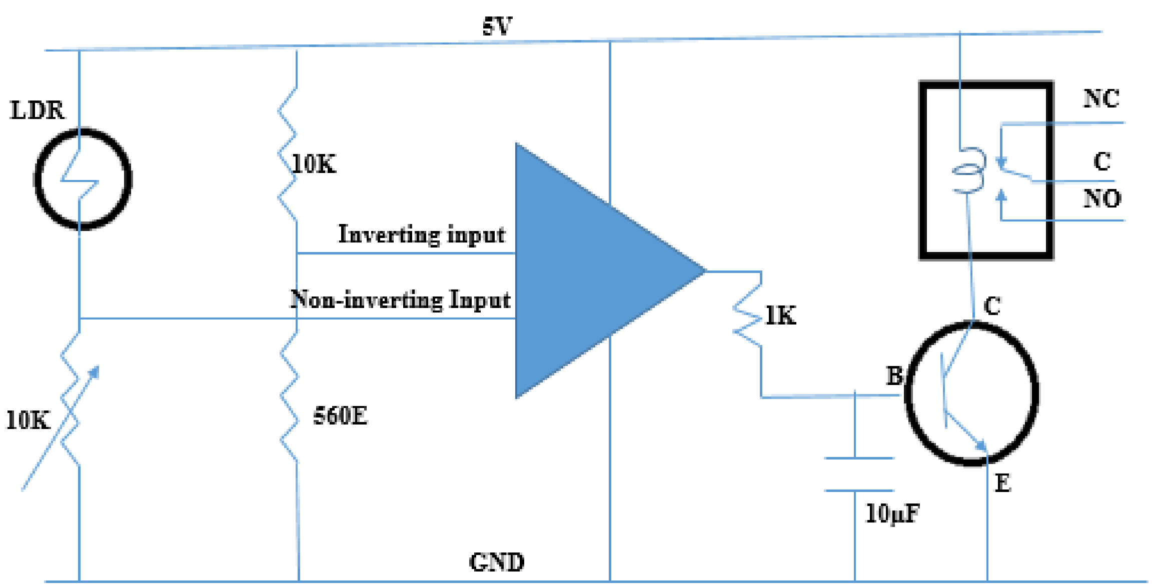
[2]Light Dependent Resistor (LDR)

[3]Resistor (100k, 560E, 1k, 100k)

[4]Capacitor (10µF)

[5]Transister (BC548)

Circuit Diagram of Automatic Street Lights



[Reference: www.electronicshub.org]

Working Principles:

Resistor 10k and resistor 560E are connected to works as a potential divider and are built across the inverting input (pin-2) and LDR and resistor 10K are connected to works as a potential divider and built across the non-inverting input (pin-3) of the opamp CA3140. Both the potential divider, opamp and relay are connected across a 5V supply. The base of transistor BC548 is connected to the output pin (pin-6) of the opamp through a 1k resistor and its collector and emitter are connected to the relay and GND respectively. A capacitor is used across the base of the transistor and GND to remove the noise present during the AC-DC conversion. Relay which works on both AC and DC provides isolation between the controller circuit and the street lights.

