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SMART CITY LIGHT SCANNER USING RAMBLER

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ABSTRACT

In metropolitan cities streetlights with poor lighting cause vehicle accidents and may provoke theft or murder during nights. Predicting faulty post lamp can maintain proper lighting in street roads. At present, faulty post lamps are checked regularly by electrician but takes long time to repair. Existing researches concentrate on incorporating sensors with wireless networks into each street lamp. There is a problem in interfacing the wireless networks with the existing lighting circuit and also it is more expensive than required for installing lamps. Hence a smart lighting system must be considered. A sophisticated system named as Rambler which is laid on the top of fixed route vehicles, collects illumination readings and location of streetlights along the route the vehicle traverse. The collected reading will be transmitted to PC and by using MATLAB's Graphical User Interface Design Environment (GUIDE), Luminance Map (LMap) will be created. By finding the difference between different LMaps found at different times, location of faulty streetlights can be identified. To avoid erroneous LMap, Inspection Point (IP) is to be installed at 2m above the ground of one or two street lamps which provide ground-truth value of illumination reading. The proposed method does not require modification of vehicle and street lamp. The proposed system can be used in metropolitan cities possibly in highways. This system can be used as an alternative system for detecting faulty street lamps in an efficient manner.

Keywords─ Fault, Rambler, Luminance Map, Inspection Map

INTRODUCTION

Road accidents are a serious reason behind death and injury. Over a million people die every year on the world's roads, and therefore the number of injuries can be as high as fifty million [1]. Street lighting could scale back accidents, theft or murder throughout nights. Hence, a timely repair and maintenance of the road lighting network is one of the foremost duties of the electrical distribution corporations [11,12]. Street lighting will enhance driver's ocular potency and additionally his ability to detect roadway hazards, and may diminish contrast between headlight glare and also the surrounding atmosphere. It prevents loss of visual clarity from contrast adaptation. Observation of street lighting network relies on measuring the ampere range of every lamp and scrutiny it with the pre determined reference values. a smart lighting system should allow vehicles or pedestrians to travel in the dark with good visibility, in safety and comfort, whereas reducing several malfunctions that occur throughout night [13]. On the other hand, poorly designed lighting systems will result in poor visibility which cannot be useful for any pedestrian or vehicle passing by that street. Street lights are the massive client of energy within the cities. An intelligent street light management system that depends on LED lamps and wireless communication technologies will detect vehicles and vary the intensity of the street light by using LED lamps as per the traffic controlling of street light system and fault detection of the lamps through wireless technology [2, 3, 5].

Power Line Communication (PLC) is the best choice for automating street lighting networks. We can both transmit and receive data by using PLC in a half-duplex manner. Use of PLC reduces operational costs and improves safety in companies and municipalities. Range, data rate,and performance of power line communications are improved by using OFDM-based PLC system known as G3-PLC which was designed for grid automation [16].

The power consumption is gained by using LEDs as the source of light that uses less power [14] and gives more illumination whereas photovoltaic discharge lamps consume more power [06]. Light dependent resistors are used for finding the faulty condition of any lamps and by using GSM modem message will be transmitted to the control room [14]. ZigBee can also be used for transmission purpose [7, 8]. Solar energy is the most often used natural resource which can be used as an alternative energy [15]. The unification of LED, solar energy and wireless communication can make an intelligent street light system.

Lighting systems in indoor spaces are getting intelligent, with a trend of luminaries becoming equipped with sensors and actuators [4, 9, 10, 13]. Occupancy and light sensors co-located at luminaries are used to monitor the local occupancy and illumination conditions respectively. At present, faulty post lamps are checked regularly by electrician but takes long time to repair. Existing researches concentrate on incorporating sensors with wireless networks into each street lamp. It provides real time status but it is more expensive than required for installing lamps. Hence a smart lighting system must be considered to detect faulty lamps which can be controlled by using software like MATLAB, C# and Dot Net. Graphical User Interfaces (GUIs) can be developed by the graphical user interface development environment in MATLAB which is used to display Luminance Map (LMap).

