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AUTOMATED KENNEL

MCIOTS – COURSE PROJECT REPORT

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OBJECTIVE

The millennium demographic is increasingly pet-friendly and invests a great deal both financially and emotionally in rearing dogs and other domestic animals. But the millennium work-schedule also keeps people out of their houses and away from their pets for long stretches of time. This alone-time isn't good for the pets or for the house.

The objective of this project is build an automated kennel that will enable a dog-parent to fulfill all the routine needs of their pet dog fulfilled at the most optimum level possible. A product such as this services a large section of society that suffers from such a dilemma. They can constantly monitor their pets and take care of them remotely.

This product can further be customized and produced for other types of pets with minimal alterations.

TARGET PERSON

This project is targeted at the dog owner demographic. It would be a good idea to apply for crowd funding for this project.

PROBLEM STATEMENT

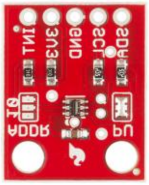
Automate various features related to a kennel and helpful to the dog and its owners. Some of these features include:

1. Sensing ambient temperature of kennel and conveying readings to owner's smart phone.
2. Sensing light level of sensor and toggling lights accordingly.
3. Checking water level within the water-bowl. Conveying results to owner's phone if bowl is empty.
4. Checking dog-food weight within the food bowl. Conveying results to owner's phone if food-bowl is empty.
5. Microphone to monitor dog's barking and send alerts for incessant barking to owner's phone.
6. PIR sensor to be activated if the dog leaves his kennel during the night. Alerts displayed through an on-board LED.
7. Capsense to enable or disable the sensor hub (for ex: in case of travel)

SENSORS, COMPONENTS AND SETPOINTS

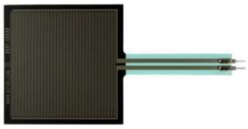
SENSORS:

1. **Ambient Light Sensor : TSL 2561:**
   Application Mechanism: Works on I2C protocol to indicate luminosity value to Leopard Gecko via GPIO Input from its in terrupt mechanism. GPIO IRQ Handler processes input from TSL 2561 to flash LEDs as required.



2. **Ambient Temperature Sensor: TMP 36**
   Analog Sensor working with onboard ADC Channel 6. Temperature is transmitted within every LETIMER interrupt of 5.5 s duration directly through the SAMB11 htp profile.

3. **FSR – Force Sensing Resistor**
   Is an Analog Sensor functioning with onboard ADC Channel 2. It essentially works like a variable resistor where output voltage increases with force acting on sensor surface i.e. resistance is inversely proportional to force. It works in a voltage divider set up with a 10kOhm resistor. If the voltage falls below 200mV an alert is triggered and displayed on the smart phone applications CSC profile.



Interlink 406 FSR

4. **Fluid Level Sensor:**
   Functions like an optical switch with on and off states for no liquid sensed and liquid sensed. It provides a digital 0 when it is in contact with liquids. It is connected directly to a” pin mode : drive mode input” initialized gpio pin. Alerts are sent to the user via the mobile application through SAMB11 whenever water is not available in the bowl.

5. **Microphone: Sparkfun Electret Microphone**
   It a simple audio sensor breakout board that outputs audio as an analog signal. This sensor is used in conjunction with onboard ADC Channel 3. Noise detected is inversely proportional to the output voltage on mV.

6. **LESENSE Capacitive Touch Sensing:**
   LESENSE allows for integration of multiple low energy sensors on board the LESENSE module of the Leopard Gecko. In this project, the CAP sense sensor is integrated to function as power on switch for the system. Four channels (Channel 9-12) have been activated. Singularly or combined, the entire cap sense strip channels output a value of not less than 512. This has been used as a threshold to determine whether the system needs to be activated or not. The selection is visible to the user on the mobile application.

