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An Innovation in the Field of Street Lighting System with Cost and Energy Efficiency

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Abstract

Background/Objectives: This paper focus on the necessity of automated street light system and the peculiar way of implementation with embedded system tools. As automation booming in the industry with a fast pace, the requirement of replacing the primitive operation of street lights with quite intelligence is necessary. **Methods/Statistical Analysis:** The previous systems were implemented with LDR and IR sensors, here the presence of movement in the roads are sensed by IR sensors and LDR powers the street lights only after evening. The excess use of IR sensors and energy involved in the above operation are reduced in our prototype. Here we use piezo electric sensors to detect the movement in the roads instead of IR sensors. The microcontroller MSP430 as the brain to control the processes involved[1]. **Results/Findings:** The results are found to be very encouraging and the sample results are presented in the results section of the paper. **Conclusion/Application**: LEDs are going to be vital lighting option in near future due to its peculiar low power consumption and cost effective nature. Our prototype will help in eliminating the current sodium vapour street lamps with better LED comprised lamps operated smartly using LDR, and piezo knock sensor.

Keywords: Adaptive Lighting, Cost Saving, Energy Efficient, Street Light

1. Introduction

The energy conservation and reduction of workforce (manpower) is currently hot debated topic in the research of science and technology. They being a vital factor nowadays in every technology, the improvisation of every existing prototype in terms of low power consumption have become major priority. Especially in a developing countries like India. Not all the areas will need street lights with full intensity, in case of village areas with few vehicle movements. This paper gives solution to controlling the intensity of the lights considering the movement in the roads.

The existing systems with IR sensors to detect movement also requires power source to function[2,3]. And they are installed on the sides of the roads exposed without any protection, which may damage due to any natural calamity and other physically aided possibilities of accidents. And we can't detect the multiple vehicles passing simultaneously; hence the intensity of the light that is depending on density of vehicles will have considerable errors.

The combination of LDR and piezo knock sensor[4] would predict the movement on the roads as well as the density of vehicles on the roads, which may increase the efficiency of energy conservation operation. The piezo knock sensors are embedded inside the surface of roads, the underground placement of these sensors reduce the possibilities of it to be damaged. And moreover the sensors are self-aided, which operates on pressure difference that produces a voltage that is sufficient to give digital 1 or 0.

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2. Methodology

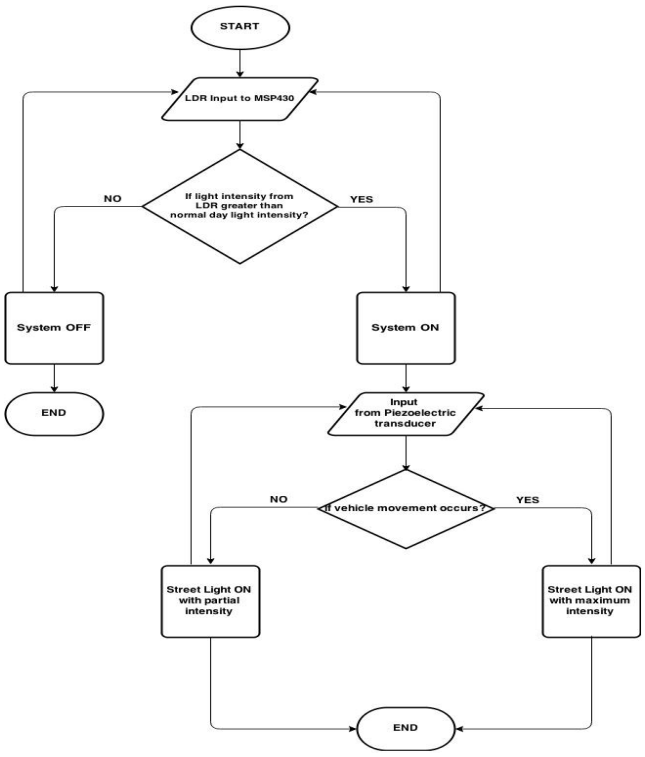

Figure 1. Block diagram for proposed work.

3. Block Diagram Description

The above flowchart operates the smart auto street light during lack of daylight. It starts with a decision from LDR, only when there is no sufficient daylight, the microcontroller switch ON the system that controls the street light mechanism. During this period, the street lights glows with partial intensity. That is, during evening, night and early morning. Once the system is switched ON, micro controller will be waiting for the signal from embedded piezo. If at all any movement is detected by the piezo that gives digital HIGH to the input pin of MSP430. Hence the street lights glows with full intensity.