PROPOSED SYSTEM

The proposed method is employed to detect faulty street lamps by using Lumination Map called as LMap. The LMap describes the illumination intensity over many street lamp locations. The technique used in this method is that, if the illumination in an area is same for several considerations, then their LMaps resembles the same. Therefore, by examining many LMaps created at different times, the location with a major modification in illumination intensity might indicate the location of a faulty lamp [15]. A custom-built device called rambler is designed to frequently collect information regarding the illumination intensity of an area of interest and make LMaps.

If a location's illumination intensity varies among several LMaps, then the information about that location will be sent to appropriate individuals for further investigation. This will enable faster remediation of the problem. Special equipment called Rambler is installed on roofs of fixed route vehicles which collect illumination readings [19], location [17, 18] and acceleration of bus.

All data from Rambler will be collected and stored in SD (Secure Digital) card. The data collected will be uploaded by RF transceiver [20] to the access point for data storage and analysis which helps to identify changes in lighting intensity. The collected data would be used to create Lumination Map (LMap). This method would not require modification of conventional streetlights. The architecture of Rambler is shown in Figure 1.

Rambler which acts as transmitter consists of GPS, light sensor, accelerometer, RF transmitter and SD. The receiver side consists of RF receiver and PC to plot LMap from the collected data. As the lighting readings may vary due to different weather conditions or dirt on illumination sensor, an Inspection Point (IP) is designed to verify the illumination reading for a particular post lamp. Inspection Point (IP) is a special device equipped with illumination sensor, GPS module and RF Transceiver which is to be installed at 2m above the ground of one or two street lamp.

IP will broadcast its sensed reading of illumination periodically. When the bus moves into the range of wire less communication of IP, rambler will receive the signal from it and save the data onto its SD card for later verification so that it avoids generating inaccurate LMap. The use of Inspection Point will be more applicable in areas like street crossings and accident zones.

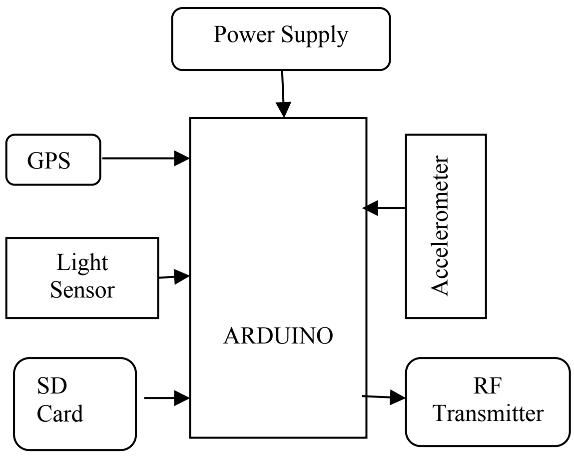

Figure-1: Architecture of Proposed Method

As the lighting readings may vary due to different weather conditions or dirt on illumination sensor, an Inspection Point (IP) is designed to verify the illumination reading for a particular post lamp. Inspection Point (IP) is a special device equipped with illumination sensor, GPS module and RF Transceiver which is to be installed at 2m above the ground of one or two street lamp. IP will broadcast its sensed reading of illumination periodically. When the bus moves into the range of wireless communication of IP, rambler will receive the signal from it and save the data onto its SD card for later verification so that it avoids generating inaccurate LMap. The use of Inspection Point will be more applicable in areas like street crossings and accident zones.

Procedure for the Proposed Method:

The procedure for the proposed method is shown in Figure 2.