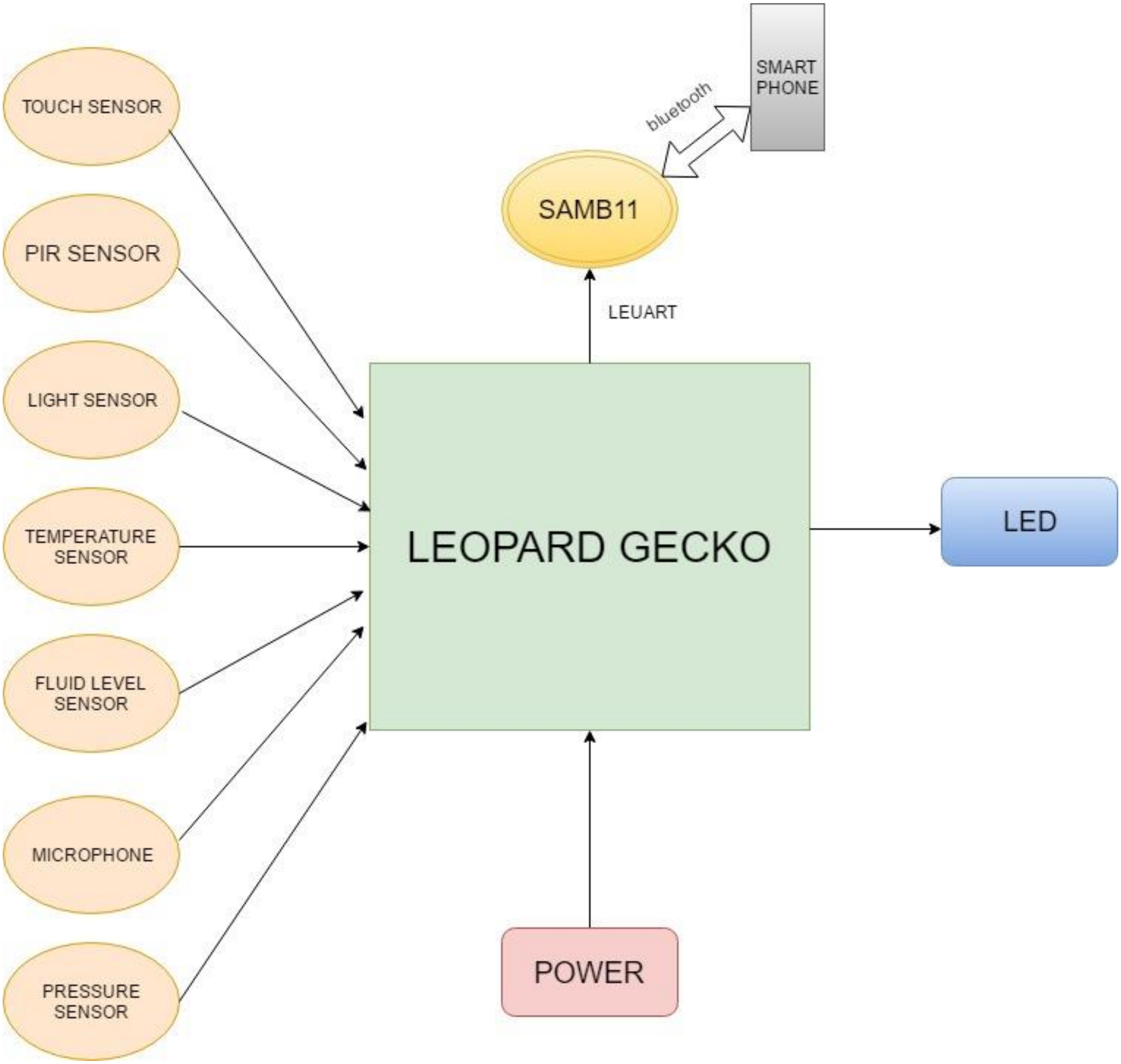
SETPOINTS AND ALERT MECHANISMS

SENSOR	TRIGGER / SETPOINT	ALERT MECHANISM
Temperature Sensor	No set point	Continuous display on smart phone app
Light Sensor	Darkness Threshold = 15 || Illuminous Threshold =2048	LED 0 toggles as reuquired
Fluid Level Sensor	Digital Sensor – Dry probe outputs “01”	Alert indicated on smart phone app
Force Sensitive Resistor	Variable Resistor with Resistance threshold - 200 Mv ADC output indicates no force i.e. weight	Alert indicated on smart phone app