4. Major Components used for Automatic Street Light

The major components of proposed innovations are discussed in a brief touch below. First in the lot is LDR and is expanded as Light Dependent Resistor.

4.1 LDR – An Understanding of How it is Used?

The constructed microcontroller system switches on the street lights when the lighting conditions become poor (i.e. evening till early morning). By using suitable Light Dependent Resistor like Cadmium Sulphide (CdS) LDR, the intensity of light is detected which helps the micro controller to switch the system on and off based on the environment's lighting conditions. A LDR may have resistance of 300k ohms in complete darkness and drops to 3k ohms in bright light. This LDR is used an analog sensor from which the analog inputs are given to the MSP430 microcontroller.

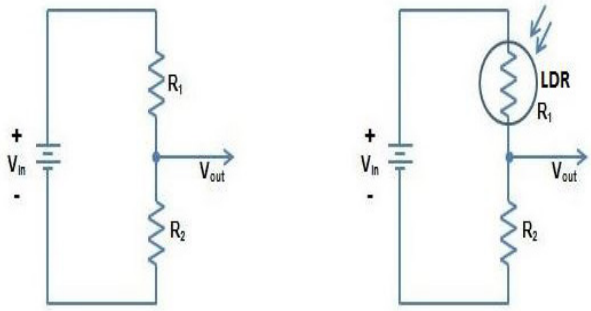

Figure 2. Voltage divider circuit[5].

$$V_{OUT} = \frac{R_2}{R_2 + R_1} * V_{IN}$$

The LDR is given a supply of 3.3 V from the MSP430 and the LDR is connected with a pull down resistor which may range from 5k to 50k ohms. The analog value is taken in-between the LDR and pulls down resistor and is given to the MSP430.

4.2 Piezoelectric Transducers

Piezoelectric Transducers is used as a knock sensor (Figure 4.) to detect the movement of vehicles in the roads. A change in mechanical energy (pressure) produces electrical signal as the output, which is basic working principle of piezoelectric transducers. Whenever there is vibration or pressure over the piezoelectric transducer it produces an electrical signal which is given to the micro controller as an analog value (Figure 5).

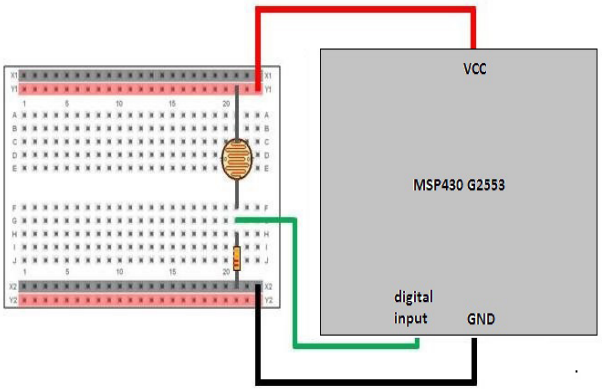

Figure 3. Basic LDR circuit.

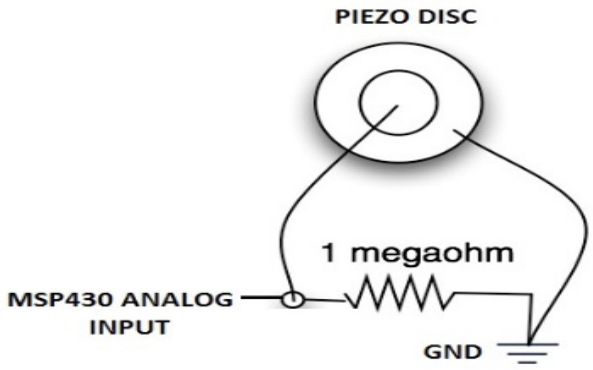

Figure 4. Piezo knock sensor.

