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Solar Powered Traffic Control System Based on Trafficdensity with Emergency Vehicle Alert

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Abstract: The objective of this paper is to use the solar energy in powering density based traffic control system with remote override facilities. Since solar energy is one of the major renewable sources and is non-polluted an attempt is made to utilize this energy in the traffic control system. A photovoltaic system is utilized for powering the system continuously. During normal time the signal timing changes automatically on sensing the traffic density at the junction by IR interruption method. But in the event of any emergency vehicle like ambulance, fire brigade etc.… requiring priority are built in with RF remote control unit to override the set timing by providing instantaneous green signal in the desired direction by blocking the other lanes by red signal. Higher traffic density at one side of the junction demands longer green time as compared to specific allotted time. The proposed traffic control system using a microcontroller of 8051 family duly interfaced with photo sensors, changes the junction timing automatically to accommodate movement of vehicles smoothly to avoid unnecessary waiting time at the junction. The density of the vehicles is measured in three zones i.e., low traffic zone, medium traffic zone, high traffic zone based on which timings are allotted accordingly. The override feature in this unit is activated by an on board RF transmitter operated from the emergency vehicle which in turn provides a high priority for all emergency vehicles.

Key words: Solar energy · Photovoltaic · PhotoDiode · RF encoder · RF decoder · Microcontroller

INTRODUCTION

Literature Review: Most of the traffic junctions are fixed type which uses constant timings for each cycle. Even though they are simple, the efficiency is very poor in high traffic conditions. In [1-3] a technique of density based traffic control system has been discussed. Here authors have proposed a system using Wireless Sensor Network to monitor the traffic density in junctions. In [4-13] author has designed a camera based tracking and classification system that uses smart camera to identify the traffic density in zones. In [8] a solar powered traffic control system has been proposed. This system uses solar cells to power the existing conventional traffic control units. It doesn't involve density based signaling. In [5] sensors based traffic control system has been designed. This system uses photo-sensors to calculate the density of the traffic on each junction and to change the signals. In [14] also proposes similar wireless sensors based system that uses photo-sensors for traffic sensing. The basic concept of density detection and calculation has been explained in the journal. In [2, 7] explains the concept of traffic detection using RFID networks. Authors of [11] have proposed same concept but using photo sensors and microcontroller logic.

Problem Statement: Existing traffic light systems have timers that are set at regular intervals. This leads to wastage of precious time of people especially in place of rescue vehicles for emergency conditions. Predetermined sequence based traffic management creates lot of issues in road. Conventional traffic signal systems are time based and cannot be varied as per varying traffic density. This causes unnecessary delay in traffic signal junctions. This also involves lot of man power and energy for its operation and maintenance [15].

Proposed System: Most of the traffic junctions are fixed type which uses constant timings for each cycle. Even though they are simple, the efficiency is very poor in high

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traffic conditions. In order to avoid problems in conventional traffic control system, the proposed method is designed. To detect the traffic density in the signals, this project uses photodiodes and IR sensors which are in line of sight configuration across the roads. The emergency vehicle alert is triggered by RF transmitters in the emergency vehicle and the RF receiver is placed in the junction. Previous approaches uses camera based or loop detection methods which are inaccurate and time consuming. Video based monitoring needs more maintenance while loop detection reliabilityis very low. In this project the circuit has two voltage sources, the battery and solar cell, in order to keep the traffic signal operating at all times even if there is a lack of the electricity. The purpose of the solar panel in the circuit is to provide a clean source of energy to run the traffic light signal and to charge the battery during the day time. The second energy source is the lead acid battery which charges by solar cell during the day time and supplies electricity to the circuit, when solar cells can't generate enough voltage to run the circuit (During night or cloudy days).

Implementation of Density Based Traffic Control Unit: The block diagram of proposed density based traffic control unit is show in Fig.2. The project uses AT89S52 microcontroller and IR sensors for deciding the signal timings based on the traffic density in each lane.

