Design of An Artificial Intelligence Haul Road Lighting System

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Abstract: The role of lighting is very much important in deciding the efficiency of the mining industry specially when it operates under dark condition. The scientific design of an artificial lighting is very essential to fulfill the lighting standards as described by various regulatory bodies. In this paper, an attempt has been made to design the artificial intelligent lighting system which is capable of saving the energy of a lighting pole. This lighting system operates on the basis of vehicle or object movement. The designed lighting system is equipped with infrared position sensor which sensed the object or vehicle movement when it passes through the sensor. The sensor controls the lighting of output light source by sensing the position of the object.

Keywords: Lighting, artificial intelligence, mining industry, light source.

I. INTRODUCTION

Mining has been continuing and would continue to be an important industry in many countries. It plays a very vital role in the overall economic growth of the country. Lighting is a major requirement when we deal with working inside a mine whether it is Underground or Opencast mining [1]. In opencast mining efficient lighting system is required while working during dark hours. In underground mining a very efficient lighting system is required when worked underground hours for whole day long [2]. Lighting can influence the performance of people in the industrial workplace by way of different mechanisms that include visual performance, visual comfort, visual ambience, interpersonal relationships, job satisfaction, and problem solving [3]. Poor lighting and reduced visual feedback decrease detection of slip trip fault (STF) hazards [4]. Parallelly, the demand of electrical energy also increases rapidly because of the huge increment in the consumer.

A section of thinker is in a favor of saving the energy when not in operation so as to wastage of energy can be controlled [5]. Thus, the efficient and proper lighting needed for the successful operation of any mines. Also, it would keep in mind that provided illumination should be energy efficient which can capable of saving some amount of energy when mines are not in operation [6]. Therefore, this paper made an attempt to design an artificial intelligent lighting system which can serves dual purpose. Firstly, it can provide efficient lighting at the work place and secondly it can save the energy. The purposed design is based on the fact that the luminaires gives light on the object when the sensor (which is placed on the luminaries) sense the object. If no object sensed by sensor then luminaries will not glow for that particular site. This paper consists of five different section. Section I discussed about the introduction of the paper which is followed by the Section II in which the material used for designing the artificial intelligence lighting is discussed. Section III gives the detail discussion about the designed model. Section IV gives the briefs discussion of the paper which is followed by Section V which consist the conclusion of the paper.

II. MATERIALS USED IN PROPOSED DESIGN MODEL

The materials used in designing the artificial intelligence lighting with their technical specification and purpose is tabulated in Table I. The block diagram of the designed model is presented in Figure 1. As shown in Figure1, the IR sensor receives the command signal from the input power supply which power the sensor to proceeds further. The command from IR sensor is further given to relay switch network and from there the output light source takes the command of relay switch network. Whenever any object crosses the IR sensor then it senses and transmits signal to the relay switch model. This further gives the activation command to the output light source (LED) which glow the light on that particular area. The procedure is further carrying by the other relay switch network to sense the object movement. If any movement sensed by the IR sensor then the same procedure will be repeated.

TABLE I. LIST OF COMPONENTS USED

S.No.	Name of Component	Specification	Purpose
1.	Battery	DC 9v DC 12v	To provide power for infra-red sensor and powering the relay switches and LEDs
2.	Relay switch module	4 switch modules	To control LEDs operation
3.	LEDs	5 mW, operating voltage 5V	Act as a luminary output light source
4.	IR obstacle avoidance sensor	Voltage: DC 3-5V, Range 2-30cm, Angle 35	To detect the motion of the vehicle
5.	Resistors	100 Ω, 220 Ω	To avoid high voltage in the designed circuit model

