University of Colorado Boulder

ECEN 5823 IoT Embedded Firmware

Final Course Project

BLUETOOTH BASED SMART STREETLIGHT

BY

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BLUETOOTH BASED SMART STREET LIGHT

Team proposals:

1.Describe what problem this project addresses

Street lights are very important in present day's smart cities. Along with networking and embedded sensors, they can receive and transmit data that help cities monitor and respond to any situation, from traffic congestion to accidents. Those very same networks can remotely control street lights to change their luminosity according to the requirements, offering cities a chance to maximize low-energy lighting benefits while also improving pedestrian and bicyclist safety.

The existing smart street lighting has certain drawbacks which are as given below:

1) Currently most of the street lights all over the world are controlled manually and thus it may cause error due to the human interaction.

2) Sometimes, we see the street lights on even in the broad daylight thereby causing energy wastage and sometimes they are not turned on even at night time thereby increasing the chances of road accidents.
3) Since the current street lighting system is not automated, it becomes difficult to pinpoint the cause of problem in the case of energy outage.

4) The life span of the current street lighting system is not optimal since energy consumption is uniform regardless of its necessity i.e traffic density.

2.How does this project alleviate or solve the problem?

The proposed smart street lighting has certain benefits over traditional street lighting system which are as given below:

1) The most important advantage of this system is that it is autonomous in nature and thereby eliminates any possibility of human error.

2) The client mobile application will keep the records of the data like number of cars passing per unit time, daily power consumption graph of street lights, percentage of energy saved daily which can help us with data analytics.

3) Smart Street lighting helps cities by lowering budget, optimizing energy consumption and reducing maintenance.

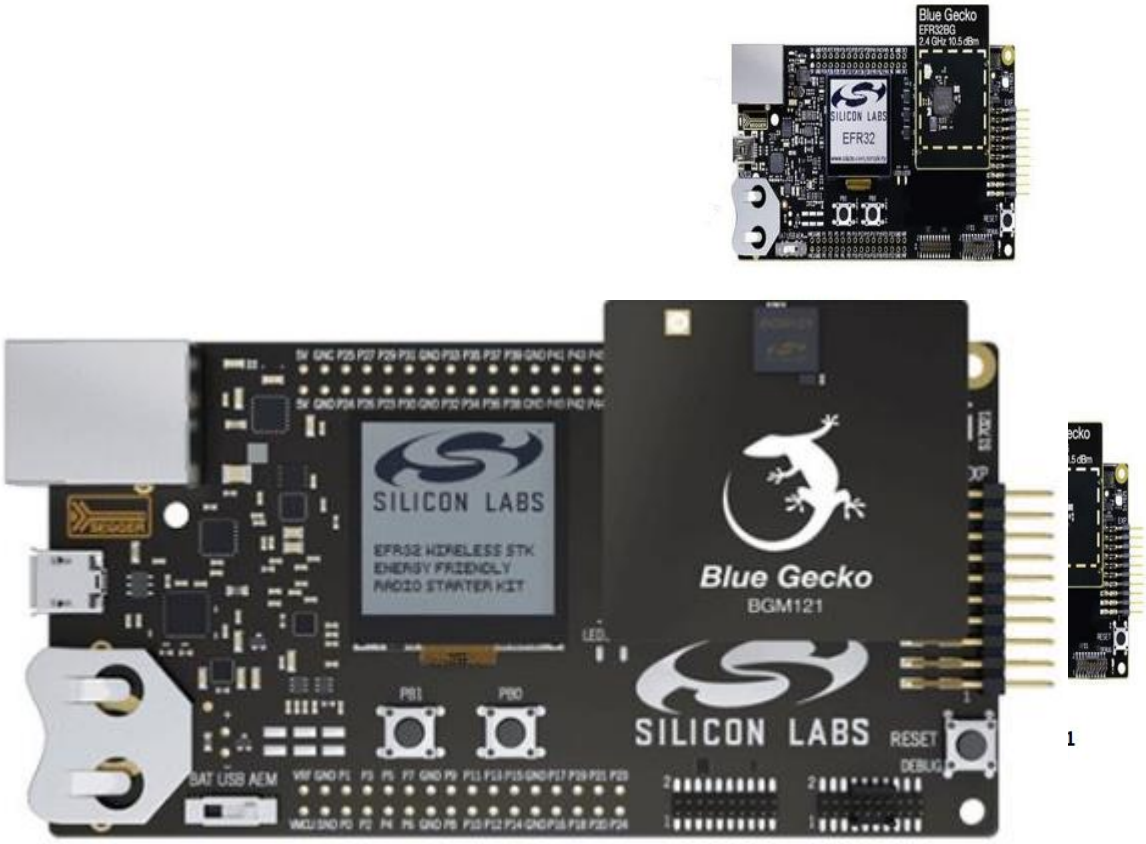
4) Networked street lighting built on a scalable platform can help in reducing crime up by considerable ratio and making roadways safer by improving visibility at night and in case of extreme weathers.

5) By implementing intelligent street lighting systems, we can increase lighting efficiencies and optimize traffic management.

Basic idea of this project is as given below:

Light sensor will be used to get the time of the day. The street lights will be on only during the night. So, when the output of the light sensor falls below certain threshold, then only the entire functionality will be activated. So, during the day time, in the case of demo, blue gecko can sleep in low energy mode. At night blue gecko will be operating and processing the data. Ultrasonic sensor is used to detect the movement of the vehicles. So below a certain threshold value of light sensor ,LEDs (Street light) will be on at the low intensity initially. As soon as ultrasonic sensor detects the movement of the vehicle, it will switch the next street light at the high intensity, thus improving the visibility. If no car is passing for some amount of time, Street lights will switch back to low intensity .One Blue Gecko will be interfaced with these sensors and work as a server. Other Blue Gecko will do the data processing and control LED (street light) and work as a client. The 3rd blue gecko will also work as client and will be responsible to process and log the important information such as number of cars passed per unit time, power consumption hourly and percentage of energy saved daily which can used for further optimization with some data analytics. A mobile application can also be used to successfully log the data as a future scope.