Microphone	Analog output - Above 900 mv ADC output indicates no noise	Alert indicated on smart phone app
Pir Sensor	Digital Sensor – Indicates “0” for movement detected	LED 0 toggles as reuquired
Capacitive Touch Sensor	Channels 9-12 activated to sense. Above 500 value indictates a valid touch.	Alert indicated on smart phone app

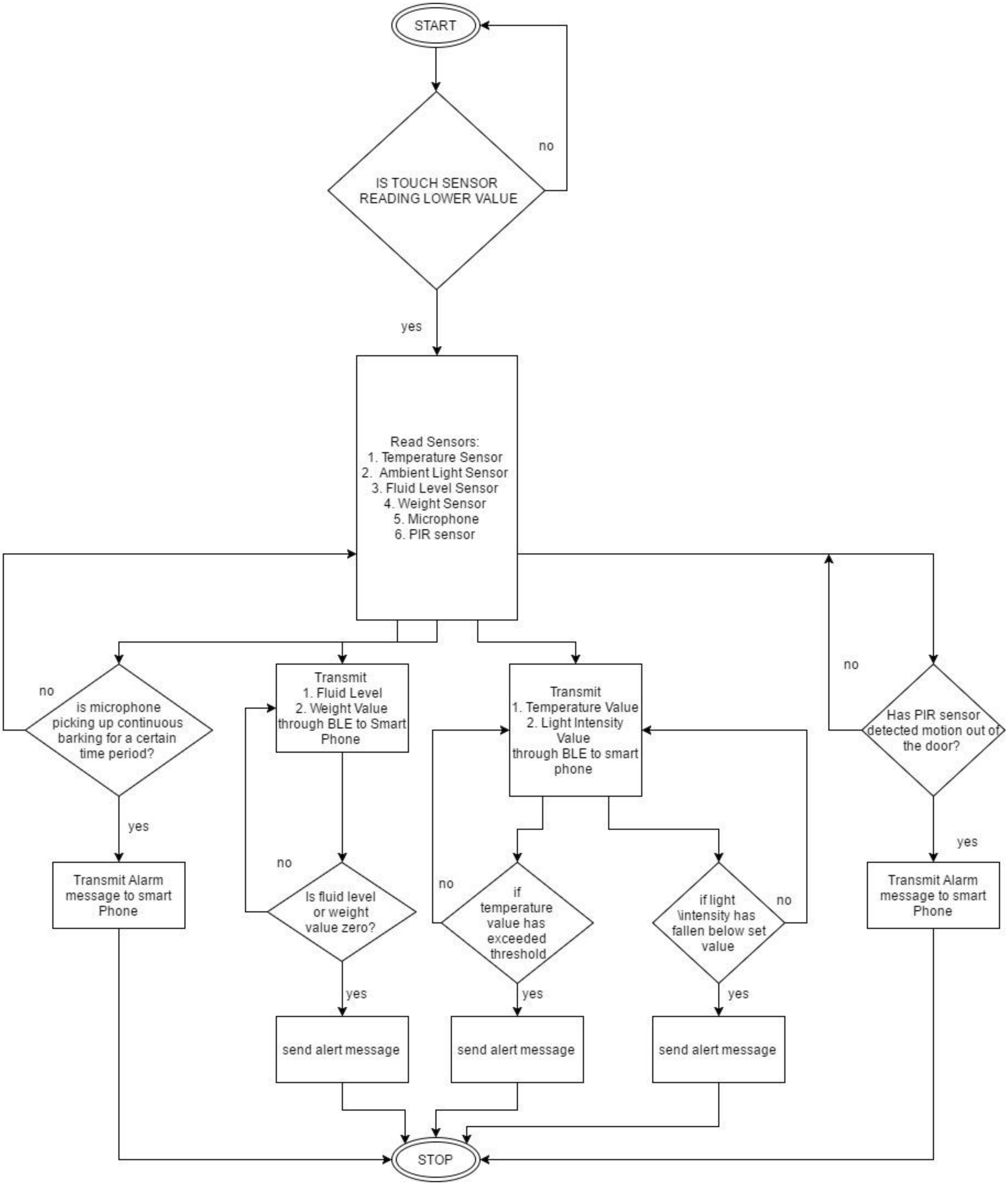
NOTE: All values related to ADC have been calculated with respect to the following ADC parameters:

12 bit resolution || 1.25 Ref Voltage || 750 Conversions per second

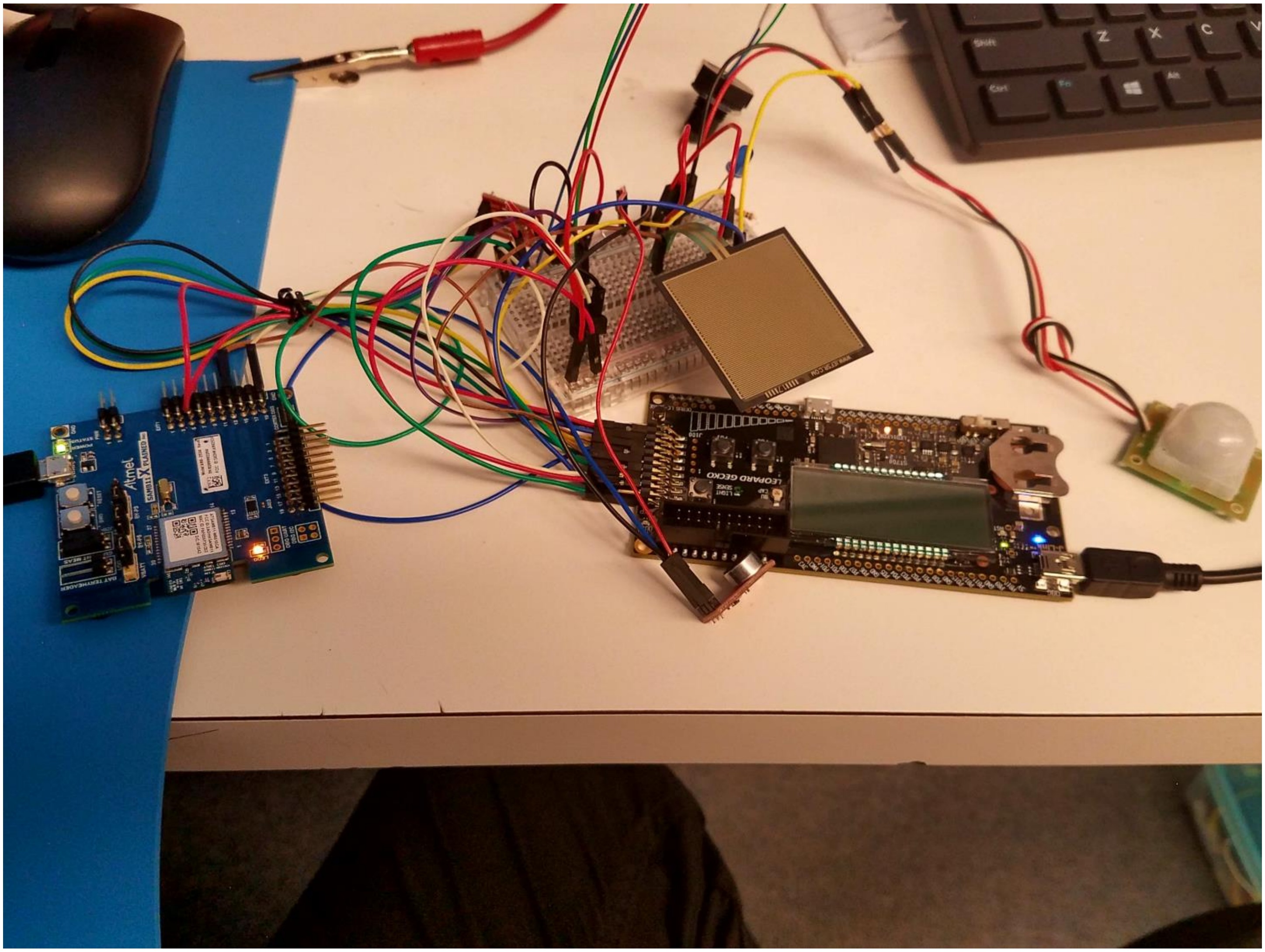
HARDWARE BLOCK DIAGRAM



SOFTWARE FLOWCHART


START
IS TOUCH SENSOR READING LOWER VALUE
no
yes
Read Sensors:
1. Temperature Sensor
2. Ambient Light Sensor
3. Fluid Level Sensor
4. Weight Sensor
5. Microphone
6. PIR sensor
no
is microphone picking up continuous barking for a certain time period?
yes
Transmit Alarm message to smart Phone
Transmit
1. Fluid Level
2. Weight Value
through BLE to Smart Phone
no
Is fluid level or weight value zero?
yes
send alert message
Transmit
1. Temperature Value
2. Light Intensity Value
through BLE to smart phone
no
if temperature value has exceeded threshold
yes
send alert message
if light \intensity has fallen below set value
no
yes
send alert message
no
Has PIR sensor detected motion out of the door?
yes
Transmit Alarm message to smart Phone
STOP

HARDWARE SETUP



PROJECT METHODOLOGY

The project can essentially be expanded into three separate parts:

1: Sensor Hub: Leopard Gecko

All the sensors are connected to the GECKO board. Outputs of the sensors are processed by the leopard Gecko at regular intervals of 5.5 seconds using the Leopard Geckos LETIMER (COMP0).