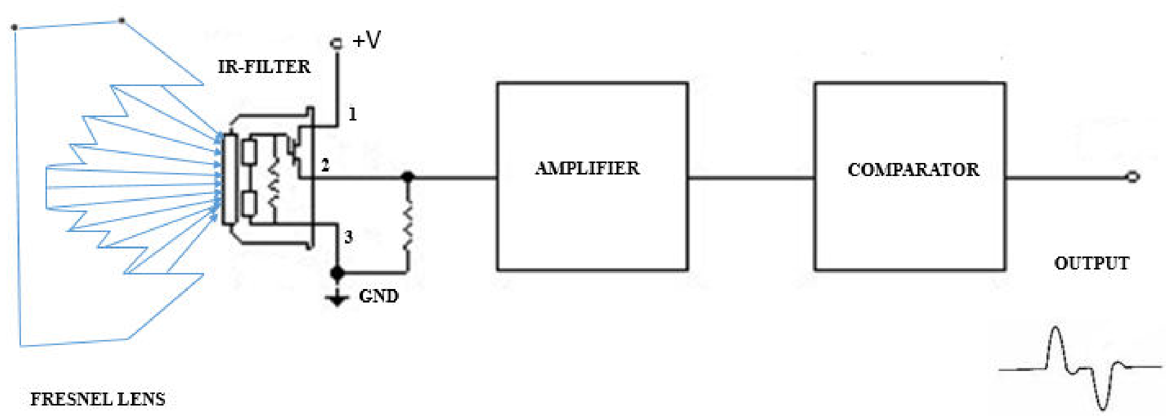
Opamp compares the analog input of both inverting and non-inverting circuits to give a digital output to the transistor which switches the relay in the terminal between NO and NC. During daytime the resistance of LDR is low in the range of 5kΩ therefore analog voltage across the inverting pin is more than the analog voltage across the non-inverting pin. So the output pin (pin-6) is low and transistor goes to the cut-off region; makes all the street lights switched off. But in nighttime the resistance of the LDR is very high in the range of 1MΩ resulting in the decreases in the analog voltage across the inverting pin than the non-inverting pin which makes the transistor in conduction region. Thus all the transistor again turned on during night time.

Chapter-4

Motion Detection:

According to problem statement (2) all the classical street lights are remain switched on from 6 pm to 6 am whether there is a pedestrian or vehicle is present or not present of any activity. The most probable peak time of movement is from 6 pm to 10 pm in a smart city; so after 10pm all the street lights are glowing at its full intensity which leads to loss of enormous amount of energy. So to overcome this problem if we can install a small motion detection device which will control the street light to glow at its 100% only in the presence of any activity in the street. To overcome this problem we can use passive infrared motion sensor (PIR) or proximity sensor or photoelectric beam detector.

PIR sensors are made up of pyro-electric crystalline elements which detects the change of thermal energy due to the emission of infrared rays by the pedestrian or any animals. Infrared radiation which is not visible to normal eyes is present in electromagnetic spectrum whose wavelength is longer than the sunlight. When an object goes in front of its nominal range; it produce infrared radiation of wavelength 9.4µm which falls on the surface of PIR. The amount of infrared radiation falls on the surface of crystalline material generates that amount of charge which is sensed by the built in FET of the PIR sensor. The sensed charged by the FET is conditioned, compared and amplified by the module and switches on the electrical or electronic circuit connected to it.



BLOCK DIAGRAM OF PASSIVE INFRARED SENSOR

The pin-2 of FET is connected to ground through a resistor of 100k and got fed to signal conditioning circuit two stage amplifier whose bandwidth is restricted up to 10Hz.Then a comparator circuit is connected next to it which sense the positive transition and negative transition of the amplifier and gives a sinusoidal output. A voltage source of 3-15 volt is given to the pin-1 of FET.

Disadvantages of PIR

- A focusing device like Fresnel lens is required in front of its crystal material.
- Radiation from the body should pass through sensor in a horizontal fashion.
- It is unable to sense object that doesn’t emits infrared radiations.

The **proximity sensor** detects the objects without any physical contact within the nominal range of its electromagnetic radiations. It senses the change in the electromagnetic field and corresponding return signal from the object. These type of sensor are of capacitive proximity sensor and inductive inductive proximity sensor. Capacitive proximity sensors are effective for plastic and polymeric target whereas inductive proximity sensors are effective for metal targets. This type of sensors are reliable as it doesn’t have mechanical physical parts. Proximity sensors are good for either vehicle movement recognition or pedestrian movements.

Photoelectric beam detector use infrared rays that travel from source to receiver. When an object passes through the path of that infrared radiation, the infrared radiation is covered by the object and presence of any pedestrian or vehicle is detected.