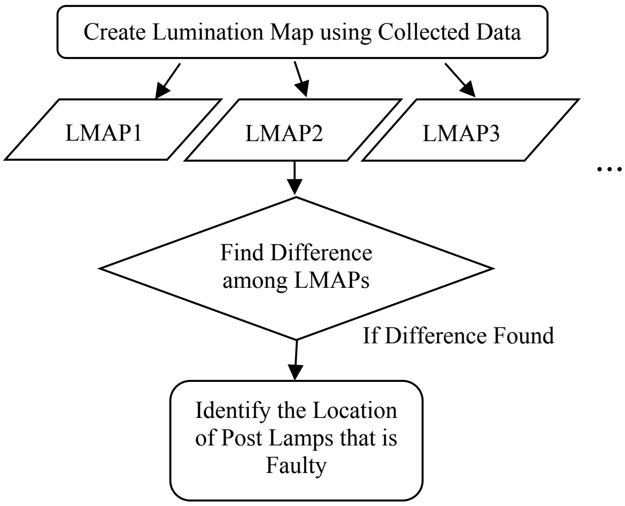

Figure-2: Procedure of Proposed Method

The proposed method uses a smart system called Rambler to detect the faulty lamps by collecting the location and luminance values of post lamps.

Algorithms for Proposed Method: Three algorithms are required for the proposed method. The first two algorithms are implemented in MATLAB's graphical user interface development design.

The first algorithm transforms the data such as location and intensity of post lamps into Luminance Map which is called as LMap. The lines 1-05 define the data to be used in the system. The lines 06-08 gets the latitude and longitude value. The lines 09-11 get the intensity value. By using the above data's, LMap is plotted.

The second algorithm is used to find $LMap_{diff}$ from different LMaps found at different time. In lines 03-04 lamps that are faulty at two different times are defined. The line 05 defines the lamp that is faulty at both the time. The lines 06-08 get the lamp that is faulty at both the time. By using $LMap_{diff}$, status report indicating area name, no. of streets in the area and lamps that are faulty at both times is generated.

The third algorithm is used for verification purpose of hardware. The line 1 gets the data from Inspection point (IP). The lines 02-03 checks if the distance between location data of rambler and inspection point is greater than the threshold value (20m) and returns Fault in GPS. But if the distance between location values is less than threshold and the difference between light intensity values is greater than threshold (20 Lux), it returns Fault in Light Sensor or otherwise it returns No fault found which is defined in lines 04-07.

Algorithm to Transform LMap

Define latitude as X
Define longitude as Y
Define light intensity as Z
Define map area S_i
Define illumination map $LMap_i$
for(∀x,y |1≤ x ≤ m and 1≤ y ≤ n)
Get latitude and longitude values
end for
for(∀x,y |1≤ x ≤ m and 1≤ y ≤ n)
Get light intensities
end for
output $LMap_i$

Algorithm to Generate LMapdiff from LMap1 and LMap2

Load $LMap_1$, $LMap_2$ in the same cell size and cell number (m x n)
Define a new $LMap_{diff}$ with the same cell size and cell (m x n)
Define $L1_{x,y}$ as lamps that are in off state in LMap1
Define $L2_{x,y}$ as lamps that are in off state in LMap2
Define $Ldif_{x,y}$ as lamps that are in off state in both LMap1 and LMap2
for (∀x,y |1≤ x ≤ m and 1≤ y ≤ n)
$Ldif_{x,y}$ =max ($L1_{x,y}$,$L2_{x,y}$)
end for
output $LMap_{diff}$

Algorithm for IP Verification

01 Receive IP (GPS x, light x) from IP
02 If Distance (GPS x, My location) > k
03 Return (Fault in GPS)
04 If Distance (GPS x, My GPS location) < k AND
05 If Absolute Difference(light x, My light intensity) > j
06 return (Fault in Light Sensor)
07 return (No fault found)

Working Flowchart of Rambler and Inspection Point: The working flowchart of Rambler and Inspection point is shown in Figure 3.

Rambler collects location and intensity values of post lamps along the way the vehicle traverse. The collected data will then be stored in Secure Digital (SD) card. When the vehicle comes into the range of Inspection Point (IP), it collects the data from it that is the location and intensity value of that particular post lamp.