Within the LETIMER each sensor generates a flag value which indicated it's alert status. On a common-ground, each alert flags value is one if the sensor has crossed its threshold value.

These alert flags are formed into a message packet within the transmit buffer attached to the LEUART on the Leopard Gecko.

Packet Structure:

LESENSE Cap Sense	Fluid Level Sensor	Weight Sensor	MIC	Temperature Value Sign	Temperature Integer Value	Temperature Decimal Value

The PIR sensor toggles LED 1 depending on its alert flag status.

The Ambient Light Sensor dynamically toggles LED0 based on the level of luminosity sensed.

2. Bluetooth Terminal: SAMB11

The SAMB11 decodes the packet and adjusts messages to be sent to the user on the CUSTOM SERIAL CHAT profile. Another profile (TEMPARATURE HTP) profile runs parallelly with the CSC to continuously display temperature on the ATMEL SMART CONNECT App.

3. User Interface: Atmel Smart Connect

This app enables pairing up with the SAMB11 BLE service and allows display of profiles to conduct custom serial chat and temperature viewing. The Custom Serial Chat has been set up to perform Duplex operation. On a request basis it can obtain data about all alert flags that have been processes by the Gecko.

COMMANDS

BLE ID: Kennel

Pairing: 123456

Custom Serial Chat:

H – for help with commands

W – Fluid Level Status

F – Food Level Status

M – MIC Status

T- Capsense Status

Temperature Profile: Dynamically displays temperature values

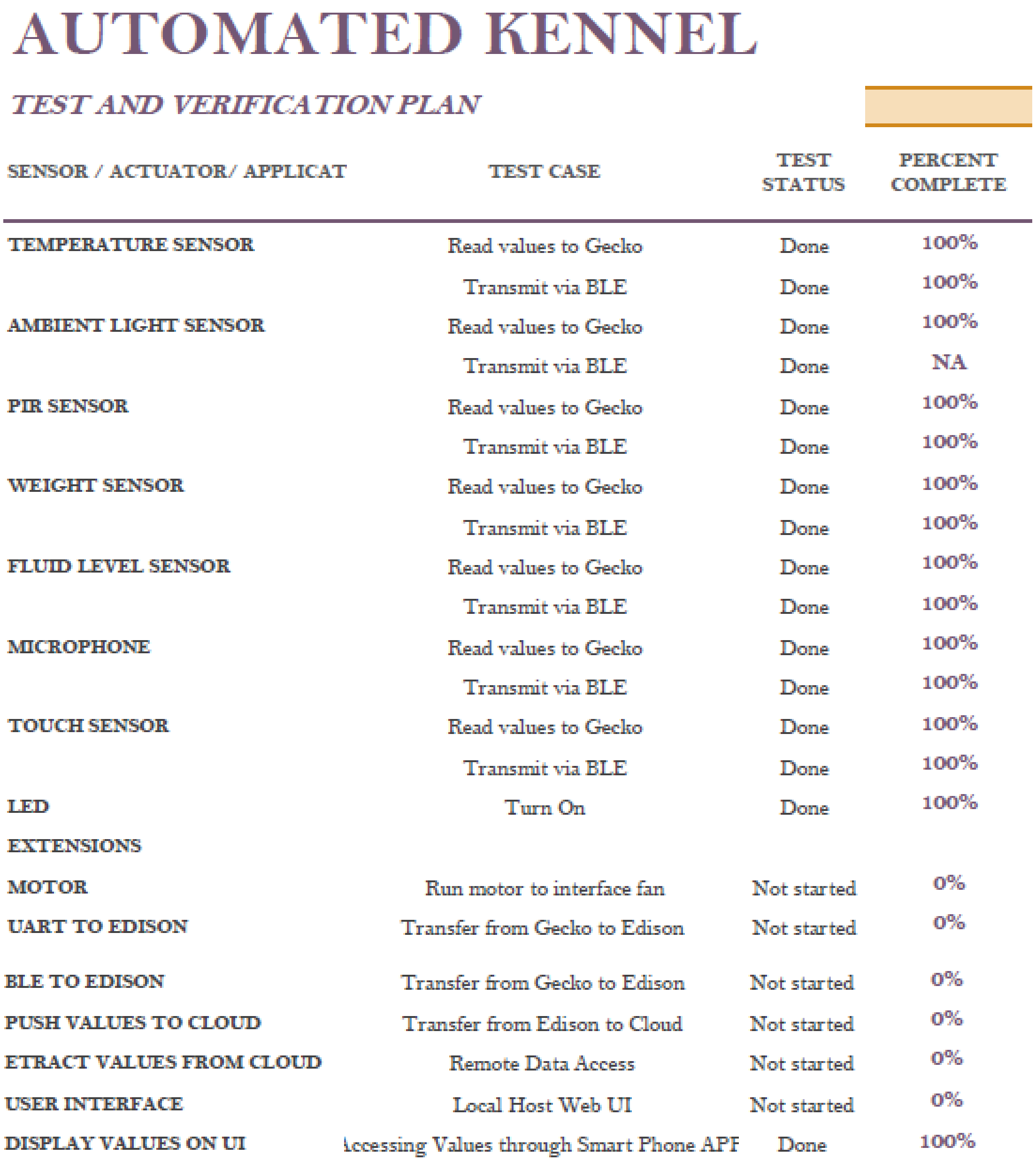
DETAILED TEST METHODOLOGY AND VERIFICATION REPORT

Each sensor will first be tested individually to ascertain whether it is providing the required functionality.

Following sensor integration, all sensors will be tested to see if they function in synchronization without causing any conflicts.

The Bluetooth transfer of data to smart phones will be the next test milestone.

Following this, the entire arrangement will be tested in totality for optimum functioning.



