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AN EFFICIENT USE OF SOLAR ENERGY TO CONTROL TRAFFIC AND ALERT SYSTEM BY USING WIRELESS SENSOR NETWORKS

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Abstract— The optimized solar traffic light control and alert system provides the better approach for traffic congestion. The system is composed of wireless modem and solar panel designed inside the modem itself. The design makes use of solar energy rather electrical energy which makes it energy efficient. The wireless modem tracks the vehicle in highway and lights the vehicle with the help of solar panel. The solar panel is composed of solar tracker that helps to detect the vehicle in highway. The system also helps to avoid the accidents in highways and also sends the SMS to respective RTO authority .the approached system uses solar energy as a major source which makes it economic The main aim behind this system is to control the accidents in broad section of highway with optimal use of solar energy.

Keywords— wireless modem, solar panel, highways.

I. INTRODUCTION

In countries today environment, road accidents has become very major issue. Therefore people need to be very safe and secure. In order to address this problem, Lighting appears to be major solution in highways. Being able to observe the Road on Daily basis and avoid the traffic is very difficult task. And that to in darker nights, it is harder to control the traffic. In night, By using light in very major Portions of Highways, Accidents can be reduced. The source of light has moved from conventional source of energy to green source of energy where solar panel is used to light the roads and highways.

Solar panels are considered to be optimal way to provide the light without any transmission lines. It represents a cost saving technology without any wires and by the use of solar energy no need to pay any recurring bills. Solar panels are composed of Photo voltaic cells whose efficiency ranges from 12% to 20%. Whenever the vehicles go through the highway, the solar panel tracks the vehicle and directs the vehicle to go in particular direction of a road. The proposed system is composed of array of sensors that helps to detect the vehicle in a highway over a long distance and it also sends the SMS to respective RTO authority. This traffic technology system helps to reduce the traffic congestion not only for narrow section of highway but also for the broad section of highway. If this new traffic technology system is added with present system, then it will be more beneficiuos for highways to control the accidents and to improve the traffic management system.

METHODOLOGY

In this system, The Wireless modem is composed of Solar Panel and Array of sensors. The Solar panel is Rotating and is also made up of Light dependent Resistor (LDR). The LDR detects the direction and also angle of sunlight and gives the signal for the Rotation of Solar panel. In this Process, the Solar Panel converts solar energy into Electrical Energy. The LED uses this light coming from Solar Panel to Control the Accidents in Broad Section of Highway. The System also sends the Traffic Jam Alert to RTO authority via SMS.

As a virtual part of a country's infrastructure, roads and highways are necessary for economic activity and people's movement. Thus, they need to be safe and further secure. In order to ensure the latter in roads and highways, lighting appears to be necessary especially in dangerous roads. Being able to properly see and observe the road to avoid the conflicting traffic and notice the behaviour of other highway user is the driver's visual crucial task. In the dark, this task is harder to accomplish and requires the presence of light to increase the visibility of hazards in dangerous portion of highways. Accordingly, Accidents are seen to be reduced by 20 to 30 percent in many countries in roads where light is introduced.

Environment protection is known as one of the critical criteria that needs to be respected by the economic world. Thus, in recent years, lighting has moved on from the conventional energy toward the use of a green energy, where solar light poles were introduced as an alternative

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solution to light roads and highways. Solar light poles are considered to be an efficient way to supply light without any lines installed. They represent a saving cost technology by their independence of wires, and by the use of a green energy that does not require any recurring bills. Even if these poles use solar energy, the fact that one of its components is photovoltaic (PV) panels drives it to have some limitations as their efficiency ranges between 12 % and 20 %. By being aware of these limitations, looking for a complementary solution is a must. Rather than having a solar light pole that stays on all night long, a control system is proposed to save battery energy and provides light efficiently. The light poles LEDs are lighted when needed, i.e., when a vehicle is detected in the highway lane. One of the technologies that enable the detection of vehicles is sensors. Thus, inspired by the WSN as an arising technology that is nowadays used in various fields such as industry, science, transportation, civil infrastructure, and security, a new system composed of a network of sensors to detect vehicles and provide light for them until they travel along some highways portions is suggested.

Automatic Street Light Control System is a simple and powerful concept, which uses transistor as a switch to switch ON and OFF the street light automatically. By using this system manual works are removed. It automatically switches ON lights when the sunlight goes below the visible region of our eyes. It automatically switches OFF lights under illumination by sunlight. This is done by a sensor called Light Dependant Resistor (LDR) which senses the light actually like our eyes. Automatic Streetlight needs no manual operation of switching ON and OFF. The system itself detects whether there is need for light or not. When darkness rises to a certain value then automatically streetlight is switched ON and when there is other source of light, the street light gets OFF.