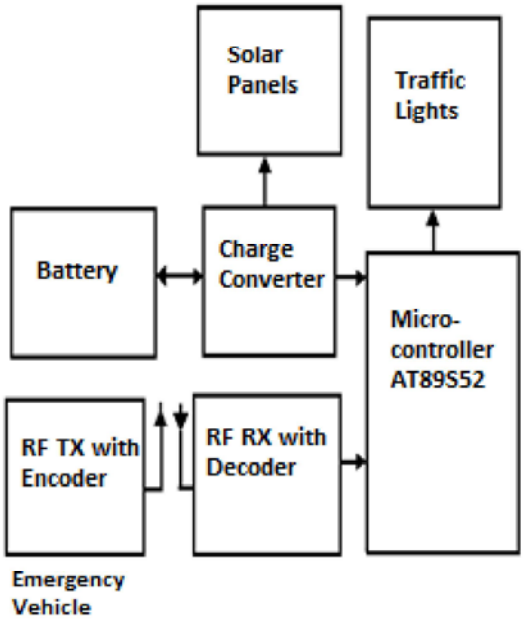

Fig. 2: Block Diagram of Solar Powered Density Based Traffic Control Unit

It uses the IR interruption concept for generating logic states to the input of the microcontroller. To achieve the same a number of IR diodes are used facing photodiodes. While the IR light falls on the photodiode the resistance of the photodiode falls increasing the bias voltage. Logic high sensed by the microcontroller input changes the green ON time to a higher value for allowing more number of vehicles to pass through. In case any other way gets more logic high, the sequential timing gets automatically increased for that way. Based on the IR interruption the green ON time increases, thus more the vehicle longer will be the green signal time. Thus dynamic time control is achieved based on the traffic density. The RF module will trigger emergency alert whenever there is any emergency vehicles such as ambulance, fire brigade, etc… This unit is powered by solar panels and a battery unit.

System Implementation: The proposed system consists of following three main units, which coordinates with each other and manages the traffic flow in the junctions efficiently and also prioritize the emergency vehicles in each traffic zone. The below are the three units of the proposed system.

- Density Detection System
- Emergency Vehicle Alert System
- Solar Power Supply

Density Detection System: The density detection system consists of an IR LED and a Photodiode which acts as an IR transmitter and receiver respectively. The system uses Microcontroller AT89S52. Each zone in the traffic junction is monitored by the IR photo sensors. These sensors monitor the density in the zone and provide input to the Microcontroller unit. Microcontroller in turn will change the signal timings as per the input provided by the sensors. If the density in a specific zone is high, then IR sensors indicate the same to microcontroller unit which has been programmed to increase the green light timings on that specific zone.

Emergency Vehicle Alert System: The purpose of emergency vehicle alert system is to prioritize the signal for any emergency vehicles like ambulance, fire brigade. This unit has two components. One is a RF encoder and transmitter circuit which will be placed in the emergency vehicle. The second component is the RF decoder and receiver which will be placed in the junction.

Whenever the emergency vehicle arrives at the junction, the driver can initiate a signal using the RF transmitter. This signal will be received in the junction RF receiver and the microcontroller unit will set the green light for the zone in which emergency vehicle is present. Rest all other zones will be set to red signal allowing the emergency vehicle to reach the destination as soon as possible.

Solar Power Supply: The solar power supply unit consists of an array of solar cells connected in parallel or series to produce DC electricity with desired parameters. The charge controller/DC-DC converter device is a two in one component which does two main functions. This device protects the battery from overcharging and deep discharging, which is very important to protect the battery and to increase its life span. It basically takes voltage supplied by solar panel and drops it down to 12 Volts and supplies both battery and the light panel. This is mainly because the solar panel output may vary up to 25V which can result in damage of the circuit components

Design and Simulation of a Charge Controller: A charge controller or charge regulator is basically an voltage and/or current regulator to keep batteries from overcharging. A charge controller or charge regulator is basically a voltage and/or current regulator to keep batteries from overcharging. It regulates the voltage (V) and current (A) coming from the solar panels going to the battery. Most "12 volt" panels put out about 20-25 volts, so if there is no regulation the batteries will be damaged from overcharging. Most of the batteries need around 14 to 14.5 volts to get fully charged. The simple charge controller will be implemented using the Multisim program.

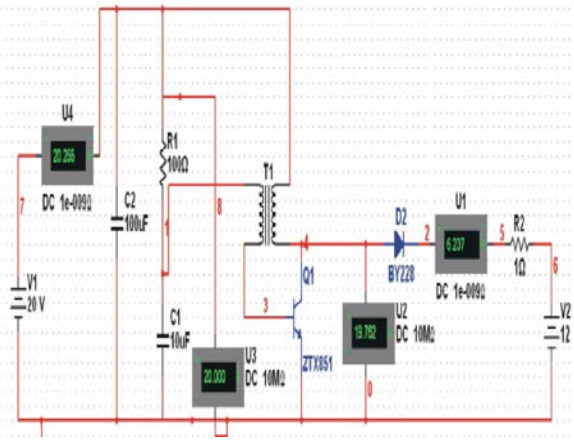

Fig. 3.1: Circuit of Charge controller

This program will simulate input, output voltages and current through the battery. The circuit built on Multisim program is shown in FIG.3.1. The graph is obtained by running a DC sweep simulation for V1, the voltage sweeps from 13 V to 20 V. The corresponding values of the current are graphed against the voltage values.