Disadvantages of this type of sensor is that it needs maintenance and calibration on a regular basis. It needs an alignment of source and receiver otherwise it doesn’t work properly.

Chapter-5

Overview on Arduino UNO

[Reference- http://arduino.cc/en/Guide/Libraries]

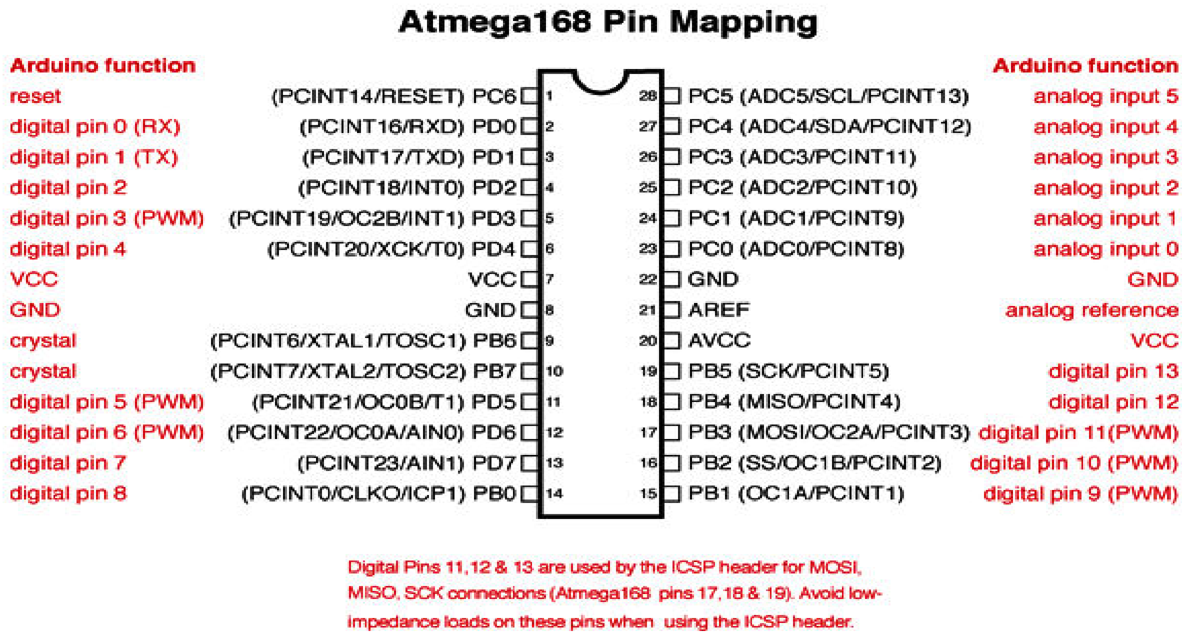
The Arduino UNO is ATmega328 datasheet based microcontroller that has 6 analog inputs, 8 digital outputs and 6 PWM outputs. It has a reset button and 16 MHz ceramic resonator with a usb connection facility along with a power jack.