The extent of darkness at which the street light to be switched on can also be tailored using the potentiometer provided in the circuit. Moreover, the circuit is carefully designed to avoid common problems like overload, relay chattering and inductive kick back in relay. The main advantages of this system consist in the reduction of the costs related to energy consumption and maintenance by integrating a vehicle detection algorithm. The introduction of a vehicle detection algorithm further reduces the power consumption costs. Increasing awareness for climate change and impeding shortage of energy sources accelerate the urge for more efficient light sources and road lighting system. Since, lighting appears for around 20% of the world's total electricity consumption, a massive changeover to more efficient lighting can help observing climate changes, increasing energy prices and maintenance costs. Thus, the main purpose of road lighting system should be to consider information regarding transportation via sensor data and take necessary action. The concept of Intelligent Street Lighting has been advanced in recent years, prompting the employment of cost-effective schemes that would primarily reduce the electrical power and maintenance costs and thus ensure maximum safety of road traffic. Currently, out-dated road lighting systems, which are very inefficient in terms of cost and energy consumption, are widely deployed all around the world. In these systems, luminaries are controlled with timers or photocells without any remote control or information retrieval options. There is no knowledge of exact amount of energy spent by each luminary and possible power leaks. Additionally, existing systems do not support any type of real time information exchange or interactive communication for adapting to changes in their surroundings. However, such a system requires not only the necessary communication infrastructure but also specific sensors to understand those changes.

II. LITERATURE REVIEW

Due to increase of environmental concerns, lighting control systems will play an important role in reduction of energy consumption of the lighting without impending comfort goals. The energy is the single most important parameter to consider when assessing the impacts of technical systems on the environment. Lighting is often the largest electrical load in offices, but the cost of lighting energy consumption is low when compared to personnel costs. Thus, its energy saving potential is always neglected. According to study, global grid based electricity consumption for lighting was about 2650TW in 2005, which was an equivalent of their electricity for lighting, whereas the share of electricity lighting is around 20-30% in hospitals, 15% in factories, 10-15% in schools and 10% in residential buildings. Intelligent lighting control and energy management system is a perfect solution for energy saving by 40%, saves lights maintenance costs by 50%, and prolongs lamp life by 25%. The system application in street light control for each lamp will reduce in streetlight electricity and maintenance cost, and increase availability of street light. List of papers and a brief introduction of it is given as below:

A. *Fabio Leccese, "Remote-Control System of High Efficiency and Intelligent Street Lighting Using ZigBee Network of Devices and Sensor", IEEE TRANSACTIONS*

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ON POWER DELIVERY, VOL. 28, NO. 1, JANUARY 2013

This paper describes a new intelligent street lighting system which integrates new technologies available on the market to offer higher efficiency and considerable savings. This can be achieved using the highly efficient LED technology supplied by renewable energy of solar panels, for which the cost of energy is independent from the power supplier prices, combined to an intelligent management of the lamp posts derived by a control system switching on the light only when necessary, increasing the lamps' lifetime. Another advantage obtained by the control system is the intelligent management of the lamp posts by sending data to a central station by ZigBee wireless communication. The system maintenance can be easily and efficiently planned from the central station, allowing additional savings. The proposed system is particularly suitable for street lighting in urban and rural areas where the traffic is low at a given range of time. The independent nature of the power-supply network enables implementing the system in remote areas where the classical installations are prohibitively expensive. The system is always flexible, extendable, and fully adaptable to user needs. The simplicity of ZigBee, the reliability of electronic components, the feature of the sensor network, the processing speed, the reduced costs, and the ease of installation are the features that characterize the proposed system, which presents itself as an interesting engineering and commercial solution as the comparison with other technologies demonstrated.

B. Imane L'hadi, marwa Rifai, yassine salih alj, "An Energy-Efficient WSN-based Traffic Safety System" ; 2014 5th International Conference on Information and Communication Systems (ICICS) IEEE Conference 2014

This paper suggests an energy-efficient WSN-based traffic safety system. The latter consists of vehicle detection for light providing through the use of sensors and actuators. Retrieved data and processed instructions are communicated through Zigbee network. The latter is ensured by the use of repeaters according to their relaying range. The VDLPS would enable the efficient lighting of dangerous highway portions. The main goal of the system is to provide light only when needed in order to optimally and efficiently use the solar light poles battery energy. When considering the implementation of such a system, it is important to keep in mind the efficiency of the LEDs which can be ensured through encapsulation. In other words, covering the LEDs with a material that can both increase their inflexion rate and protect them from dust is to be considered.