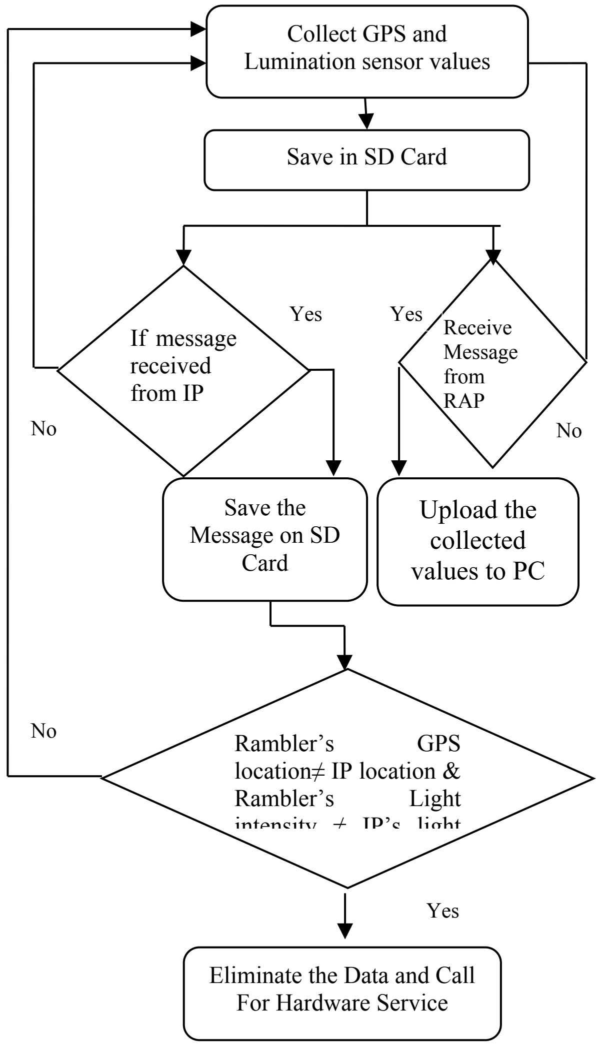

Figure-3: Working of Rambler and Inspection Point

This data collected from IP is also then stored in SD card. The inspection point periodically broadcast the data collected to the vehicle carrying rambler. This data will be useful for further verification in order to avoid generating inaccurate LMaps. This data will be used to check the device placed in rambler and is also used to verify the data collected by rambler. If the data collected by rambler varies with the inspection point, the device rambler stops working and call for hardware service.

When the vehicle comes to the range of rambler's access point (RAP) that is bus station, it transfers the data collected by rambler to the control unit by using RF transceiver. In the control unit by using MATLAB's coding, LMap is created. By finding the difference between different LMaps generated at different time, lamps that are faulty are detected.

RESULTS AND DISCUSSION

Software programming is done by using MAT-LAB's graphical user interface design environment (GUIDE). The Data exploration tool in MATLAB is used to plot the data. The location that is latitude and longitude values and the light intensity values of post lamps are entered manually. By using GUI, necessary components are placed in the component palette which is shown in Figure 4.

