

Intelligent lighting system using Arduino and PWM

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Abstract - The primary considerations in the area of lighting systems are automation, power consumption, and cost-effectiveness. Power saving is the most critical factor as the power shortage is increasing drastically. Automation leads to intelligent systems, which not only reduces manpower but also makes it cheap. The main objective of the paper is to save electrical energy automatically used in powering lights by the application of power-saving elements. This power saved can be used in other applications, such as in irrigation, lighting villages, towns, and many other industries. We have used Arduino in this intelligent system, designed to control the lighting. The designing of a new system must not lead to consumption of massive amount of electricity or illuminate a large area with highest intensity of light unnecessarily. Providing lighting is one of the most important and expensive expenditures on electricity for a city. Lighting can account for 30-50% of the total energy expenditure in typical cities worldwide. Inefficient lighting wastes a significant amount of capital every year, and poor lighting also leads to accidents. The use of energy-efficient systems can reduce the cost of lighting drastically and also provide excellent efficiency. So, in this paper, we propose an intelligent light control system with the help of PIR, LDR, and Arduino. This system can be implemented in workplaces, museums, libraries, etc. As stated earlier, to provide an efficient & energy-saving lighting system by evaluating the external lighting condition and then adjusting the lights accordingly, sensors are used. The system mainly consists of sensing elements like PIR, LDR, which is followed by processing unit Arduino that takes input from sensing elements and gives its output to the LEDs using Pulse width modulation (PWM).

Key Words: Lighting, Arduino, PIR, LDR, PWM.

1. INTRODUCTION

This world has two kinds of light sources, natural ones, and man-made light sources. The latter are the ones that need to be controlled all the time manually. These ultimately lead to wastage of electricity, and at the same time, the manual control is also not that much effective. To overcome these shortcomings of controlling the lighting systems manually, intelligent systems have to be used in their place. The ancient lighting system had only two options on and off. This kind of operation meant energy loss due to continuous operation at maximum voltage though actual requirement might be less depending on the external lighting condition. The simplest solution to it is to calibrate the lights according to the external lighting condition. This is what we are aiming for in our intelligent lighting system. In this paper, we propose an advanced light control system with the help of PIR [1], LDR sensor, and Arduino. The passive infrared

sensor is used to detect the motion in our lighting vicinity, after detecting the presence of motion, LDR is used to assess the present lighting conditions [2] and PWM is used to illuminate the LED's at an optimum level of brightness to conserve energy. All the processing is done by Arduino UNO from taking the inputs from sensing elements and giving output to the LED'S.

2. COMPONENTS USED

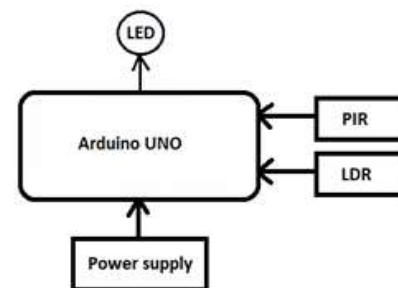


Fig -1: Block Diagram

2.1 Arduino UNO

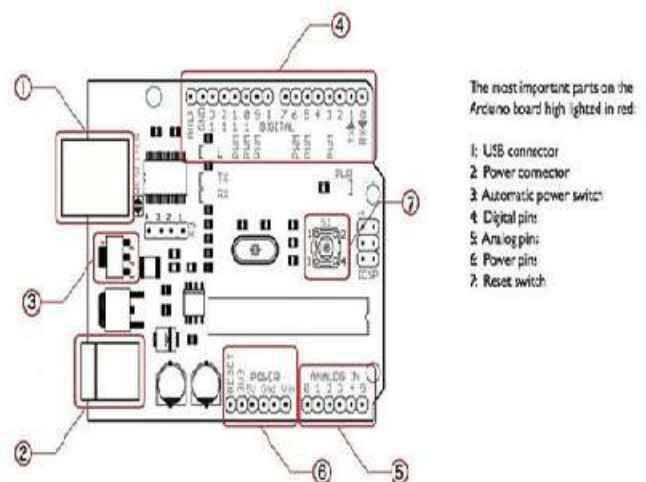


Fig -2: Arduino

The Arduino UNO is an open-source ATmega328P based microcontroller board. The board consists of both the digital and analog input/output (I/O) pins, which can be interfaced with various expansion boards (shields) and other circuits. The board consists of 20 pins, of which 14 are digital pins and 6 are analog pins, and it is programmable by the Arduino IDE

(Integrated Development Environment) via a type B USB cable. It can be powered by using a USB cable or by an external battery, as it accepts voltages between 7 to 20 volts. The boards feature a serial communication interface, including Universal Serial Bus (USB), which are also used for loading programs from personal computers. A quartz crystal of frequency 10MHz is used in the Arduino.