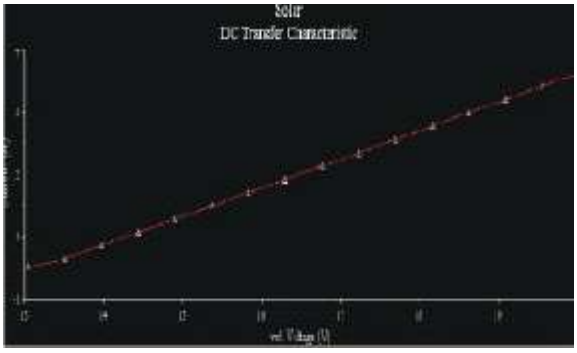

Fig. 3.2: Battery Current vs. Solar Panel Voltage

Signal Flowchart: The flow chart in FIG.4 represents the working of the proposed density based traffic control system with emergency vehicle alert.

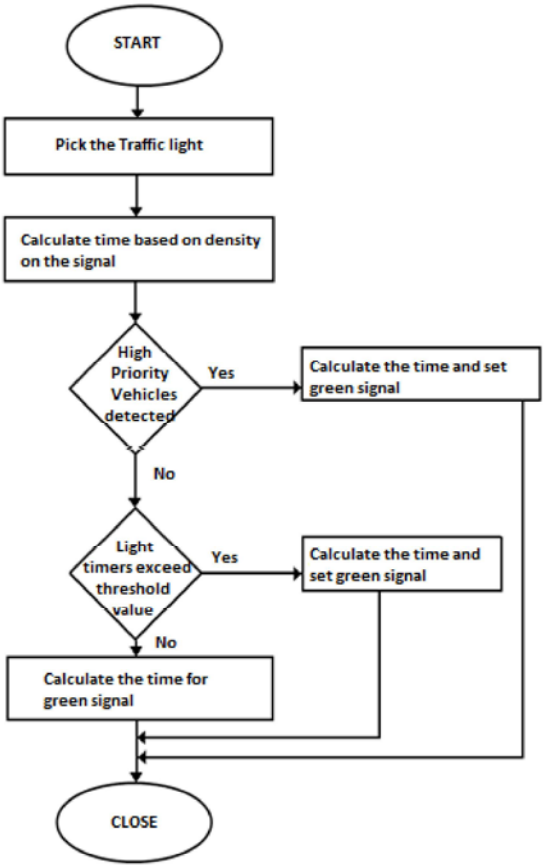

Fig 4: Signal Flow Chart

The IR sensors at the junctions calculate the density of traffic in each junction and provide input to the microcontroller. If there is any emergency vehicle alert generated, then that specific signal will be made green else the signal with high density will be made green. Once the time on any green signal reaches the threshold, the corresponding next signal will be made green.

RESULTS AND DISCUSSIONS

The proposed system overcomes the problem of traffic jam on intersection at the traffic signal system is introduced.Here the first objective is developing priority based signaling which helps to give priority to emergency vehicles in the road.

Second objective of the project is to calculate the density of vehicle on the road for low traffic smoothly without congestion. This approach is used to control the traffic smoothly. It is also helpful to overcome the traffic jam problem and avoiding congestion. It also helps in providing the emergency services like fire brigade vehicle, ambulance or police on pursuit at right time without delay. Traffic signal management when properly designed, operated and maintained provides significant benefits like less congestion, saving fuel consumption. Vehicle emissions are also reduced and it also improves the air quality.

Advantages:

- Effective time consumption on traffic signals
- Reduces time taken by the emergency vehicles at the signals.
- Usage of renewable energy source in traffic system.
- Reduced fuel consumption in vehicles at junctions.
- Reduced pollution
- Reduced man power.

CONCLUSION

This project proposes an advanced traffic control system that resolves the problems faced in conventional traffic signal systems. It provides effective time consumption on traffic signals. This also reduces man power involved in the management of traffic signals and thus reduces cost and increases safety on road. Usage of solar power makes this project more energy efficient. Also emergency vehicle override system reduces the time taken for emergency vehicles like ambulance, fire brigade and police vehicles to reach destination on time avoiding wastage of time in many traffic signals and thus reduces life risks and property damage. Overall it gives an economic consumption of fuel and man power. Proposed method also reduces the chance of traffic light violations in the junction.

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