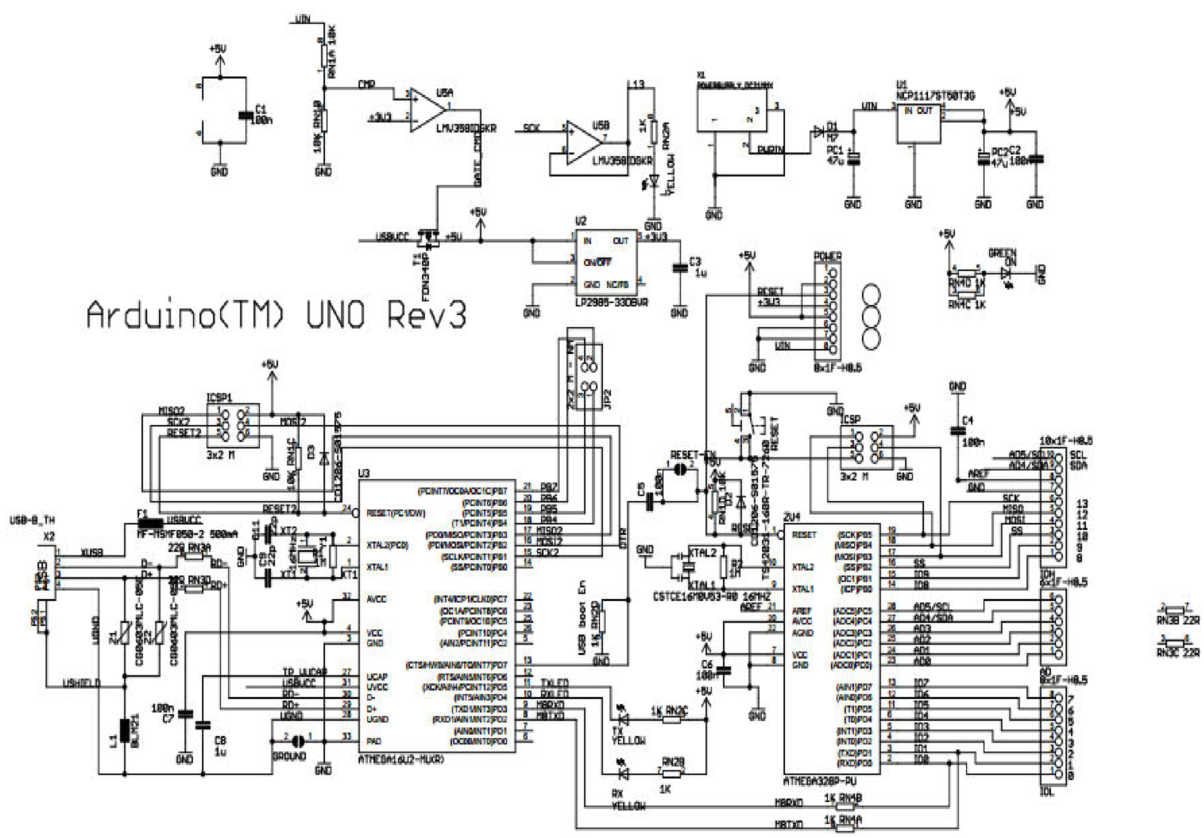
"Uno" implies one in Italian and is named to stamp the forthcoming arrival of Arduino 1.0. The Uno and version 1.0 will be the reference renditions of Arduino, making headway. The Uno is the most recent in a progression of USB Arduino sheets, and the reference model for the Arduino stage.

Summary:

Microcontroller	*ATmega328*
Operating Voltage	*5V*
Input Voltage (recommended)	*7-12V*
Input Voltage (limits)	*6-20V*
Digital I/O Pins	*14 (of which 6 provide PWM output)*
Analog Input Pins	*6*
DC Current per I/O Pin	*40 mA*
DC Current for 3.3V Pin	*50 mA*
Flash Memory	*32 KB (ATmega328) of which 0.5 KB used by boot loader*
SRAM	*2 KB (ATmega328)*
EEPROM	*1 KB (ATmega328)*
Clock Speed	*16 MHz*
Length	*68.6 mm*
Width	*53.4 mm*
Weight	*25 g*

Atmega168 Pin Mapping And schematic Diagram of Arduino UNO:





Physical Characteristics

The greatest length and width of the Uno PCB are 2.7 and 2.1 inches individually, with the USB connector and force jack augmenting past the previous measurement. Four screw gaps permit the board to be connected to a surface or case. Note that the separation between advanced pins 7 and 8 is 160 mil (0.16"), not an even numerous of the 100 mil dispersing of alternate pins.