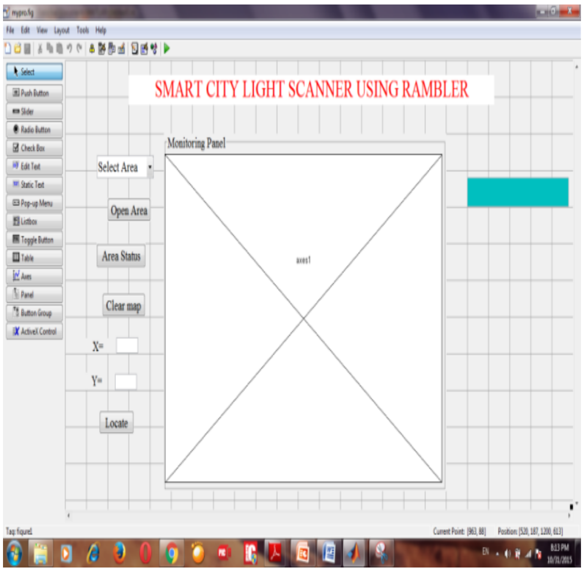

Figure-4 Components in Layout Editor

Output Maps: On saving the layout editor, a Fig file is generated. On clicking Run button, it switches to programming of GUI where necessary coding has to be implemented. After loading the location and intensity values of streetlight, LMap is obtained. The LMap for area 1 is shown in Figure5 which plots location and intensity values for that area. On clicking open area, LMap is obtained. Here an area is divided into three streets differentiated by three colours namely red, green and blue. Red denotes street 1, green denotes street 2 and blue denotes street 3. Latitude act as X axis and longitude act as Y axis.

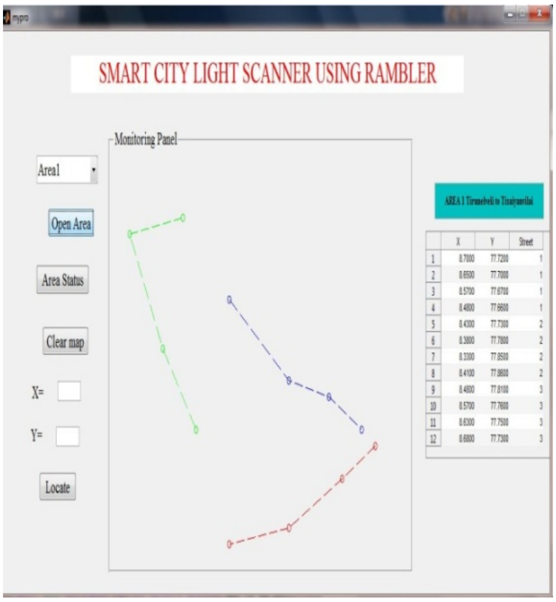

Figure-5: LMap for Area 1

A particular location of an area can also be found by editing its latitude and longitude values in the X and Y text box as shown in Figure 6.

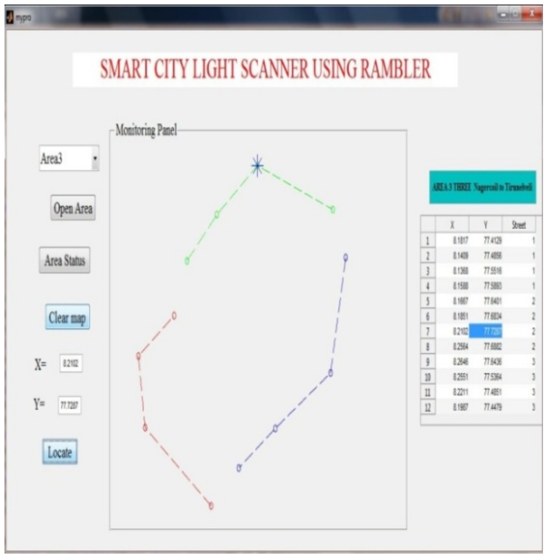

Figure-6: Pointing a particular location

Status Report: The technical information required for the project is latitude, longitude and luminance values of post lamps. But this information is not adequate for the line man to repair the faulty lamps. Hence, another fig file is created to know area status of each post lamp which is shown in Figure 7. Some post lamps are made as faulty in an area for a particular period of time (10 to 11pm) and some other post lamps are made as faulty in that same area for another particular period of time(11 to 12pm).