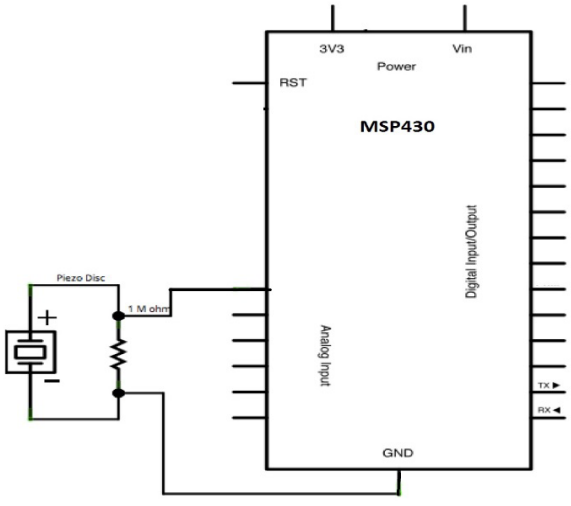

Figure 5. knock sensor connected to analog input of MSP430.

5. The Construction and Working of Smart Automatic Street Lighting

The system starts to works only at low or poor lighting conditions. Piezoelectric crystal strips are embedded on the roads[6] at calibrated intervals. There are strips can arranged in many ways depending on the road conditions provided.

In a highway, whenever a vehicle moves over a piezo transducer, an electric pulse is generated due to the pressure created by the vehicle. This electric pulse is responsible for efficient and smart automatic street lighting in the roadways. The electric pulse is sensed by the microcontroller and it triggers the intensity of the street light to maximum associated with it for a predefined time.

As the vehicle moves on, each street light gets triggered one by one providing a better vision to the driver and efficiently conserving energy.

When there is no movement of vehicles, the MSP430 micro controller does not receive any analog electrical signal from the piezo transducer. Hence the street light glows with a partial intensity around 30 to 40 percentage of its maximum intensity during the poor lighting conditions. The energy for lighting a street lamp can be obtained from solar energy which is a renewable source of energy.

6. Advantages of this System

- The greatest advantage of the system is that the piezo sensors act independently without any external power sources.
- They do not cause any radiation exposure to the pedestrians and vehicles.
- They provide energy conservation without compromising on viewing comfort and safety.
- And since the lights go back to their normal intensity after the vehicles move over the next piezo strip, the energy saved is very high.

7. Setbacks and Improvisation

- The piezo can produce voltage only when there is constant pressure difference.
- The piezo can't give digital HIGH, if any vehicle halts for longer time.

- The integration of this for pedestrian cross can help the late night drivers to detect any movement in the highways.

8. Results based on the Prototype

- When vehicles move over the piezo embedded road, the microcontroller reads a digital HIGH and the code actuates the street light to glow with full intensity for considerable amount of time until the vehicles crosses that particular street light.

Figure 6. Our prototype with few street lights.

Figure 7. Glows with reduced intensity.

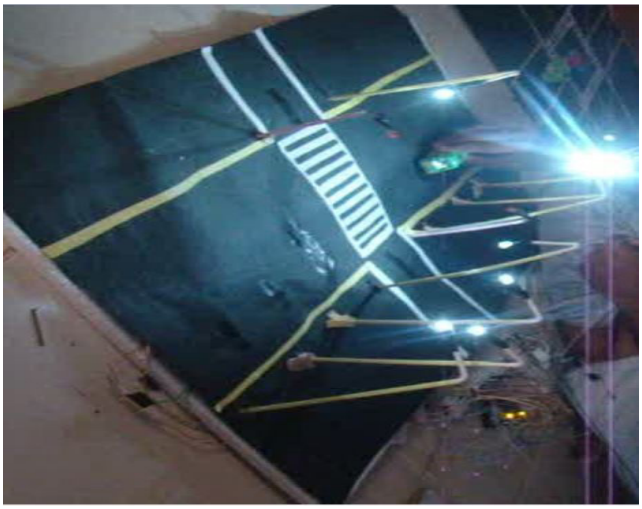

Figure 8. The first street light glows with full intensity as the toy car passes.

- In the prototype we used a basic piezo knock transducer. The terminals are connected to the MSP430 Launchpad into with a high resistance connected parallel to diminish loading effect.

9. Conclusion

LEDs are going to be vital lighting option in near future due to its peculiar low power consumption and cost effective nature. Our prototype will help in eliminating the current sodium vapour street lamps with better LED comprised lamps operated smartly using LDR, and piezo knock sensor.

And also the integration of solar powered street lights with this concept, the power saving factor can be solved and the backup energy duration for street lights could extend.

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