C. Cagdas atict, tanir ozcelebi, johan J.Lukkien, members IEEE, "Exploring user-centered intelligent road lighting design: a road map and future research directions"; IEEE Transactions on consumer electronics, vol.57, No. 2, May 2011.

This paper describes that, designing an intelligent road lighting system is a necessity because of the inefficiencies in the traditional systems. These old systems not only consume huge amounts of energy but also are capable of reacting to the changes in their environment. This paper describes an intelligent road lighting system to carry out user experiments on a real dynamic test bed and identify social and technical challenges. While building a software-controlled road lighting test bed, various research problems are addressed in detail. Authors have investigated intelligent road lighting systems from user experience, technology, energy perspectives and proposed useful services that can be enjoyed using the same infrastructure.

D. Case study: IoTcomm Technologies, China.

On similar paths, IoTcomm Technologies, china works. They have developed smart road light control as shown in fig (1). They also have developed smart tunnel light control system. A project of Shenyang-Sihun Highway project is developed under smart road light control system. Here, lamp controllers are communicated through Internet/GPRS to the monitoring centre.Another project realized by Australian government was about designing an intelligent transportation system. This system will address community issues concerning poor visibility during winter time by the use of high-visibility LEDs.

III. WIRELESS SENSOR NETWORKS

A sensing subsystem is responsible for the sharing of information between the sensor network and the outside world.

Characteristics of WSN

- Some of the unique characteristics of a WSN include:
- Limited power they can harvest or store.
- Ability to withstand harsh environmental conditions
- Ability to cope with node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity of nodes Large scale of deployment
- Unattended operation

Classification of Sensors Used in Vehicle Detection

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There are a wide variety of sensors available in market today. Table 1 shows the variety of current sensor technologies and compares the strengths and weaknesses with respect to installation, parameters measured, and performance in bad weather, variable lighting, and changeable traffic flow. Many over-roadway sensors are compact and mounted above or the side of the roadway, making installation and maintenance relatively easy. Some sensor installation and maintenance applications may require the closing of the roadway to normal traffic to ensure the safety of the installer and motorist.

IV. SYSTEM ARCHITECTURE

The purpose behind establishing the architecture of the system is to build the connection between the IP network level and the wireless sensors at the physical level. The role of the following architecture is to drive data and instructions from one layer to the other. The system architecture of this wireless sensing energy optimization application is presented in this section along with the description of every layer.

