System Requirement Specification

Project – ICT 3206

Bachelor of Information and Communication Technology

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Degree Programme

Department of Information and Communication Technology

Faculty of Technology

Rajarata University of Sri Lanka Mihinthale

Details of the Research Project

Title : Smart Traffic Light Control System Using Arduino

Group Name : Trouble Makers

Group Number : 11

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1. Research Project Problem Statement

Traffic congestion is an increasing problem in cities and sub urban spend more of their time commuting to work, school, shopping, and social event as well as dealing with traffic light jambs and accidents. Traffic became heavy in all directions, more to and from cities as well as between sub urban locations. Sub urban business locations required huge parking lots because employees have to drive; there were few buses trains, or trolleys to carry scatter workers to their work place. The hope of reduced congestion in the sub urban had not been realized; long commutes and traffic jams could be found everywhere.

Traffic congestion has been one of the major problems encountered in large cities. Traffic congestion usually depends on parameters such as season, weather, time, day and also unpredictable situations such as construction activities, special events or accidents. All these measures should be taken onto the account so that traffic congestion will not create bottleneck and delays such as long waiting times, loss of fuel and money to the road users. As the cities become more developed, there will be more difficult in monitoring and controlling of city traffic. Many methods have been studied and develop to reduce traffic congestion such as the construction of a new roads and flyovers in the middle of the city, restricting of large vehicles in the city during peak hours, and also development of sophisticated traffic monitoring and control systems. However, traffic congestion still happens especially in the bigger cities during peak hour due to the limited infrastructure and mismanagement of the traffic control systems. Currently, traffic light control system that commonly installed in many cities are timer, programmable logic controller (PLC) and microcontroller. They are installing on the street based on the situation of the road or junctions. The problems that usually faced by the current traffic light systems are:

I. **Heavy traffic light in the morning, before office hour and in the evening**

Immediately, after office hour, increasing number of vehicles in the road causes heavy traffic jams. This situation usually happens at the junctions on main road. This causes long waiting time in the popular direction. The timer is not intelligent to sense the presence of vehicles and thus the sequence of traffic light remains the same following the preset time on the timer.

II. No traffic, but still need to wait

Traffic light control functions according to the time that has been set in the systems. At the certain junction sometime, when there is no vehicles, but the road users still need to wait for the signal to change from red to green. This contributes to long waiting time for no reason.

III. Emergency car stuck in the traffic jam.

During peak hour, the emergency vehicles also will stick in traffic flow due to the road user need to wait for the traffic signal to change from red to green. This problem is more critical and should be avoided since it involves with life and death issue.

From the above scenario, an alternative solution is needed to solve or reduce the above problems. The proposed system should be relatively cheap to maintain and yet reliable to handle traffic flows with minimum queue time/ length.

2. Research Project Scope

2.1 Introduction

Traffic congestion becomes a serious issue in our day-to-day activities. It brings down the productivity of individual and thereby the society as lots of work hour is wasted in the signals.

Avoiding traffic jams for example is thought to be beneficial to both environment and economy, but improved traffic-flow may also lead to an increase in demand. It indirectly also adds to the increase in pollution level as engines remain on in most cases, a huge volume of natural resources in forms of petrol and diesel is consumed without any fruitful outcome.

Another major problem is emergency vehicles such as ambulance, fire engines are affected by traffic jams and consequently many people could lose their lives because of an ambulance delay. Newer schemes need to be implemented by bringing in sensor-based automation technique in this field of traffic signaling system.

Present day traffic signaling system is fixed time based which may render inefficient if one lane is operational than the others. To optimize this problem, we have made a framework for a smart traffic control system. Sometimes higher vehicles at one side of the junction demands longer green time.

This research proposes a simple, low cost and real-time traffic light control system, aimed at removing many flaws and improving traffic management.

The next attractive feature of the system is its preference given to the emergency vehicles. This is done by providing special communicating devices that can control the traffic lights so that lane opens and allow that vehicle to pass the signal.

