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## TELEMETRIC CONTROL OF TRAFFIC LIGHTS INTERSECTIONS ASPECT RATIO IN GHANA

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#### ABSTRACT

This paper presents the current operation and maintenance of traffic light intersections and the design of a telemetry system to monitor and control traffic light intersections in the Accra metropolis. Telemetry is a technology that allows the remote measurement and reporting of information of interest to the system designer or operator. The design of a telemetry system constitutes the selection of a suitable hardware system and the appropriate software for the design of a human machine interface (HMI) to monitor the state of traffic lights intersections and taking appropriate actions to resolve faulty traffic lights intersections.

Keywords: traffic lights, telemetry control system, monitoring, intersections, human machine interface.

## **INTRODUCTION**

A traffic light also known as a traffic signal or stop light, is a signaling device positioned at road intersections, pedestrian crossings and other locations to control the movement of vehicles and pedestrians. Traffic light intersections are employed country wide to improve the efficiency of traffic flow and reduce average travel time of both vehicles and pedestrians. Recent and continuing growth has resulted in increasing demand for travel on urban highways. Many highways are operating under congested condition throughout much of the day. Traffic congestion causes considerable cost due to unproductive time losses, accidents and also has a negative impact on the environment such as air pollution and fuel and on the quality of life, noise and stress. The economic consequences of traffic congestion are enormous. Due to the ever increasing need for transportation, there is more and more traffic congestion in developed and developing countries [1, 2, 3, 4]. Traffic congestion continues to hinder economic and social development and also has a negative impact on the people, quality of life as well as the environment. The presence of traffic congestion cost a lot each year in form of lost productivity. In the year 2000, it was estimated that drivers in 75 of the largest metropolitan areas of the world spent more than sixty eight billion dollars in person hours of lost time and wasted fund [12,

#### **Traffic lights installation**

There is significant difference from place to place in how traffic light intersections are installed so that they are visible both to drivers and pedestrians. Mounting and networking of traffic light intersections depends on the design and location. Figure-2 depicts a typical layout of a T-Junction traffic intersection which is shown below.

#### Maintenance of a traffic lights intersection

The Maintenance of traffic signals is a fundamental aspect of the Department of Urban Roads. At present there are 89 junctions and 4 pedestrian crossings 13]. In USA the cost of congestion is estimated to be 67 billion dollars each year [14]. This includes 3.6 million dollars in additional travel time and 5.7 billion gallons of fuel wasted while sitting in traffic [14].

Traffic delays result in increased air pollution, thus contributing towards the deterioration of the health and welfare of the citizen. The problems of traffic congestion are enormous, (such as queues, accidents, pollutant emissions,) a complete satisfactory scientific understanding of the phenomena of traffic congestion is still lacking [3, 4]. A reliable scientific description is crucial to study several scenarios and to take a good decision. Over the years, traffic lights have suffered and continue to suffer a lot of setbacks due to the frequent faults and the way of maintenance. Because of all the enormous problems of traffic congestion, this paper was developed to present the current operation and maintenance of traffic light intersections and the design of a telemetry system to monitor and control traffic light intersections in the Accra metropolis. Traffic lights normally have three main lights: a red light meaning 'stop', a green meaning 'go' and the amber light meaning 'stop if possible'. Automatic control of interconnected traffic lights was introduced in March 1922 in Houston, Texas.

controlled by traffic signals within the city of Accra. The Department of Urban Roads is responsible for the operation, maintenance, improvement and repair of all of the traffic signal installations.

There are two main contractors employed to assist with the maintenance, Facol Roads Limited and Signal Limited. They both deal with technical faults such as the following: replacing of fused bulbs in signal heads and push buttons, alignment of signal heads and poles, resetting of controller in times of malfunction, tracing and repairing of cables in manholes, signal heads and pole compartments.

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Figure-1. A modern traffic light.



Figure-2. Typical layout of a T-junction intersection.

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Figure-3. Routine maintenance of a traffic lights intersection.

It was observed that the existing system of routine maintenance is very expensive, time consuming and inherently inefficient. This problem calls for a highly efficient telemetric control system which will monitor all the traffic light intersections and also establish some control over traffic light intersections from a base station. This paper is intended for the design of a telemetry (The word is derived from Greek roots tele (remote), and metron (measure).system through the selection of hardware system architecture and the appropriate software for the design of a human machine interface to monitor the state of traffic light intersections and taking actions to resolve faulty traffic light intersections.