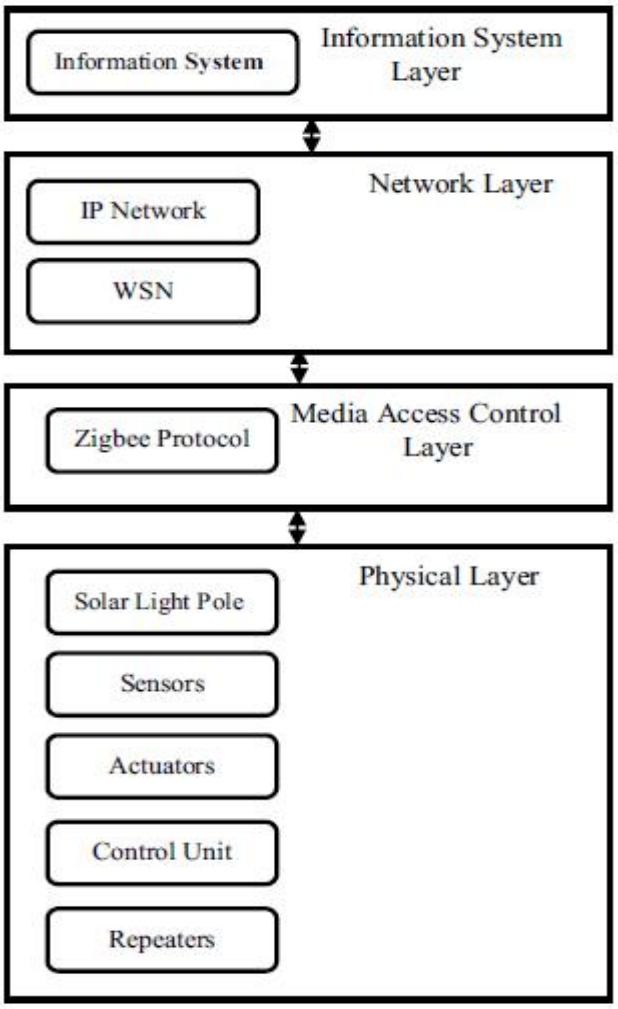

Fig.1 Solar Light Pole Components

The above Fig. shows the considered instructions and data flow among the layers' system. As soon as the sensor, in the first solar light pole, detects a vehicle, data are sent to the control unit using Zigbee Protocol which has a connectivity ensured by the use of repeaters throughout the path of the WSN. Once the data are processed, instructions to switch on or off the LEDs of the connected poles are sent to the actuators located at the first pole using the same communication protocol.

A. Physical Layer

The physical layer is composed of a group of wired solar light poles with a sensor and an actuator located at the first pole of the group. Switching on or off the LEDs of a group is managed by a control unit. The communication between these components that is ensured by a protocol is discussed in the system design.

B. Media Access Control Layer

The Zigbee Protocol Media Access Control Layer plays the role of a coordinator between the physical layer and the network layer by standardizing a set of communication rules between the involved devices.

C. Network Layer

In order to communicate the vehicle detection throughout the WSN, the Zigbee Protocol communicates the data to the IP Network. The latter is the link layer between the low level data and the information system. Its role consists of enabling the system to recognize each sensor by its location.

D. Information System Layer

This layer consists of the management system that implements the business logic. The latter is responsible of data processing and information sending. In this context, the control unit is the main location of the information system since it is responsible of receiving data, processing them and sending instructions.

V. WORKFLOW OF THE SYSTEM

The vehicle passing by the equipped highway portions is detected by the sensor of every group of solar light poles.

- Once the instructions are sent, they are received by the actuator of group 'n' and group 'n-1'. Thus the LEDs of group 'n' are to be switched on when the LEDs of group 'n-1' are to be switched off.
- The sensor of group 'n' sends the signals through Zigbee network, which is ensured by repeaters at every 600 m and an access point at 300 m of the highway portion, to the control unit to be processed and sent back as instructions.

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- Zigbee network, which is ensured by repeaters at every 600 m and an access point at 300 m of the highway portion, to the control unit to be processed and sent back as instructions.
- Amplifiers are also used in order to amplify the input signal entering the control unit and the output signal leaving the control unit.

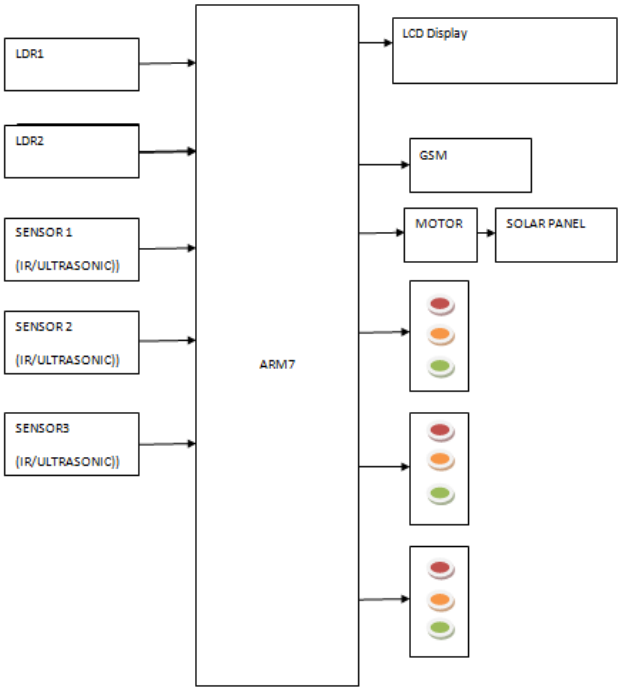

Fig.2 Proposed System Overview

Flowchart of the System Operating Logic

The flowchart in Fig. below explains the logic of the system workflow by presenting how the data is transferred and communicated throughout the stages of the system. Here the Wireless Modem is designed with array of sensors and Solar Panel is designed in the modem itself. The Flow Chart is represented for 3 Sensors Shown below. The Flow Chart can also be represented for a group of 4 or more Sensors.