2.2 PIR

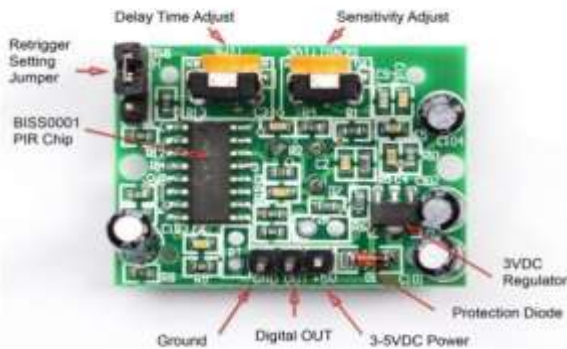


Fig -3: Passive Infrared Sensor

The passive infrared sensor is an electronic device, which measures the radiating infrared light from objects in its field of view. They play an essential part in the construction of PIR-based motion detectors. Motion is detected when an infrared source such as humans with temperature, passes in front of an infrared source with another temperature, such as a wall. All objects are known to emit radiation called black body radiation. This radiation is invisible to the human eye but can be detected by an electronic sensor designed for this particular purpose. The term 'Passive' means that the PIR does not emit energy of its own but merely accepts the incoming infrared radiation. The PIR sensor is sort of an infrared camera, which remembers the amount of infrared energy focused on its surface. If there are any changes in the infrared energy, it detects it accurately. Once power is applied to the PIR, the electronics in the PIR settle into a quiescent state shortly, and it energizes a small relay that controls the set of electrical contacts, leading to detection.

2.3 LED

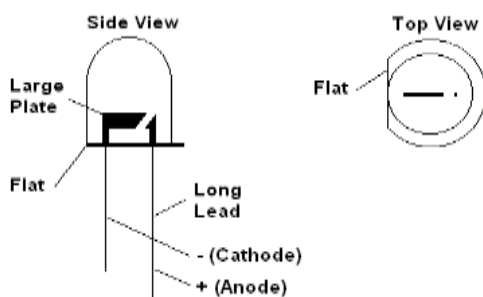


Fig -4: Light Emitting Diode

A light-emitting diode (LED) is a semiconductor light source with two-lead. It is a p-n junction diode when activated starts emitting light. When the necessary voltage is applied to the leads, electrons start to recombine with the electron holes within the device, releasing energy in the form of photons. This effect mentioned above is called electroluminescence, and the color of the light emitted (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are tiny in size (less than one mm²).

2.4 LDR

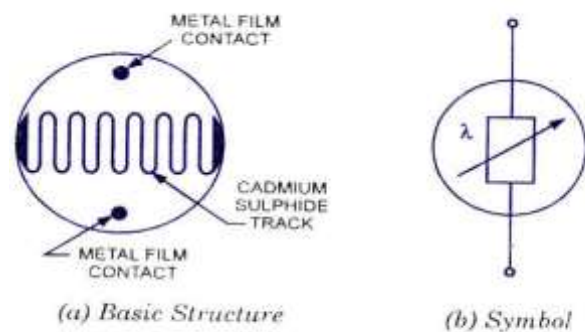


Fig -5: Light Dependent Resistor

A Light Dependent Resistor (LDR) or a photo resistor is a light-sensitive device whose resistance is inversely proportional to the electromagnetic radiation it absorbs. It works on the phenomenon known as photoconductivity. Photoconductivity is a phenomenon in which the material's conductivity increases when the light absorbed by the material increases. When incident light of energy higher than the semiconductor's band gap energy falls on the material, it excites the valence band electrons to the conduction band. As a result, the charge carriers number increases, which in turn increases the conductivity of the material. LDR's have high resistance under normal conditions. It takes about 8 to 12 ms to lower its resistance when light falls on it.