## MATERIALS AND METHODS

# Construction, operation, monitoring and maintenance of traffic light intersections

The traffic light system consists of important components such as the controller which is the brain of the system, the sensors, which detect the presence of vehicles and the signal head which acts as the actuator. Figure-4 depicts the component parts of the traffic light system.



Figure-4. Functional block diagram of a traffic lights intersection system.



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#### Vehicle transducer

As part of optimum operation of traffic light intersections, there are all sorts of technologies for detecting vehicles. Some of these technologies are microwave and millimeter-wave radar, active LED infrared radar, video image detection system (VIDS) and loop detector among others []. Because the traffic flow rates change from time to time, it is often desirable to adapt the detector to the actual offered traffic light controller. Detectors that indicate the presence or absence of vehicles are necessary for this type of control. With the information from these detectors, the duration of phases, and/or the order of the phases can be changed.

## Active LED infrared radar

Infrared (IR) detectors operate on the same principles as microwave radars, but transmit low power

energy from light emitting diodes (LEDs) or from laser diodes. The detector senses a portion of the reflected energy in its field of view. The distance of an object from the detector is found by measuring the two-way travel time of the infrared pulse, from the detector to the target and back. The IR detector then focuses the rebound energy from vehicles and translates it into electrical pulses. IR detectors can be used for passage of moving objects, presence or absence of objects and detecting speed of objects (Huang and Miller 2003). Active IR detectors can be mounted on bridge overpasses or on existing poles. More than one IR unit can be mounted to a pole without signal interference degrading performance. Units are typically mounted at heights between 15 and 30 ft. (Huang and Miller, 2003).







Figure-6. An installed active IR detector.

## **Loop Detectors**

Loop detectors are the most common form of detectors implemented in Ghana. A loop detector consists of an insulated electrical wire placed on or below the road surface. The loop is attached to a signal amplifier and a power source, creating an electromagnetic field in the area of the loop. The wire loop is excited at frequencies from 10 kHz to 200 kHz. In conjunction with pull box electronics, the loop becomes an inductor, whose inductance decreases whenever a vehicle or other larger metallic object passes over it or stops on it. The resulting inductance change generates a signal to a controller.

Loop detectors are only as responsive as their hold times. The hold time (in milliseconds) is the pulse duration that the loop sends to its receiver. The loop is effectively inoperable while sending a pulse. Loops are capable of detecting the presence or passage of vehicles. When used in series, loops can also relay speed information. Single



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loops can be used to obtain average speed, by assuming an average vehicle length (Huang and Miller, 2003). Rectangular shaped loop detectors are subject to cross-talk by loops in adjacent lanes and by the reinforcing steel in the road; the right-angle corners of these loops make them subject to deterioration under heavy loads. Diamond shaped loop detectors reduce cross-talk because they have no sides that are parallel to reinforcing steel or to other diamond loops in adjacent lanes. Also, the corners of the diamond type create concentrated magnetic fields that allow for a precise determination of when a vehicle enters and leaves the detection zone. The circular shaped loop detector reduces cross-talk and may provide a uniform magnetic field height that can be increased without field "spillover" beyond the boundaries of the loop. They have no sharp corners. A single loop with a signal amplifier

costs around \$700.00 including installation [Huang and Miller, 2003].

Loop detector installation requires a saw cut in the road in the shape of a loop which is either rectangular, diamond or circular. After the slot is cleaned and removed of sharp corners, a copper wire typically 14 to 18 gauge is wound around the saw cut several times. The saw cut is filled with the remaining cavity and epoxy. Pre-wound loops Pre-wound loops are manufactured to customer specifications and then encased in a seal removing a lot of the problems associated with loop installation. They can be installed during repavement or they can be laid directly into a saw cut, where, the saw cut for a pre-formed loop must be made wider to accommodate the protective encapsulation [Huang and Miller 2003]



Figure-7. Loop detector installed beneath the asphalt of a road intersection.