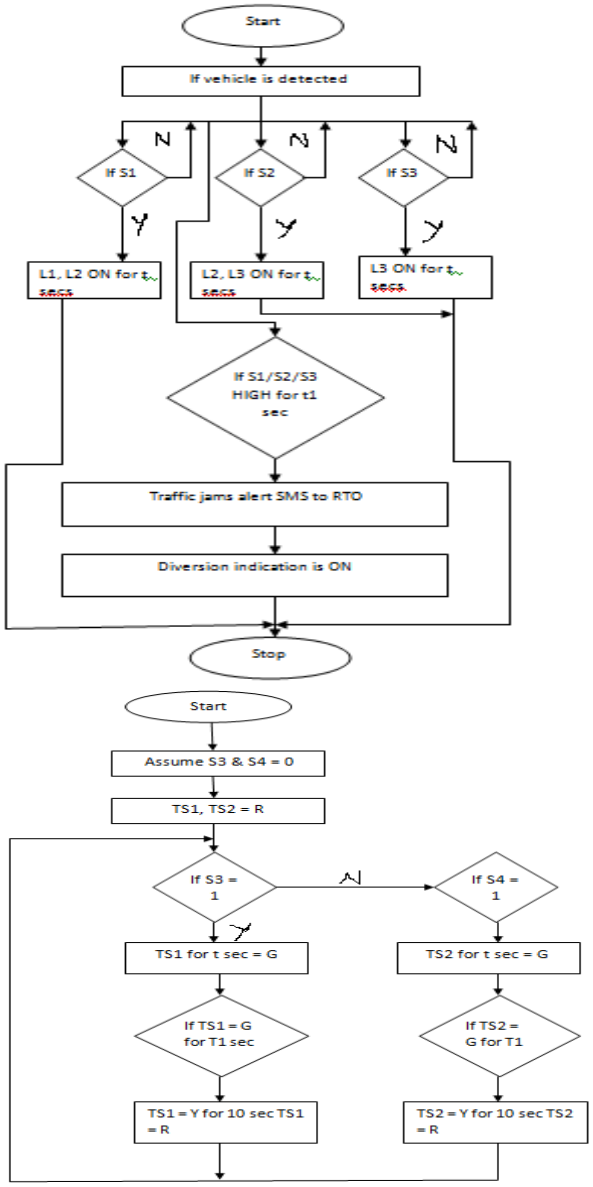

Fig.3 Traffic flow Management System

The Traffic Control for the broad portion of Highways with the Symbolic representation of 3 Sensors that is represented as S1, S2, S3 is shown in the Fig.

A. The Vehicle that is going through the Highway is detected with the help of Sensor.

B. The Array of Sensors is designed in the Wireless Modem for the detection of the Vehicle in highway roads.

C. The Wireless Sensor detects the Vehicle when it Passes through the Highway and indicates with the help of indicator.

D. When the Wireless Sensor detects the Vehicle, it sends the data to GSM Modem and in turn it sends the SMS to Traffic Controller and RTO Authority.

E. Simultaneously, the data sent to the Traffic Controller also sends the data to Diversion indicator.

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F. If Diversion Indicator is off, then it represents that the Highway road is free of vehicles and there is no traffic jam.

The Flow chart of the traffic management system is as shown in Fig-3. In this system the working condition is represented for Sensor 3 and Sensor 4 respectively. It can also be represented for other Sensors also.

A. Initially both the Sensors S3 and S4 will be in ideal condition. i.e The Status of lights will be in red condition.

B. The Vehicle going in the highway is detected through the Wireless Sensor.

C. When the Vehicle is detected by the Sensor, then it gives the green signal status for some period of time.

D. When another Vehicle is detected in another wireless sensor in another path, then the vehicle that is going in first path will go and the status of light switches from green light to yellow light.

E. After some time when signal switches from yellow light to red light, then the another path Switches to green light which indicates the vehicle to pass through the highway.

F. The Similar Process repeats for all the vehicles when the Multiple Sensors detects the vehicles in highway.

VI. CONCLUSION

The proposed system shows the efficient use of solar energy to control the traffic in highways. The main goal of this project is to control the accidents and avoid traffic jam in broad section of highways using wireless sensors and divergence indicator. The advantage of this system is it is energy efficient because of use solar energy rather than electricity. The project implemented is cost effective which makes it very easy to use everywhere in India.

FUTURE SCOPE

A. A Software Application containing array of sensors in Wireless modem can be designed in mobile using different Wireless technologies. Similarly another Software application containing the Solar Panel present in Wireless modem can also be designed in mobile. By using these techniques, the vehicle can be tracked in highway using mobile itself.

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