3.Functional block diagram of the team project



4.Summary of each individual project and how it plays a role in solving the problem

In this project we used Light sensor and Ultrasonic sensor to monitor and change the intensity of light based on the motion of cars on the highways. At night time, as soon as the Ultrasonic sensor senses motion of cars, the intensity of the street light is increased and in other times its kept dim. During the day time the street lights are kept off.

One blue gecko interface with light and ultrasonic sensor works as server. One blue gecko will act as client, whose LED functions as street light. The 3rd Blue gecko which logs the important parameters works as a client.

This way we achieve not only energy saving but also efficient and smart street lighting system will also lower expenditure, reduce maintenance cost, eliminate human errors while controlling street light.

5.Project team members

1) Nikhil Divekar
2) Shreya Chakraborty

6.Validation Plan

Sr.No	Developments	Description	Tested by	Test Date	Progress	Passed/failed
1.	Developing persistent memory routine	State of LEDs retained even after power off/reset and the count of vehicles retained	Shreya & Nikhil	March 28th	State of LEDs &number of vehicles retained	Passed
2.	Establishing communication bus module I2C	I2C read and write functions verified	Nikhil & Shreya	March 20th	I2C register read and write commands successful	Passed
3.	Interfacing code to SPI LCD display	Displaying the no of times obstruction occurs and increments the no each time.	Shreya & Nikhil	March 24th	Successfully displaying values	Passed
4.	Testing if Sensors are working	The sensors have been tested using Arduino to verify if they are fully functional with no defects	Nikhil & Shreya	March 20th	Sensors are functional and in good condition	Passed
5.	Interfacing with ultrasonic Sensor through GPIO	Server gecko connected with ultrasonic sensor in normal gpio mode	Shreya	March 30th	Ultrasonic sensor working and gives proper waveforms in oscilloscope	Passed

6.	Data from Ultrasonic Sensor	The Ultrasonic sensor shows distance of the obstacle	Shreya	April 6th	The distance of the obstacle from the sensor is obtained in cms	Passed
7.	Interfacing with light sensor	Server gecko interfaced with light sensor using I2C.	Nikhil	April 1st	Light sensor interfaced, coding part associated is completed	Passed
8.	Data from Light Sensor	The output gives the absolute luminosity of the surrounding	Nikhil	April 7th	The light data is displayed on lcd in lumens, threshold value for day/night applied	Passed
9.	Integrating Sensor to Application code	Code associated with each sensor written	Shreya & Nikhil	April 2nd	Both the sensors connected to the server gecko together giving appropriate values as expected	Passed
10.	Connection of the Server gecko to the client gecko and data transmission	The sensor values from the server gecko control the intensity	Shreya & Nikhil	April 10th	The Server is getting connected to the client	Completed

		of the LEDs				
11	Client 1 implementation	Dimming of the LEDs according to the traffic density	Shreya and Nikhil	April 13th	LEDs glowing at two different intensities	Completed
12	Client 2 implementation	Number of vehicles and amount energy saved displayed on Client 2	Nikhil and Shreya	April 14th	Car count displayed perfectly with energy saving calculated per secong	Completed

		on client gecko				
11.	Implementing BLE service/ Client Profile – Alert Notification Service/profile	service exposes alert information in a device	Shreya	April 11th	exposes information about the count of new alerts. Coding in progress	In progress
12.	Implementing BLE service / Client Profile – Environmental Sensing Profile/custom service	Service exposes environmental factors like light data which we can configure using custom service	Nikhil	April 11th	Coding in progress	In progress
13.	Implementing Client2: Smartphone App using android studio – Bluetooth on & off	Bluetooth is able to be turned on and off on the smartphone via the app	Nikhil & Shreya	April 9th	Coding in Java in Android Studio done and tested	Passed
14.	Smartphone app Bluetooth devices connectivity with server	The app is able to discover and connect to nearby Bluetooth devices	Nikhil & Shreya	April 11th	The devices are being discovered and connection part of the coding in progress	Partially passed, More efficient code in progress
15.	Over the air data transmission between the server and the smartphone app	The Server sends the sensor data to the app over the air	Nikhil & Shreya	April 11th	Coding in progress	Partially done

		through bluetooth				
16.	Connection of the Server gecko to the 2nd client gecko	The client 2 Gecko is sent Values from the server gecko to log specific information	Nikhil & Shreya	April 30th	Correct data is being displayed on the lcd to log information	completed
17.	MITM protection is implemented on both the clients during Client Server pairing with specific messages on the lcd	For security preventing the man in the middle attacks .	Nikhil	April 12th	MITM Protection is applied on the client side with a button press pass key	completed
18.	Client 2 services implementation	Another custom service named data service is implemented on the client 2 gecko to keep count of vehicles	Shreya	April 1st	The services have been added and works according to the desired plan	Completed

19.	Implementation of Bluetooth Low energy modes	The BLE and sleep modes have been applied to the project to save energy	April 30th	The power consumption of the project reduced to around 200 micro apms.	completed
20.	LED control of the client 1 gecko	The leds of the client gecko glow in the intensity as per the sensor data – high when obstacles detected and low when night time	April 30th	The leds are glowing as per the desired configuration	completed
21	Data analysis on client gecko 2	Client gecko 2 shows the car count as well as energy saved	May 1st	Works as expected	completed