#### Signal heads and pedestrian push button

Manhole Concrete Slab

A signal head consists of signal faces that control traffic for specific movement in a single direction. In Ghana the most common signal heads are the vehicle 3-aspect and the pedestrian 2-aspect where their usual colours are solid red, yellow and green light and/or green/yellow turn arrows. A pedestrian push button assembly is for activating a signal generator to generate a signal at a street crosswalk. Both signal heads consist of respective number of 20 cm<sup>2</sup> signal faces (lanterns), standard type double insulation 230/12 V 50 VA transformers, 12 V 50 Hz 50 W 820 lumens 2,000 hrs life

expectancy halogen bulbs, polished anodic electrolytic casing 99.9 % pure aluminium reflectors and polished glass lenses. It is installed in a manner that prevents it from overheating by the halogen bulb, which enables constant reflection of light upon the entire lens surface. In special cases, an arrow with the colour of the lens is created on a black background, only on the green lens. The vehicle signal head in particular is installed on 2.5 m steel pole with the aid of bolts and nuts. This pole is mounted on a pole pedestal buried about 0.5m into the ground. Proper alignment of vehicle signal heads and poles are ensured for proper vision to all road users.

10





Figure-8. Signal heads of a traffic lights intersection (Anon, 2007)



Figure-9. Detailed parts of a vehicle signal head.



Figure-10. Detailed parts of a pedestrian signal head.



Push Button Display

Figure-11. Pedestrians push button installation (Anon, 2008).

The pedestrian push button assembly has a rigid frame having a piezoelectric material of a solid state switch positioned across a central aperture, and an elastic sealing ring positioned in a groove surrounding the piezoelectric material. A button is secured to the rigid frame such that a seal contact portion of the button sealable rests against the elastic sealing ring. A very small space separates an abutment surface of the button and a stopper surface of the rigid frame, and an elastic pressure portion of the button contacts the piezoelectric material. When operated, the elastic sealing ring is sufficiently biased to urge the elastic pressure portion against the piezoelectric material to generate a pulse signal which travels through wires to the controller to announce the presence of a pedestrian at the junction (Anon, 2006). The pedestrians push button is installed about 1.2 m from the surface of the ground on a traffic light pole with the help of bolts and nuts.

#### **Traffic lights controller**

A traffic signal is typically controlled by a controller mounted on a concrete pad. Traffic controllers use the concept of phases, which are directions of movement lumped together. For instance, a simple intersection may have two phases: North/South, and East/West and these phases are either controlled by controllers fixed time mode or detector which is through the use of transducers. Although some electromechanical controllers are still in use (Trade Fair-Accra), modern traffic controllers are of programmable logic controller (PLC) technology. The typical controller consists of miniature circuit breaker, power panel, programmable logic controller and the dimming transformer, Figure-4.



Figure-12. An installed traffic light controller

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The miniature circuit-breaker provides efficient and reliable protection for traffic light cables and the controller cabinet in traffic light installations. Three different tripping characteristics provide the ideal solution for all applications from cable protection up to the protection of controller cabinet [Brittain, 2003]. The power supply module takes 240 V ac and distributes 5 V dc power to the PLC's Central Processing Unit, 24 V dc to the transducers and 240 V ac to both the dimming transformer and output devices. The dimming transformer is a single phase 240/110 V transformer, which in conjunction with the PLC reduces the illumination of the signal heads in the evening. This usually affects the vision of drivers.

 Table-1. Specifications of a typical traffic light

 Miniature circuit breaker

Туре	3 pole
Rated current (A)	40
Rated operating current (A)	0.04
Rated voltage (V)	230
Residual operating current rating (A)	42
Switching capacity (kA)	4.5
Mechanical life (Years)	1000



Figure-13. 40 A miniature circuit breaker (Anon, 2007)

A programmable logic controller (PLC) is a specialized computer-type device used to control equipment in an industrial facility. The PLC provides soft wiring connections and flexibility between system devices as opposed to hard, inflexible, costly and time-consuming wiring of traditional traffic light control systems installations. All equipment are wired to the PLC and the executable computer control program stored in the PLC's memory provides the "wiring" connection between the devices. Soft wiring enables changes in the traffic light system to be made easily and cheaply.



Figure-14. Block diagram of a programmable logic controller.



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The PLC basically consists of the central processing unit, memory and the input/output modules as depicted in Figure-14. The programming device, detachable, is added to the PLC to achieve the needed programming functionality. The central processing unit (CPU) as the "brain" of the PLC retrieves, decodes, stores, and processes information from input devices such as vehicle transducers and accordingly executes the control program stored in its memory in order to generate the output signals to control field actuators such as the signal head. The I/O modules are units with connection terminals to which the transducers and signal heads are wired.