2.2 Methodology

The basic hardware concept in the methodology is the smart traffic light control system is composed of two separate devices: the traffic master controller and the portable controller. Figure 1 shows the hardware implemented circuit of the smart traffic control system the traffic master controller is mounted with the traffic lights at the roads intersection and is responsible for the lighting transition and their timing slots. The Traffic Light Control System consists of mainly Arduino mega 2560 Microcontroller, which is the heart of the system, IR Sensors placed on top of every lane just far away from signal lights, IR sensors are arranged on each lane, above the road at a certain distance, say 50 m (each side of the junction). These IR sensors are connected to one microcontroller. The IR sensor collects the data that has crossed it and transfers it to the microcontroller. It will analyze every lane has how much vehicles have and the green signal will be assigned to vehicle count. The signal lights are connected to the microcontroller, which reflects the vehicle count in the form of green light. More time slice will be assigned to a particular lane, which has much vehicles. The lane which has less traffic gives its own time to another lane which has much vehicle. So as vehicles pass through from the IR sensors the number of vehicles will be counted and the information will be sent to the microcontroller. It calculates the time slice of each vehicle to be projected as output in the form of a green light beam. For each vehicle crossover, the time calculated for each vehicle will be 2 sec. So, for additional vehicle pass through, multiple of 2 sec. will be added. If there is continuous vehicle blockage at IR sensor, it is a denotation that traffic has reached a certain maximum limit (maximum time limit is 100 seconds) and the green signal beaming time will be set depending on calculated time based.

The next attractive feature of the system is its preference given to the emergency vehicles. This is done by providing special communicating devices that can control the traffic lights so that lane opens and allow that vehicle to pass by. The other basic components is ZigBee transmitter system (portable controller). ZigBee module receives the command orders form the portable controller and calls the corresponding emergency subroutines. The portable controller commands the master controller by means of ZigBee transceiver that communicates wirelessly with the other ZigBee component. An Arduino UNO constitutes the hardware core of the portable controller. It is connected, in addition to ZigBee, to that change signal light to green to emergency vehicle . The Zigbee receiver in the portable side will obtain this which is transmitted from the main controller sid.