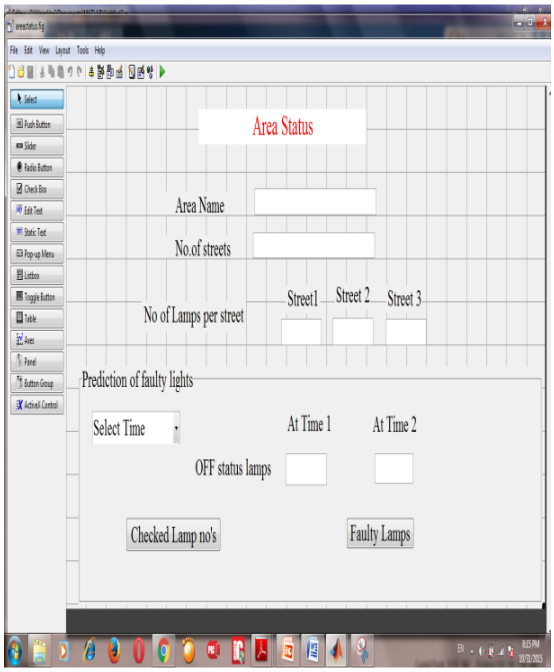

Figure-7: Area status adequate for line man

By finding the post lamps that are faulty at both the period of time, they are made in a separate table. On clicking area status, it gives the area name, no. of streets in that area, post lamps that are faulty at time1and post lamps that are faulty at time2 and from that it provides the list of lamps that are faulty at both time. The status report for area 1 is shown in Figure 8, where at time 1, lamps 4, 7 and 10 are at off state whereas at time 2, lamps 3, 4, 7 and 10 are at off state.

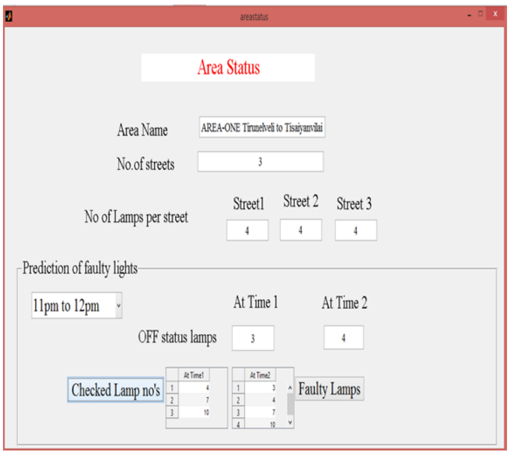

Figure-8: Status Report for Area1

On clicking Faulty lamps push button, lamps that are faulty at both time that is 4, 7and 10 are found which is made in a separate table as shown in Figure 9 and the faulty lamps are plotted in Map as shown in Figure 10.

Figure-9: Detected faulty lamps in Area 1

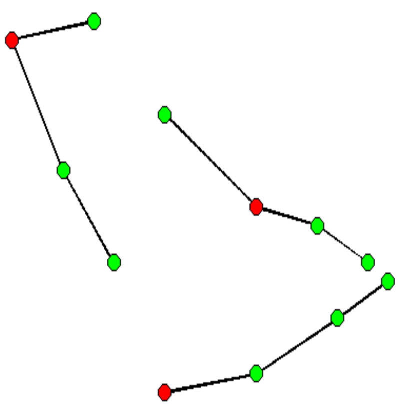

Figure-10: Detected faulty for Area1 in Map

CONCLUSION AND FUTURE WORK

The proposed method uses MATLAB's Graphical User Interface Design Environment (GUIDE) for software programming to detect the faulty post lamps in cities. The location and luminance values of post lamps are entered manually. By using the above values, LMap is obtained. By finding the difference between different LMaps generated at different time, lamps that are faulty are detected. The proposed system that is to be implemented in hardware doesn't need modification of streetlights and vehicles. The smart system Rambler which is to be designed should be placed on top of fixed route vehicle, collects the required information of post lamps along the route the vehicle traverse. The collected data will then be transferred to control unit, through which LMap will be created by the MATLAB's coding. This system provides user friendly status report and it does not require incorporating sensors with wireless networks into post lamp, which reduces the cost of the system and makes the system, to detect faulty lamps in an efficient manner.

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