# THEORY OF DESIGN OF A TELEMETRIC CONTROL SYSTEM

#### Wireless radio telemetry system

Telemetry is a technology that allows the remote measurement and reporting of information of interest to the system designer or operator. Telemetry is invaluable in circumstances where the equipment is remote, inaccessible or increased accessibility goes with a health risk. Radio, as a means of communication, is the medium through which data at remote locations are reported wireless. Wireless telemetry is the wireless transmission and reception of measured quantities or data for the purpose of remote monitoring making use of a radio frequency system to implement the data link. It offers convenience and increased information accessibility to equipment or data located in hazardous and remote areas. A basic wireless radio telemetry system consists of an input transducer, the transmitter and receiving station



Figure-15. Functional block diagram of a telemetry unit.

Transducers convert the measured physical quantity or data into a usable form for transmission. The type of transducer employed is synonymous with the form of energy conversion which in turn is determined by the type of transmission desired. In a radio telemetry system, the transmitter and receiver have much in common with communications equipment whilst the transducers are unique to telemetry. The radio link can transmit an analog of the continuous variable being measured, or, with pulsecode methods, it sends the measurement data digitally as a finite number of symbols representing a finite number of possible values of the measurement signal at the time it is sampled. The range of a radio link is limited by the power

Table-2. Frequency bands for telemetry.

Frequency range	Application
88-108 MHz	Low power, noninterference
216-260 MHz	General telemetry
400-475 MHz	Command destruct
1435-1540 MHz	General telemetry
1710-1850 MHz	Video telemetry
2.2-2.3 GHz	General telemetry

(Source: Hoeppner, 2000)

radiated toward the receiver from the transmitter and by the sensitivity of the receiver. The wider the bandwidth, the more the effect from noise, and therefore the more transmitted power required for a detectable signal.

#### **Frequency bands for telemetry**

Multiplexing remains a common and extremely useful technique for increasing the information-carrying capability of a single transmitting radio telemetry line. When it is desirable to monitor different physical parameters or locations, it may be wasteful to have too many duplicating telemetry transmission lines.

Frequency plays an enormous role in radio communication coverage. Ultra-high frequencies (UHF) offer communication distances of around 25Km to 100Km and above with appropriate site locations and heights while unlicensed low band products (400 MHz) offer limited distances. Unlicensed spread spectrum devices with antennae offer distances of 10Km up to 20Km, with mobile phone coverage being country-wide. Satellite coverage can be "local" or "global" depending on the network and the amount of satellites employed and its purpose (Hogg, 2003). A reliable radio communication requires a highly reliable 'line of sight' path. Repeaters in conjunction with high gain antennae are used to give greater radio coverage. Table-3 gives frequency bands for transmission and reception of some radio modems.  $\ensuremath{\textcircled{O}}$  2006-2009 Asian Research Publishing Network (ARPN). All rights reserved.





Frequency Range, MHz			
Transmission Reception			
848 to 858	920 to 934		
920 to 934	848 to 858		
925 to 943	906 to 924		
855	860		
924	944		

(Source: Hogg, 2003)

## Radio telemetry unit

Radio telemetry unit (RTU) is a special purpose PLC with a modem connected to a radio transceiver and an antenna. The difference lies in the limited number of RTUs input/output arrangement as compared to that of a PLC. Thus, the selection criteria for a PLC apply to the RTU. Combination of both RTU and PLC in a complex system is possible. All RTUs are designed to allow the monitoring and control of remotely located equipment. By connecting two RTUs together via a radio or telephone link transfer of status information measured on one to another is possible. More complex networks allow several RTUs to be connected via a communications network to one master unit so that the remote sites can be monitored all at a convenient central location (such as the offices).



Figure-16. Block diagram of radio telemetry unit (Source: www.logicbeach.com).

## Radio telemetry unit interfacing and configuration

Radio telemetry unit (RTU) is interfaced to a personal computer (PC) and programmable logic controllers (PLCs) via a non-protocol interfacing RS232 port. Most RTUs use this interfacing medium while others use PCMCIA ports in addition to the RS232 which allows a range of PC cards to be inserted into the RTU to allow connection to Ethernet networks.