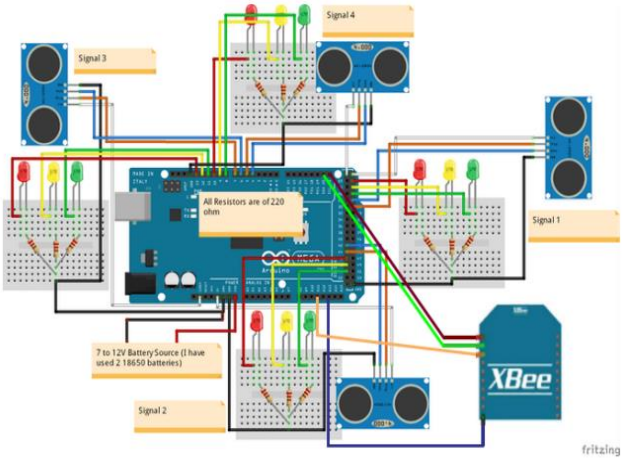

Figure 1 Traffic Light Unit Circuit diagram

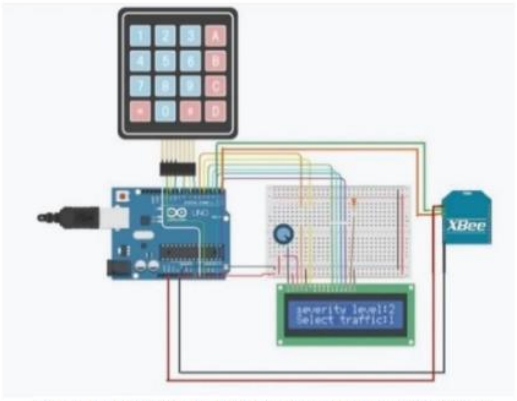

Figure 2 Emergency Vehicles Portable unit circuit diagram

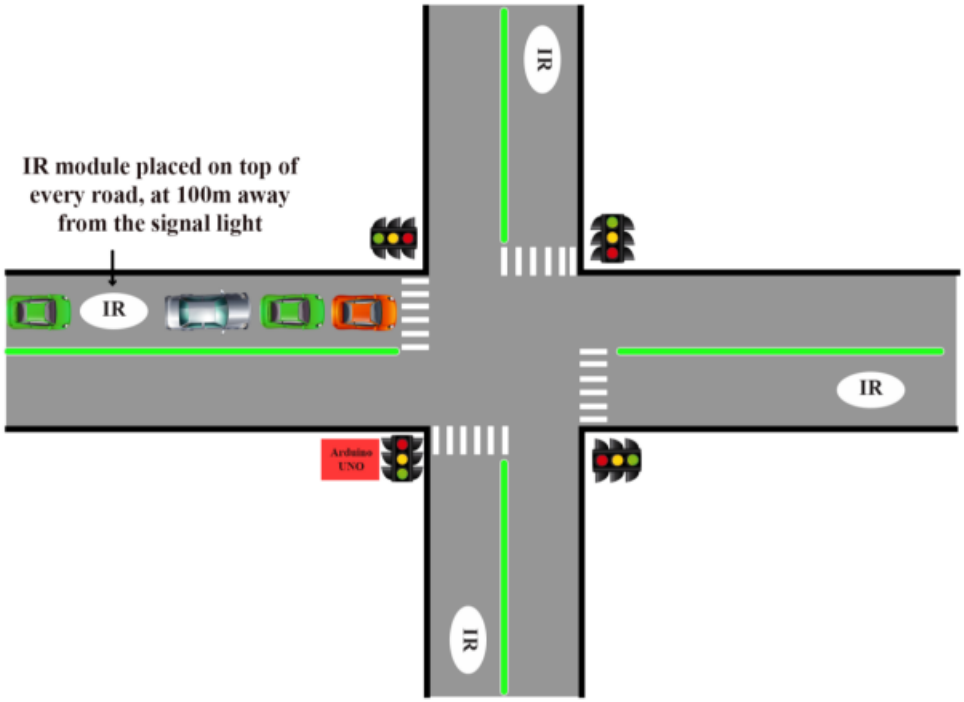

Figure 1 Intersection of four directional road

2.3 Intended Solution

In our project we focus on optimization of traffic light controller in a city using IR sensor and developed system using microcontroller Arduino mega 2560, another part is emergency vehicles are using Portable Controller that can control the traffic lights so that lane opens and allow that vehicle. We present this project because to reduce traffic congestion which results in long waiting times to turn signal green, loss of fuel.

3 Research Project Overview

It is seeing terrible road congestion problems in cities. Infrastructure growth is slow as compared to the growth in number of vehicles, due to space and cost constraints. Also, traffic is non lane based and chaotic. It needs a traffic control solutions, which are different from the developed Countries. Smart Traffic Light Control System can reduce the negative impact of congestion. In recent years, wireless networks are widely used in the road transport as they provide more cost effective options. Technologies like Microcontroller, ZigBee and IR sensor can be used in traffic control to provide cost effective solutions. Our project is reducing traffic congestion and unwanted long-time delay during the traffic light switch overs especially when the traffic is very low. It is designed to be implemented in places nearing the junctions where the traffic signals are placed, in order to reduce the congestion in these junctions. This system reduces the waiting time as traffic signal's light will change according to vehicle count. So, it also reduces traffic jams. It keeps a track of the vehicles in each road and accordingly adjusts the time for each traffic light signals.

The higher the number of vehicles on the road. the timing of the signal will change automatically by counting the number of vehicles. if there will be no traffic on the other signal, one shouldn't wait for that signal. The system will skip that signal and will move on the next one. Saves the emergency vehicle passengers from any accident it avoids the time wasted by waiting the emergency vehicle for the red light. Heavy traffic jam it wastes time as well as fuel also and it happened at the main junctions when people have emergency such as before office hour, morning and after office hours, evening.