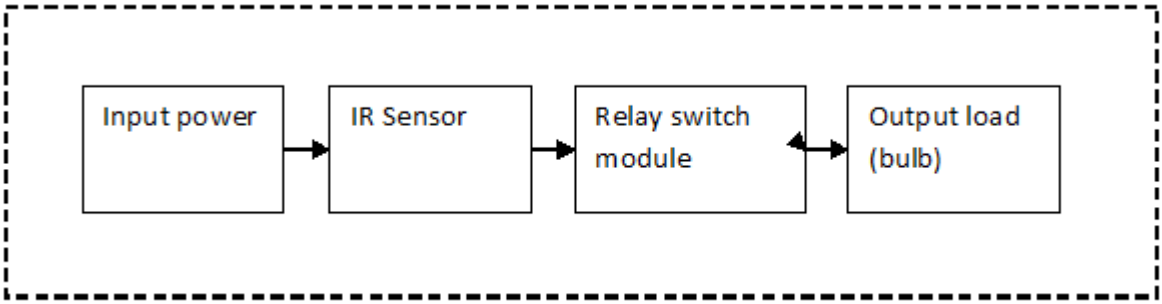

Fig. 1 Representation of block diagram of artificial intelligence lighting system

III. DESIGN OF ARTIFICIAL INTELLIGENCE LIGHTING SYSTEM

The most prominent solution of saving the energy during lighting the luminaries is by providing a control strategy of their ON and OFF. The purposed system is designed in such a manner that it ON (glow the light) when any vehicle or object crosses the lighting pole and in rest condition it gives the OFF signal. By this way, we can save the sufficient energy from a lighting pole in order to use it's in the demanded time. The designing of an artificial intelligence lighting system consists of 8 LEDs, 10 resistors, 4 Infra-red sensors and 1 number of four switch relay model. The opposite sided lighting pole arrangements were considered while designing the purposed lighting system. The schematic diagram of double-sided opposite lighting arrangement is shown in Figure 2. The purposed scheme was designed specially by keeping the haul road frame work in mind. In this, the distance between two opposite lighting poles was considered as the haul road of a coal mines which was colored by black color. The designed lighting system is presented in Figure 3.

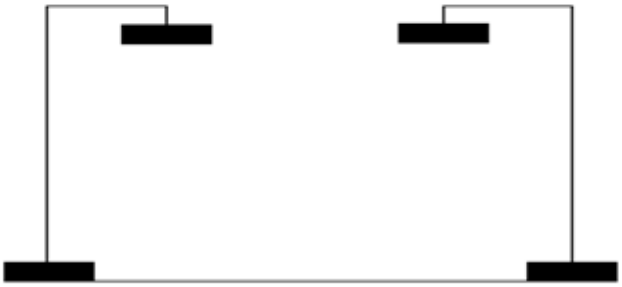

Fig. 2 Double sided opposite lighting arrangement

Fig. 3 Schematic diagram of purposed lighting system

As depicted in Figure 3, the opposite side of lighting pole is connected in a series configuration which glow at a time when any vehicle or object comes under their range. Thereafter, the other four poles in same side is connected in a parallel configuration. Each lighting pole is associated with their individual IR sensor whose aim to sense any physical movement in their operating range. These IR sensors are powered by 9v battery along with relay switch module where LEDs are powered by12v battery.

Initially, the IR obstacle detecting sensor will be HIGH. So, when there is no vehicle in front of sensor, IR transmitter does continuously transmit the IR light. Whenever a vehicle block any of the IR sensor, then the emitted rays will reflect to the IR receiver after hitting the object, then sensor will sense it as a motion and lights will be turned ON by relay switch module. As the object/vehicle moves forward and blocks the next IR sensor, the next series of bulbs will be turned ON.

IV. CONCLUSION

Lighting is a major requirement for any mining industry specially when it operates under the dark working hour. The availability of complete lighting arrangements consumes a significant amount of power by the industry. Therefore, to save the energy and in the same time to provide the efficient lighting system for the mining industry a artificial intelligence lighting system is needed. The artificial intelligent lighting system provided the lighting arrangements when any vehicle or objects pass through it and in other case it shows the OFF-lighting condition. The aim of this research paper is to address the design of an artificial intelligent lighting system for haul road of the mining industry. The purposed scheme was designed based on the two ended double-sided lighting pole structure.

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