Figure-17. Radio telemetry interfacing (Hogg, 2003).

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The radio telemetry system may typically be configured in either of two ways; either point to point (PTP) or point to multi-point (PTMP). The PTMP has a master device which periodically reads and writes data between itself and several other slave devices. There can be only one master in this type of system.

#### Transceiver and antenna unit selection

The success of a telemetric control system using radio frequency largely depends on its transducer and transceiver unit. The transceiver is a dual purpose device that has the ability to transmit and receive data signals. Factors that influence the choice of a transceiver and antenna unit are sensitivity, selectivity, range, noise level. A radio telemetry system could be categorized as local, centralized or distributed Control

#### Local control radio telemetry system

A local control radio telemetry system is a system in which sensors/transducers, a controller, and controlled equipment is within close proximity and the scope of each controller is limited to a specific system or subsystem. Local controllers are typically capable of accepting inputs from a supervisory controller to initiate or terminate locally-controlled automatic sequences, or to adjust control set points, but the control action itself is determined in the local controller. Required operator interfaces and displays are also local. This provides a significant advantage for an operator troubleshooting a problem with the system, but requires the operator to move around the facility to monitor systems or respond to system contingencies.

#### Centralized control radio telemetry system

Centralized control describes a system in which all sensors/transducers, actuators, and other equipment within the facility are connected to a single controller or group of controllers located in a common control room. Locating all controls, operator interfaces and indicators in a single control room improves operator knowledge of system conditions and speeds response to contingencies. Centralized control systems are only considered for small facilities.

## Distributed control radio telemetry system

Distributed control system architecture (Figure-20) offers the best features of both local control and centralized control. In a distributed control system, controllers are provided locally to systems or groups of equipment, but networked to one or more operator stations in a central location through a wireless communication circuit. Control action for each system or subsystem takes place in the local controller, but the central operator station has complete visibility of the status of all systems and the input and output data in each controller, as well as the ability to intervene in the control logic of the local controllers if necessary. This is considered to be the most appropriate system because it easily fits into the current traffic light system.



Figure-18. Local control system architecture (source: Schoomaker, 2006).

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Figure-19. Centralized control system architecture.



**CONTROL ROOM** 

Figure-20. Distributed Control System Architecture

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## Proposed Design of Telemetric Control of Traffic Light s Intersections

signal heads), traffic light controllers, human-machine interface ("HMI"), communication link and software.

The proposed telemetry system includes master station, input-output signal hardware (transducers and



Figure-21. Distributed control system architecture for traffic lights.

## System Components

#### a. Controller

A traffic signal is controlled by a controller inside a cabinet mounted on a concrete pad. The cabinet typically contains a power panel, to distribute electrical power in the cabinet; a detector interface panel, to connect to loop detectors and other detectors; detector amplifiers; and the controller itself. Traffic controllers use the concept of phases, which are directions of movement lumped together. For instance, a simple intersection may have two phases: North/South, and East/West and these phases are either controlled by controllers fixed time mode or detector which is through the use of transducers.

The controller however, is in the existing traffic system and needs not to be replaced.

#### **b.** Transducers

As part of optimum operation of traffic light intersection, there are all sorts of technologies for detecting vehicles, everything from microwave and millimetre-wave radar, active LED infrared radar, video image detection system (VIDS), loop detector etc. Because the traffic flow rates changes from to time, it is often desirable to adapt the detector to the actual offered traffic. Detectors that indicate the presence or absence of vehicles are necessary for this type of control. With the information from these detectors the duration of phases, and/or the order of the phases can be changed. The common once used in Ghana are the inductive loop type and tha active infrared red detector. This also is in the existing traffic system and needs not to be replaced.

#### c. Master Station

The term "Master Station" refers to the servers and software responsible for communicating with the field equipment (traffic light controllers), and then to the human machine interface software running on workstations in the control room, or elsewhere. In these telemetry systems, the master station is composed of a single PC.

Master stations have two main functions:

- i. Periodically obtain data from traffic light controllers.
- ii. Control remote devices through the operator station.



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## d. Communication Link

The communication link is provided by sixty four GS35 GSM Siemens modem. A GSM modem is device that allows you to send and receive information over the GSM network with computers. Sixty three of GSM modems will be connected to the remote traffic controllers through an RS232 serial port interface on the controller

and the last connected to master station in the control room. The communication service will be provided by any of the GSM service providers in the country. The on site sixty three GSM modems will be sending messages (fault massages) from faulty intersections to the master station GSM for processing.