4 Data Requirements

The basic information for making this system was collected from one of the four lanes. The junction is located in the main city where most vehicles can go. Basically, it was rare from the collected data that the vehicles spend more time to cross the signal light parallel. How does an existing signal system work? What is its technical information? Such information was collected. Most of the data came from the Internet. Retrieved from the Internet in the form of video, audio, article etc. We used infra-red technology to refer to a lot of data as we needed a system that could work in real time based on the data obtained. This smart traffic light control system is mainly based on microcontroller. The main technology used is the IR sensor. The IR sensor counts vehicles in real time and receives that data and sends it to the main microcontroller.

Another section of the emergency department is also operational today. That is, the portable controller transmits the lane number to required for the emergency vehicle to go from the emergency vehicle pilot to the main microcontroller using ZigBee technology.

5 Implementation Requirements

5.1 Functional Requirement

Functional Requirements are the statements of services the system should provide and how the system reacts to particular inputs and how the system should behave in particular situation. The requirement specifies that a function that a system or component must be able to perform.

- System will allow admin of the system to rewrite traffic data.
- Arduino mega microcontroller will automatically adjust the signal timing.
- By measuring the traffic vehicle count on road signal timings should be adjusted.
- According to much vehicle count the system should clear out the particular way and then the next route accordingly.
- There should be an emergency override that allows traffic authorities to remotely let go a particular signal in case an ambulance or important vehicle arrives on that way.
- System will provide interface to emergency vehicle pilot to control the flow of traffic i.e. portable controller used to manage emergency situation.
- The signal lights are connected to the microcontroller, which reflects the vehicle count in the form of green light.
- So as vehicles pass through from the IR sensors the number of vehicles will be counted and the information will be sent to the microcontroller.
- If there is continuous vehicle blockage at IR sensor, it is a denotation that traffic has reached a certain maximum limit (maximum time limit is 100 seconds) and the green signal beaming time will be set depending on calculated time based.

5.2 Nonfunctional Requirement

In systems, Non-functional requirements are requirements which specify criteria that can be used to judge the operation of a system, rather than specific behaviors. This should be contrasted with functional requirements that specify specific behavior or functions. Typical non-functional requirements are Reliability, Availability, Scalability, Performance, Usability, Maintainability,Security, Portability and Cost. Other terms for non-functional requirements are "quality attributes" and "quality of service requirements".

- **Efficiency**

Efficiency in general describes the extent to which time or effort is well used for the intended task or purpose. It is often used with the specific purpose of relaying the capability of a specific application of effort to produce a specific outcome effectively with a minimum amount or quantity of waste, expense, or unnecessary effort.

- **Scalability**

Scalability, as a property of systems, is generally difficult to define and in any particular case it is necessary to define the specific requirements for scalability on those dimensions that are deemed important. It is a highly significant issue in electronics systems whose performance improves after adding hardware, proportionally to the capacity added, is said to be a scalable system.

- **Reliability**

Reliability is the ability of a person or system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances. System should be reliable enough to satisfactorily the performance.

- **Availability**

System should be available every time and on every window it should support.

- **Usability**

System should be user friendly and should provide information error message to inform user when something goes wrong.

- **Maintainability**

System should be easily maintainable. It should be flexible enough to stand with change and exceptions. The system should also handle new requirements. It should have capability to maintain in new environment.

- Security

Security is the main issue. System should be safe and ensure the security. It will ensure secure transfer of data.

5.3 Software Requirements

Operating System : Windows XP or Higher

IDE **:** Arduino, XCTU digi zigbee

Language **:** C#

5.4 Hardware Requirements

Processor **:** Pentium IV or above.

RAM **:** 2 GB or more.

Hardware Space **:** Minimum of 80 GB.

Other Components **:**

- 4 IR Sensors
- Jumper WIRE
- 12 LED Lights (4-Yellow,4-red,4-green)
- Arduino mega 2560 Microcontroller
- ZigBee
- Arduino UNO microcontroller
- 2 breadboards