USB Overcurrent Protection

The Arduino Uno has a resettable poly-fuse that shields your PC's USB ports from shorts and overcurrent. Albeit most PCs give their own particular inner insurance, the fuse gives an additional layer of security. In the event that more than 500 mA is connected to the USB port, the circuit will consequently break the association until the short or over-burden is uprooted.

Memory

The ATmega328 has 35 KB (with 0.5 KB utilized for the boot loader) which includes

- 2KB for SRAM
- 1KB for EEPROM

Power

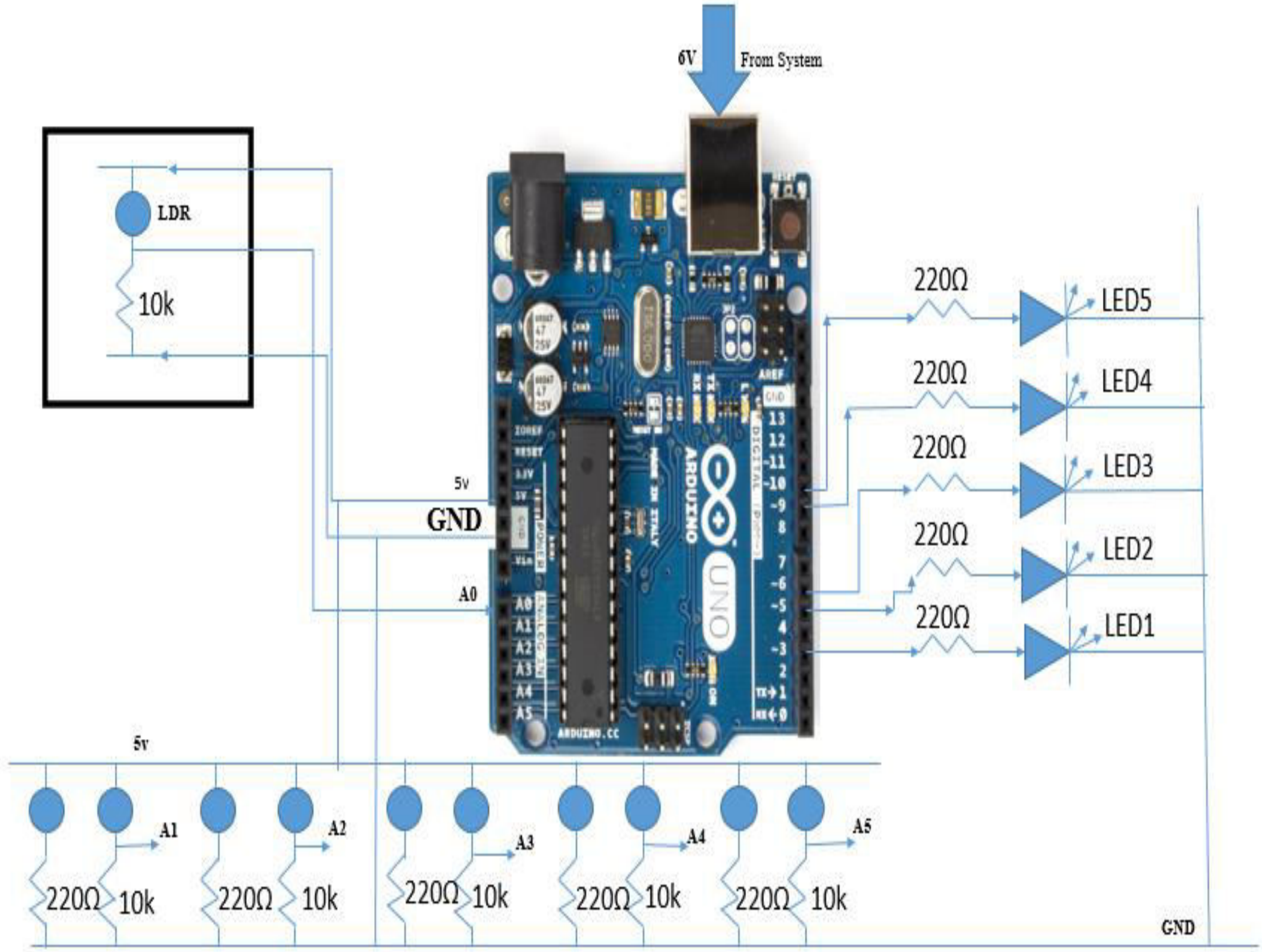
It can only works on 7-12 volts which can be possible via USB connection from the system. We can give supply to it by using a battery between Vin and GND. It also provides a IOREF pin to decide whether it should work on 5v or 3.3v.