Figure-22. GSM modem connection to traffic light controller through RS 232 port.

## **GSM Network Structure**

The GSM network is divided into three major systems as follows: the switching system (SS), the base

station system (BSS) and the operation and support system (OSS), all together with some additional functional elements.



Figure-23. GSM architecture (source: www.iec.org).

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#### System Software



Figure-24. Software architecture.

#### a. Short message service server (activeXpert software)

SMS Messaging Server is an SMS messaging framework that enables on site GSM modems to send, receive and process SMS messages. The framework is designed to scan the GSM modem every five second for "fault" message and update the Microsoft access database software.

#### b. Database software (microsoft access)

Microsoft Access is a relational database management system from Microsoft which combines the relational Microsoft Jet Database Engine with a graphical user interface and software development tools. It is a member of the 2007 Microsoft Office system. Access is used in this case to store messages from the SMS messaging server (ActiveXpert software) in codes of "01-99" in it database.

#### c. Dynamic data exchange server (DDE)

This is software created by visual basic to aid two or more software to communicate with each other. That is, HMI software communicate (RS View) with the database software (MS Access) through the dynamic data exchange server software.

#### **d. Human machine interface software** (RS View)

A Human-Machine Interface or HMI is the apparatus which presents process data to a human operator, and through which the human operator controls

the traffic light intersections. This will be done with the aid of RS View software. The RS View was essentially born out of a need for a standardized way to monitor and to control multiple remote traffic light controllers. This software's interface will show the map of central Accra with corresponding animated traffic light intersections. These animated traffic light intersections will change colour when the database is updated as a result of faulty remote traffic light intersection sending an SMS message to the master station.

#### **Application to the Accra Traffic Lights Intersections**

## Cost analysis

The cost analysis involves weighing the total expected costs of existing way of maintaining traffic light intersections against the improved method of maintaining traffic light intersections in the Accra municipality. The cost of implementing this project will be run for two years.

# Cost of Existing Method of Maintaining Traffic Lights Intersections

Table-2 shows cost of existing method of maintaining traffic light intersections. It takes into account the items used in the routine maintenance in Accra their various quantity and cost. The grand cost of maintaining the existing traffic light intersections is found to be GH¢ 29,520.00.

Item	Quantity	Unit cost (GH¢)	<b>Total</b> (GH¢)
Fuel	9 gallons	4.00	25,920.00
Maintenance	1	150.00	3600.00
Grand Total			29,520.00

Table-2. Cost of maintaining existing traffic intersections.



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# Cost of Improved Method of Maintaining Traffic Light Intersections

Table-3 shows the cost of improved method of maintaining traffic light intersections. It takes into account

the items used in the routine maintenance in Accra and various quantity and cost. The grand cost of maintaining the improved traffic light intersection is found to be GH¢ 15,472.00.

Table-3. Cost of maintaining the improved traffic light intersections.

Item	Quantity	Unit cost (GH¢)	<b>Total</b> (GH¢)
Fuel	0.73 gal	4.00	2,088
Maintenance of Vehicles	1	12.00	288.00
Software	1	2,7000	2,700.00
GSM Modem	65	150	9,750.00
SMS Message	3650	0.04	146
Master Station	1	500	500
Grand Total		15,472	

## Net Profit of Improved System of Maintaining Traffic Light Intersections

This profit is realised by subtracting the cost of improved method of maintaining traffic light intersections from the cost of existing method of maintaining traffic light intersections. The differences in cost is given by;  $GH\phi 29,520 - GH\phi 15,472 = GH\phi 14,048$ 

## CONCLUSIONS

Telemetric control of traffic light intersections will introduce a more effective way of carrying out maintenance. Upon calculating the cost of establishing or carrying out this project, it was realized that the new system has high initial cost. However the running cost will be very low if this project is implemented.

#### RECOMMENDATIONS

To minimize faults on site, all halogen signal heads should be replaced with LED signal heads because of its almost everlasting life span. Since the telemetry system is more beneficial compared to the existing system, I recommend that the project be implemented by Facol Roads Limited and other traffic light maintenance companies as it will go a long way to increase their efficiency and profit margin.

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