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Mobile Computing and IoT Security (ECEN 5023)

Project Report

Convenient Peripheral

Smart Home System

Contents

Overview

The project involves the development of a sensor hub used for smart home system, which uses four different sensors for washing machine monitoring, temperature monitoring and sleep monitoring based on ambient light. This device acts a peripheral device which connects to a phone over Bluetooth. We had plans of developing different peripheral devices and communicating to a hub which transmits all the data to a mobile phone. This was planned with a NRF52 Nordic semiconductor development kit. This peripheral device is named as ***Convenient Peripheral*** as the user can switch to different modes based on their convenience.

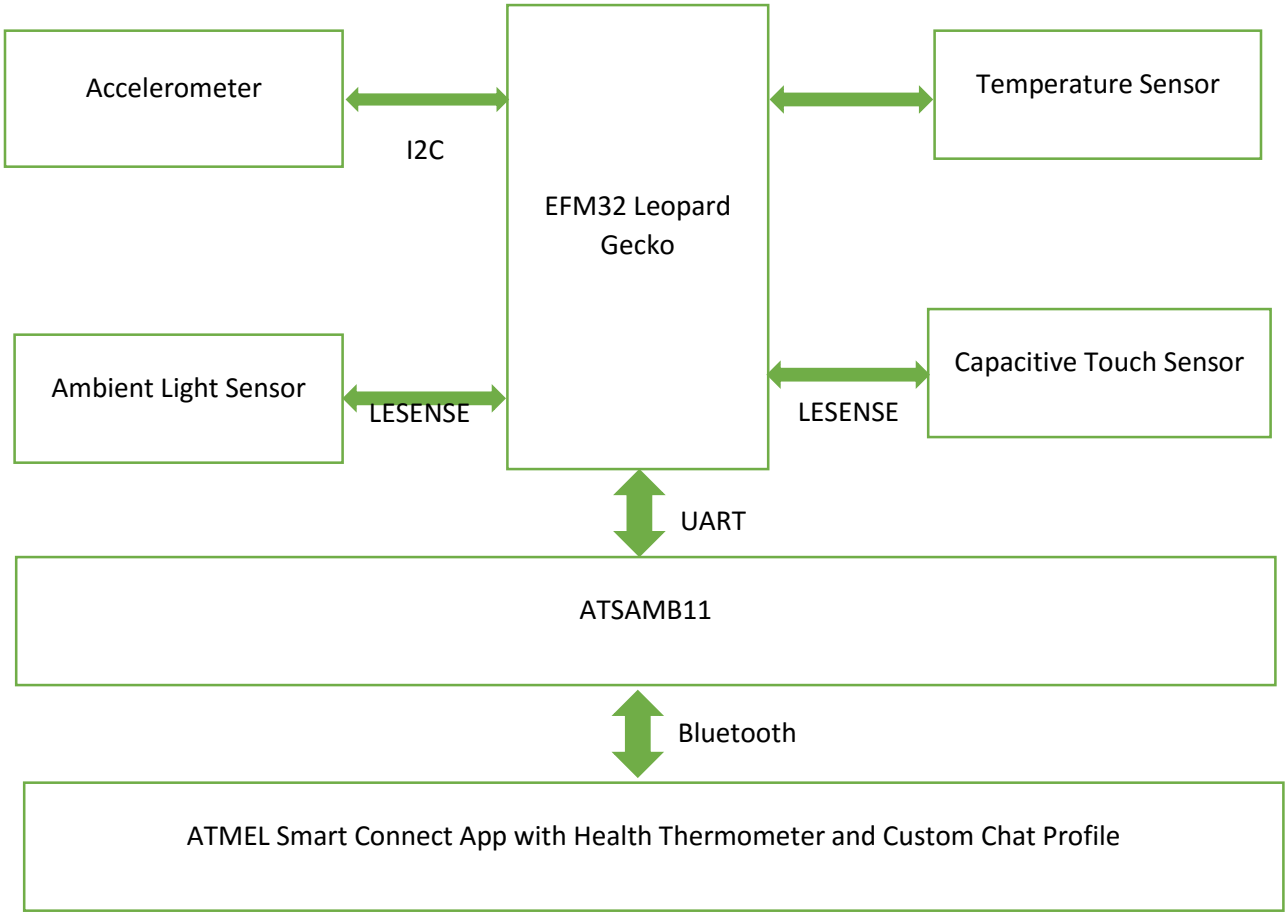
The module has the following functionalities:

1. Monitor the state of washing machine and notify when the job is finished
2. Monitor the room temperature
3. Using capacitive touch control the washing machine monitoring
4. Using the light sensor, determines that you wake up from your bed and gives an option to turn on the coffee maker

Project Solves the following

1. It notifies us when the washing machine completes washing of our clothes
2. Based on ambient lighting it determines our time out from bed and asks whether to turn on the coffee machine through BLE Chat profile service in a mobile application
3. Monitors the temperature of the home

Hardware block diagram

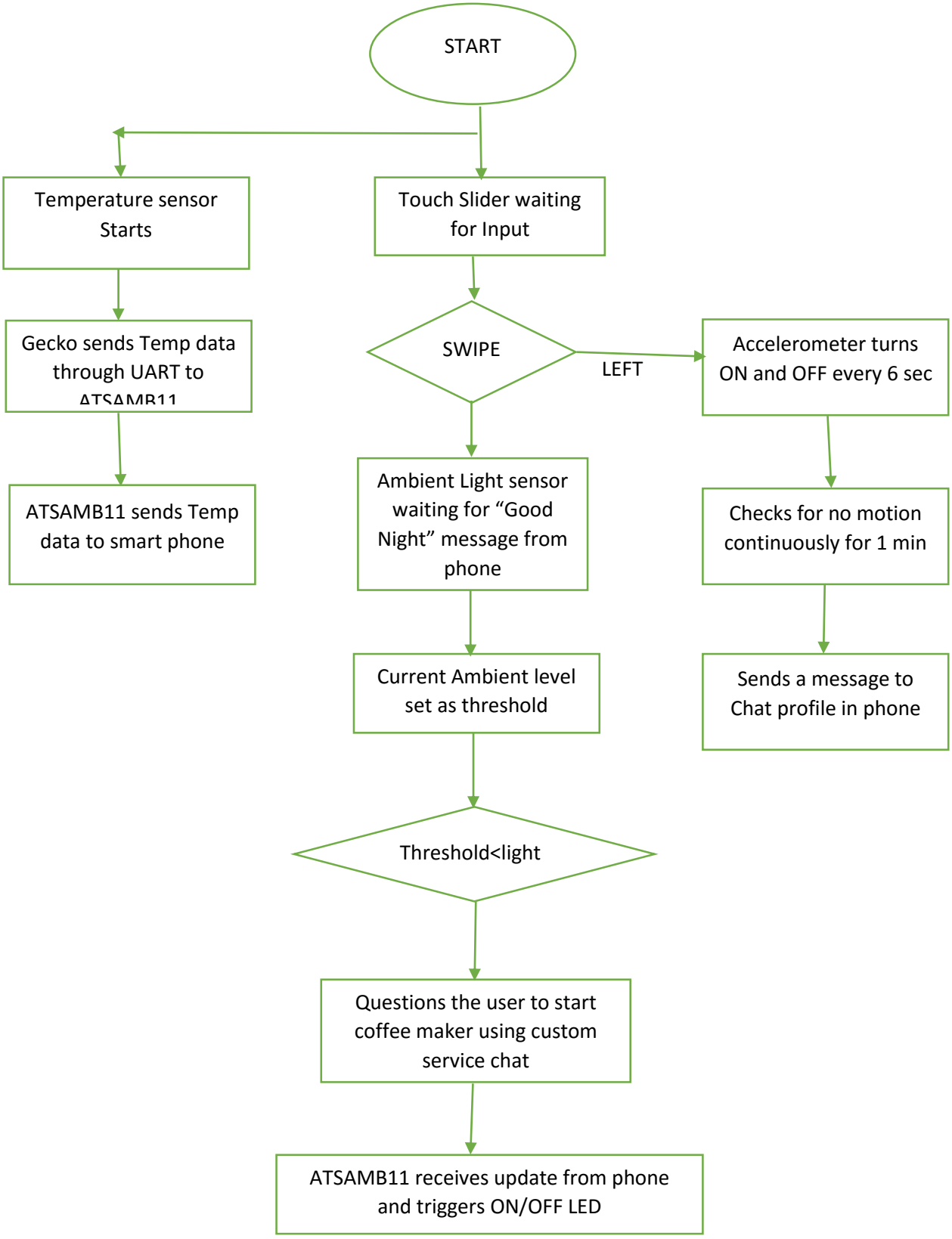


List of Components

This is a list of key components used in the system:

1. EFM32 Leopard Gecko
2. ATSAMB11 Xplained Pro – Bluetooth device
3. SparkFun Triple Axis Accelerometer Breakout -MMA8452Q
4. Leopard Gecko Internal Temperature sensor
5. Leopard Gecko Internal Ambient sensor
6. Leopard Gecko Internal Capacitive sensor
7. ATMEL Smart Connect mobile application with following profiles
    a. Custom Chat Profile
    b. Health Thermometer Profile

Software Organizational Flow chart



List of commands used in software

The list of commands sent to the Leopard Gecko and ATSAMB11 are as below:

1. Temperature sensor output sent from Leopard Gecko to ATSAMB11 through UART
2. Capacitive sensor output sent used by Leopard Gecko to update the use case in operation (Washing machine monitoring)
3. Accelerometer output sent used by Leopard Gecko and decides when the washing machine stops
4. Ambient light sensor output used by Leopard Gecko which decides when it crosses the threshold
5. ATSAMB11 receives the message via the chat server and sets the ambient threshold and assumes that the user went to sleep and commands the Leopard Gecko
6. ATSAMB11 receives the command to turn ON the coffee machine when the user wakes up from sleep, which is decided by Leopard Gecko

List of key software set or trigger points

The list of triggers that trigger an event is given below:

1. Capacitive touch sensor output, when swiped washing machine will be monitored
2. When “good night” message received from the user’s mobile the current ambient light is set as the threshold and when this threshold crosses an event is triggered
3. An event is triggered when the accelerometer senses that there is no motion detected in the washing machine for more than a minute

Aspects of the project viewed as high risk

The following are viewed as high risk:

1. Here assumptions are made for the washing machine operation that a washing machine does not vibrate for more than a minute it is OFF state
2. It is assumed that the user turns off the light and sends a message before going to bed and the current lighting is taken as threshold and change in light intensity is assumed to be the time the person wakes up.

These assumptions provide a risk that it may not happen when used in real life.

Plan Development Schedule

The updated development schedule is given below:

Module	*Planned Completion Date*	*Completion Date*	*Remarks*
Circular Buffer & LEUART DMA	11/01/2016	11/01/2016	Changed in schedule and accomplished
Capacitor touch sensor	11/05/2016	11/06/2016	
Ambient light sensor	11/07/2016	11/08/2016	
Accelerometer	11/12/2016	11/15/2016	
BLE to Leopard Gecko UART	11/14/2016	11/16/2016	Postponed from 11/01/2016
Chat server in BLE	11/19/2016	11/22/2016	
Integration, testing and defect fixing	11/22/2016	11/26/2016	
Nordic device Implementation	12/02/2016		Planned for release in the future
Power Optimization	12/05/2016	12/06/2016	

Test and Verification Methodology

The test cases for the completed implementation has been modified, but this will be modified in the progress of the development. The test case document is attached below:

Test cases.xlsx

Difficulties Encountered

There were few technical difficulties encountered, which we managed to overcome successfully. LESESNE setup for the purpose of Ambient light sensor and Touch slider simultaneously was challenging. The Custom Chat Profile had issues when it was included into the main code and after a lot of hard work we were able to bring it to a working condition.

Known Issues: When using the Atmel Smart Connect App, the Custom Chat Profile works well until the Health Thermometer Profile is opened. If the thermometer profile is opened once, the notifications sent from ATSAMB11 are not received in the Chat profile. When this occurs the mobile has to be disconnected and connected again.

Summary

The *Convenient Peripheral* can be a part of our smart home system along with the other peripheral devices like the Refrigerator monitoring peripheral and Security peripheral. The device is named as it is used for different purposes as commanded by the user. The sensor hub has the capacitor touch slider, which when swiped and fixed on the washing machine will monitor the vibration of washing machine while it washes clothes and notifies the user when the vibration is not seen for a certain period of time. The washing machine monitoring can also be turned off anytime if the user swipes again. Similarly, the peripheral can also turn on the coffee machine when the user wakes up from sleep by monitoring the light intensity of the room. The threshold for light is set automatically based on the user's message sent when he goes to sleep. The temperature of the home can also be monitored with this peripheral device.

Lessons Learned

There were many new concepts that we learnt in the project:

1. Use of LESENSE to get the data from different sensors from low power mode
2. Use of circular buffer to transmit data
3. Working with BLE profiles helped us to gain more knowledge required for IoT devices
4. Writing drivers for UART
5. Writing drivers for I2C
6. Understanding of BLE concepts such as Slave Latency, Connection Interval and Advertising Interval.