Input and Output

- Serial: 0 (RX) pin to receive serial data.
- Serial: 1 (TX) pin to transmit serial data.
- External Interrupts: Pin 2 and 3 are used to activate interrupt command.
- PWM: 8-bit PWM outputs are provided in ~3,~5,~6,~9,~10,~11
- LED: 13. The built-in-led shows whether Arduino is on or off.
- It has 6 analog input named A0,A1,A2,A3,A4,A5

Chapter-6

Design and Implementation:



(Block Diagram of Smart Street Lighting System)

- I have used one LDR circuit to distinguish between the day and night. LDR circuit is no other than a potential divider circuit. LDR with a small register in series is connected across the 5V and GND of the Arduino Uno and from the midpoint of the LDR potential divider circuit the output of the circuit is feed to A0 of the Arduino which turn on all the street lights which are represented by Led connected to the PWM output (ie: ~3, ~5, ~6, ~9, ~10).

- LDR is a special type of resistor whose value depends on the brightness of the light which is falling on it. It has resistance of about 1M-ohm when in total darkness but a resistance of only 5 k-ohm when brightness is illuminated. The voltage is directly proportional to the conductance so more voltage we will get when there is sunlight and vice-versa and then we have to set a reference value for the switching actions of the Led. The reference value is set to 500.
- Five infrared receiver and sender circuits are made to detect the movements and output from the receiver is fed to the input terminal of A1,A2,A3,A4,A5 which corresponds to the led connected to ~3,~5,~6,~9,~10 respectively. All the object sensors are connected between 5V and GND of the Arduino UNO.

Structural Analysis and Working Principle:

- The output from the LDR is connected to the A0 and initially LDR flag and LDR value is set to zero. The value of LDR reference value is initialized and set to 500. If the Arduino UNO reads any value from LDR whose value is more than the LDR reference value than it will turn on the street lights.
- The output from object sensor1 and object sensor 2, object sensor 3, object sensor 4 and object sensor 5 are connected to the pin A1,A2,A3,A4,A4 and reference value of all sensor is set to 500.
- Another five integer value for each object sensor are set to zero and if any object sensor detects any presence of objects then Arduino UNO compares the value with the object reference value. If the sensed value is less than the reference value it will glow with 100% of its intensity otherwise 10% of its intensity.
- Arduino is using serial mode 13 to glow the bulbs.