2.5 PWM

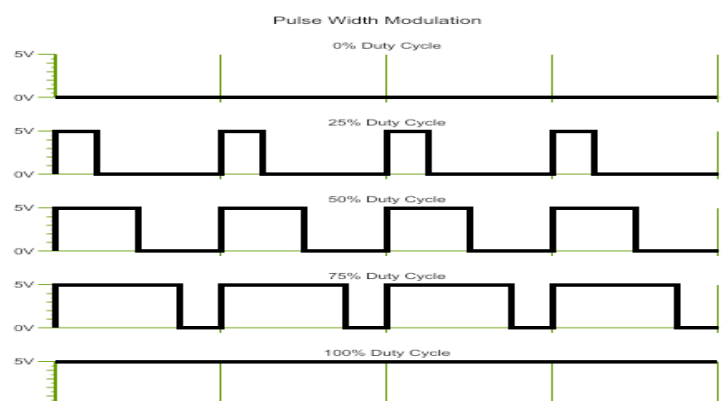


Fig -6: Pulse Width Modulation

Pulse width modulation is a technique which is widely used to control analog devices like Motor, LEDs using a modulating digital signal. PWM involves varying the width of the pulse to limit the power in which the devices operate, and hence it is known as pulse width modulation. The most crucial factor of PWM is the duty cycle, which is usually controlled to regulate the power given to the devices. The duty cycle is defined as the ratio of on-time of the pulse to its total time. A pulse with the duty cycle of 50% indicates that the pulse is high for 50% of the time and low for the remaining time. This translates to the devices running only at its 50%. A duty cycle of 0% indicates that the pulse is low for the whole time, and hence the device remains off the entire time. A duty cycle of 100% shows that the pulse is ON the entire time, so the device is at its 100%.

3. WORKING

The passive infrared sensor in the system checks for any motion in the area that we want to illuminate. The sensor gives HIGH as output when motion is detected, and the output of the sensor is given to the processing unit Arduino which determines whether the LED's should be on or off. If the sensor detects no motion, then the Arduino receives LOW from PIR, which keeps the LED's off.

Once the input from the PIR is high, the inputs from the LDR are checked by the Arduino. As LDR is a light-dependent sensor, it gives its input based on the amount of lighting the area already has. In the daytime, the area is well illuminated, and hence the inputs from the sensors are high. Likewise, if the area is under illuminated, then the inputs are low. LDR can give its input to Arduino in 1023 discrete levels. If the reading is 0 from LDR, then the place under consideration is dark, and needs to be illuminated brightly. As the reading increases, the brightness with which we have to operate the LEDs reduce. The brightness of the LED can be controlled using PWM. When the output of the LDR is between 0 to 200, a pulse width modulation of 100% duty cycle is given to the LEDs, which powers it without any off time keeping it at its full brightness. When the output from the LDR is between 200 to 500, a duty cycle of 75% is given to the LEDs, which keeps its brightness at 75%. Likewise, if the outputs are between 500 to 800, the area is illuminated to certain level already, and hence a duty cycle of 50% is given so that the LED's brightness is at its 50%. When it's above 800, the area is already well lit, and the LEDs are provided with 25% or 0% duty cycle to save power.

4. FUTURE USES

The temperature control systems used in homes and industries can be designed using this concept. The temperatures can be monitored, and air conditioner or thermostat can be operated at optimum temperatures. It can also be used to automate a process in industries where temperature or other parameters play an essential role in the transition of the process to its next stage.

5. CONCLUSION

Intelligent Energy Saving System is not limited to any particular application. It can be used anywhere in process industries with little modifications in the software coding according to our requirements. This concept not only ensures that our work can be used in the future but also has the flexibility to adapt and extend, as needs change along with time.

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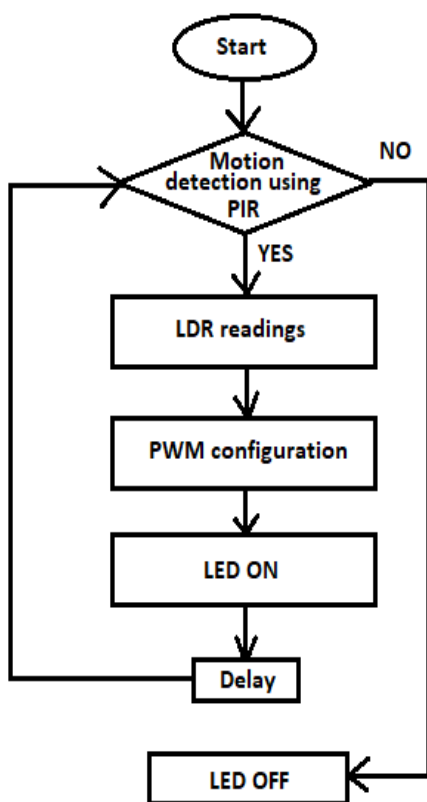


Fig -7: Flowchart

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