Chapter-7

CODING:

```
#define L1 A0  //connect LDR to pin A0
#define S1 A1  // IR SENSOR-1 TO pin A1
#define S2 A2  // IR SENSOR-2 TO pin A2
#define S3 A3  // IR SENSOR-3 TO pin A3
#define S4 A4  // IR SENSOR-4 TO pin A4
#define S5 A5  // IR SENSOR-5 TO pin A5
               //connect bulb 1-5 as directed below

int ldrFlag  = 0;
int ldrValue = 0;
int ldrRef   = 500;

// set the reference value for each sensor
int ref1 = 500;
int ref2 = 500;
int ref3 = 500;
int ref4 = 500;
int ref5 = 500;

int val1 = 0;
int val2 = 0;
int val3 = 0;
int val4 = 0;
int val5 = 0;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  pinMode(13,OUTPUT);
  digitalWrite(B1,LOW);

}

void loop() {
  // put your main code here, to run repeatedly:
  ldrValue = analogRead(L1);
  val1 = analogRead(S1);
  val2 = analogRead(S2);
  val3 = analogRead(S3);
  val4 = analogRead(S4);
  val5 = analogRead(S5);
```

```
 Serial.print(val1);Serial.print("\t");
 Serial.print(val2);Serial.print("\t");
 Serial.print(val3);Serial.print("\t");
 Serial.print(val4);Serial.print("\t");
 Serial.print(val5);Serial.print("\t");
 Serial.print(ldrValue);

 if(ldrValue > ldrRef)  ldrFlag = 0;
 else                   ldrFlag = 1;

 if(ldrFlag == 1)         // 10% glow if ldr is off
 {
    Serial.println(     "LDR OFF ");
    digitalWrite(13,LOW);
    analogWrite(3,30);
    analogWrite(5,30);
    analogWrite(6,30);
    analogWrite(9,30);
    analogWrite(10,30);
    //100% glow when obstacle is sensed
  //  if(val1>ref1) analogWrite(B1,250);
    if(val1<ref1) { digitalWrite(3,250);  }
    if(val2<ref2) { digitalWrite(5,250);  }
    if(val3<ref3) { digitalWrite(6,250);  }
    if(val4<ref4) { digitalWrite(9,250);  }
    if(val5<ref5) { digitalWrite(10,250);  }

 }
 else                      //switch off all when ldr is on
 {
   Serial.println(     "LDR ON ");
    //analogWrite(B1,0);
    digitalWrite(13,HIGH);
    analogWrite(3,0);
    analogWrite(5,0);
    analogWrite(6,0);
    analogWrite(9,0);
    analogWrite(10,0);
 }
  delay(500);
}
```

Chapter-8

Observations and Outcomes:

For a comparative study we have to take the following assumptions:

Assumptions:

- Suppose a 10 km long one-way street contains 500 street lights and the nominal range of all the street lights are 20 meter.
- All the street lights are supposed to glow for a period of 12 hour from 6 pm to 6 am.
- One street light is supposed to consume 1 kwh power for a period of 1 hour when it glows with its maximum intensity so that one street light consumes maximum 12kwh in a day.
- So 500 street lights consume maximum 12kwh*500=6000kwh power in a day.
- All the vehicles are crossing the street lights at a speed of 40km/hr.

Case-1: (from 1am to 5am; let only one vehicle is in motion)

All the 500 street lights are consuming a power of 500 kwh for a period of one hour and a vehicle is crossing the lane at a constant speed of 40 km/hr.

In conventional street light system all the street lights are supposed to consume 500 kwh.

Time required to cross the nominal range of one street light = $\frac{Nominal\ Range\ of\ one\ street\ light}{speed\ of\ the\ vehicle}$

$$= \frac{20\ m}{40\ \ *\ \ \frac{1000\ m}{3600\ s}}$$

= 1.8 second or 0.5 * 10^{-4} hour

So every street lights will glow with 100% intensity for only 1.8 second and rest period 3598.2 second it will glow with 10% of the maximum intensity.

Now we can see that when a street light glows with its maximum intensity it consumes 1000 watts for 3600 seconds so it consumes 0.278 watts for 1 seconds with 100% intensity and 0.0278 watts with 10% intensity.

So one street light will consume 100.02 watt and 0.5 watt and total 100.52 watt power when a vehicle crosses it. So a street having 500 street lights will consume 50.26 kw.

Case-2: (from 5am to 6am and 12 pm to 1 am; let only 10 vehicles are in motion)

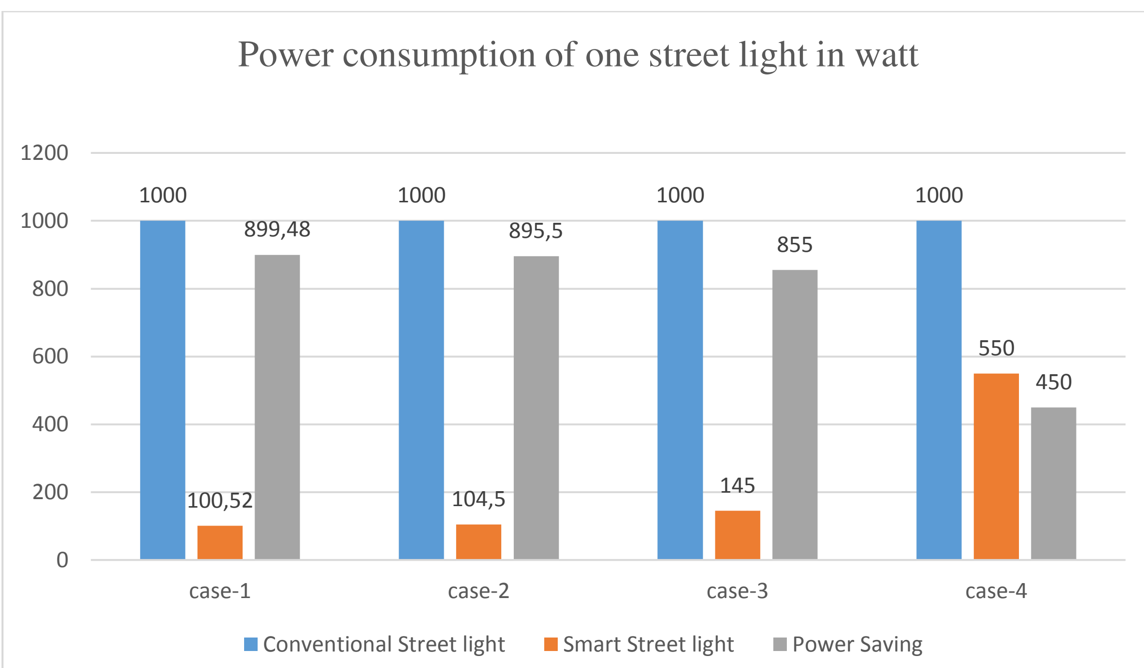
If 10 vehicle crosses the street light one by one; so for a period of total 1.8 * 10 = 18 seconds they will be in the nominal range of street lights. So total 5 watts + 99.5 watts = 104.5 watts.

Case-3: (from 10pm to 12am; let only 100 vehicles are in motion)

If 100 vehicle crosses the street light one by one; so for a period of total 1.8 * 100 = 180 seconds they will be in the nominal range of street lights. So total 50 watts + 95watts = 145watts.

Case-4: (from 6pm to 10pm; let only 1000vehicles are in motion)

If 1000 vehicle crosses the street light one by one; so for a period of total 1.8 * 100 = 1800 seconds they will be in the nominal range of street lights. So total 500 watts + 50watts = 550watts.



Conclusions:

This paper expounds the configuration and development of Smart Street lighting control framework circuit. Circuit meets expectations appropriately to turn road light ON/OFF. In the wake of planning the circuit which controls the light of the road as delineated in the past segments. LDR sensor and the object sensors are the two fundamental conditions in living up to expectations the circuit. On the off chance that the two conditions have been fulfilled the circuit will do the wanted work as indicated by the particular system. Every sensor controls the killing ON or the lighting segment. The road lights have been effectively controlled by Arduino UNO. With orders from the controller, the lights will be ON in the spots of the movements. Besides the downside of the road light framework utilizing timer controller has been succeeded, where the framework relies on upon photoelectric sensor. At long last this control circuit can be utilized as a part of a long roadway between the urban areas as well as the rural areas.

The venture points were to lessen the reactions of the present street lighting framework and discover an answer for power loss. In this venture, the first thing to do is to set up the inputs and yields of the framework to control the lights of the street. The model acts not surprisingly and will turn out to be exceptionally valuable and will satisfy all the present limitations if actualized on a vast scale.

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