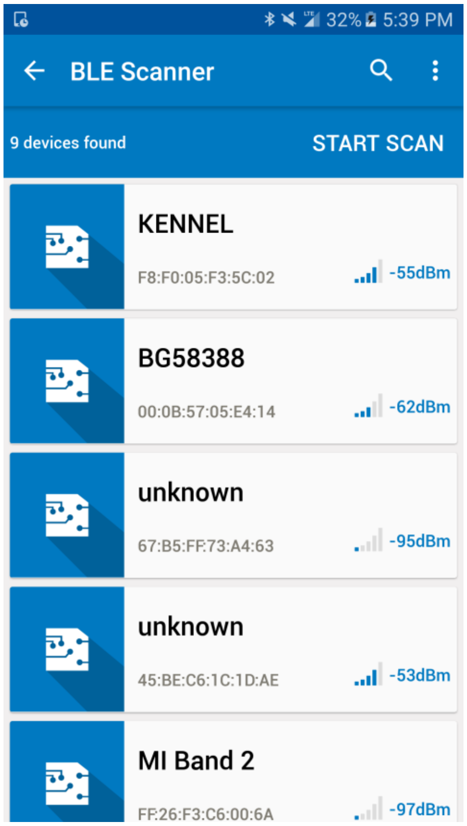
AUTOMATED KENNEL

TEST AND VERIFICATION PLAN

SENSOR / ACTUATOR/ APPLICAT	TEST CASE	TEST STATUS	PERCENT COMPLETE
TEMPERATURE SENSOR	Read values to Gecko	Done	100%
	Transmit via BLE	Done	100%
AMBIENT LIGHT SENSOR	Read values to Gecko	Done	100%
	Transmit via BLE	Done	NA
PIR SENSOR	Read values to Gecko	Done	100%
	Transmit via BLE	Done	100%
WEIGHT SENSOR	Read values to Gecko	Done	100%
	Transmit via BLE	Done	100%
FLUID LEVEL SENSOR	Read values to Gecko	Done	100%
	Transmit via BLE	Done	100%
MICROPHONE	Read values to Gecko	Done	100%
	Transmit via BLE	Done	100%
TOUCH SENSOR	Read values to Gecko	Done	100%
	Transmit via BLE	Done	100%
LED	Turn On	Done	100%
EXTENSIONS			
MOTOR	Run motor to interface fan	Not started	0%
UART TO EDISON	Transfer from Gecko to Edison	Not started	0%
BLE TO EDISON	Transfer from Gecko to Edison	Not started	0%
PUSH VALUES TO CLOUD	Transfer from Edison to Cloud	Not started	0%
ETRACT VALUES FROM CLOUD	Remote Data Access	Not started	0%
USER INTERFACE	Local Host Web UI	Not started	0%
DISPLAY VALUES ON UI	ccessing Values through Smart Phone AP	Done	100%

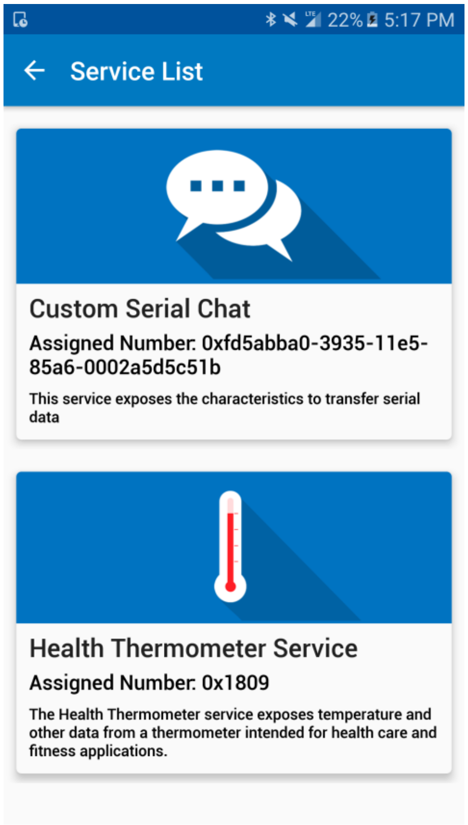
USER INTERFACE

Atmel Smart Connect:



9 devices found START SCAN

KENNEL	F8:F0:05:F3:5C:02	-55dBm
BG58388	00:0B:57:05:E4:14	-62dBm
unknown	67:B5:FF:73:A4:63	-95dBm
unknown	45:BE:C6:1C:1D:AE	-53dBm
MI Band 2	FF:26:F3:C6:00:6A	-97dBm



Custom Serial Chat

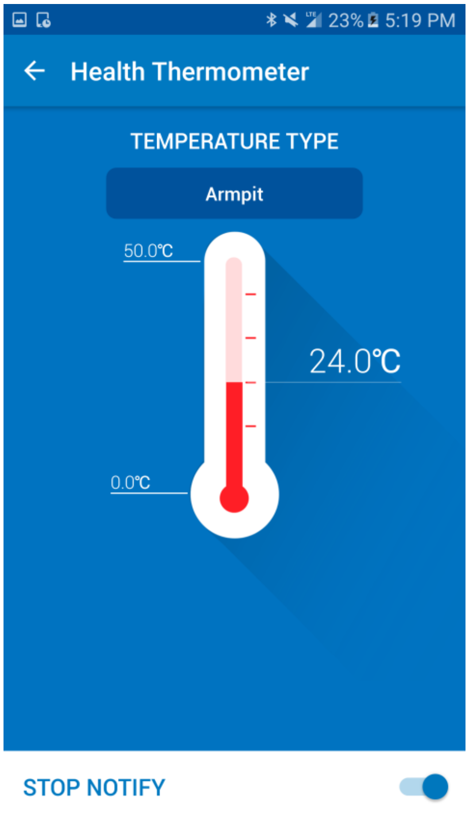
Assigned Number: 0xfd5abba0-3935-11e5-85a6-0002a5d5c51b

This service exposes the characteristics to transfer serial data

Health Thermometer Service

Assigned Number: 0x1809

The Health Thermometer service exposes temperature and other data from a thermometer intended for health care and fitness applications.

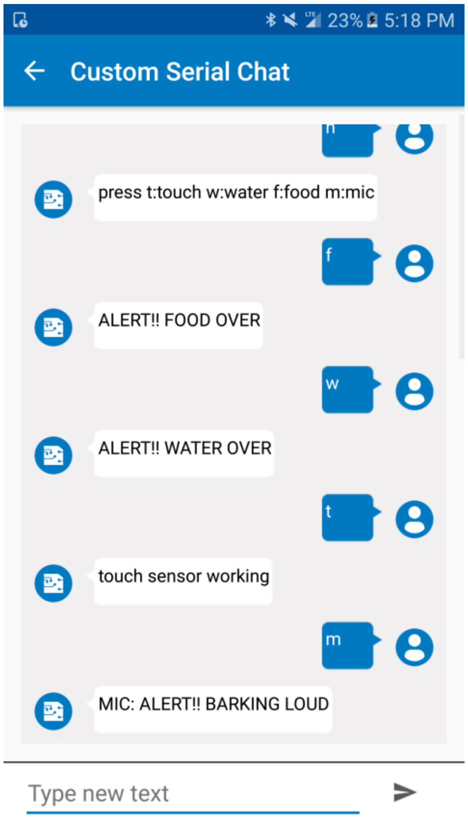


TEMPERATURE TYPE

Armpit

24.0℃

STOP NOTIFY



n

press t:touch w:water f:food m:mic

f

ALERT!! FOOD OVER

w

ALERT!! WATER OVER

t

touch sensor working

m

MIC: ALERT!! BARKING LOUD

Type new text

SUMMARY OF FUNCTIONALITY

All planned functionalities work as follows:

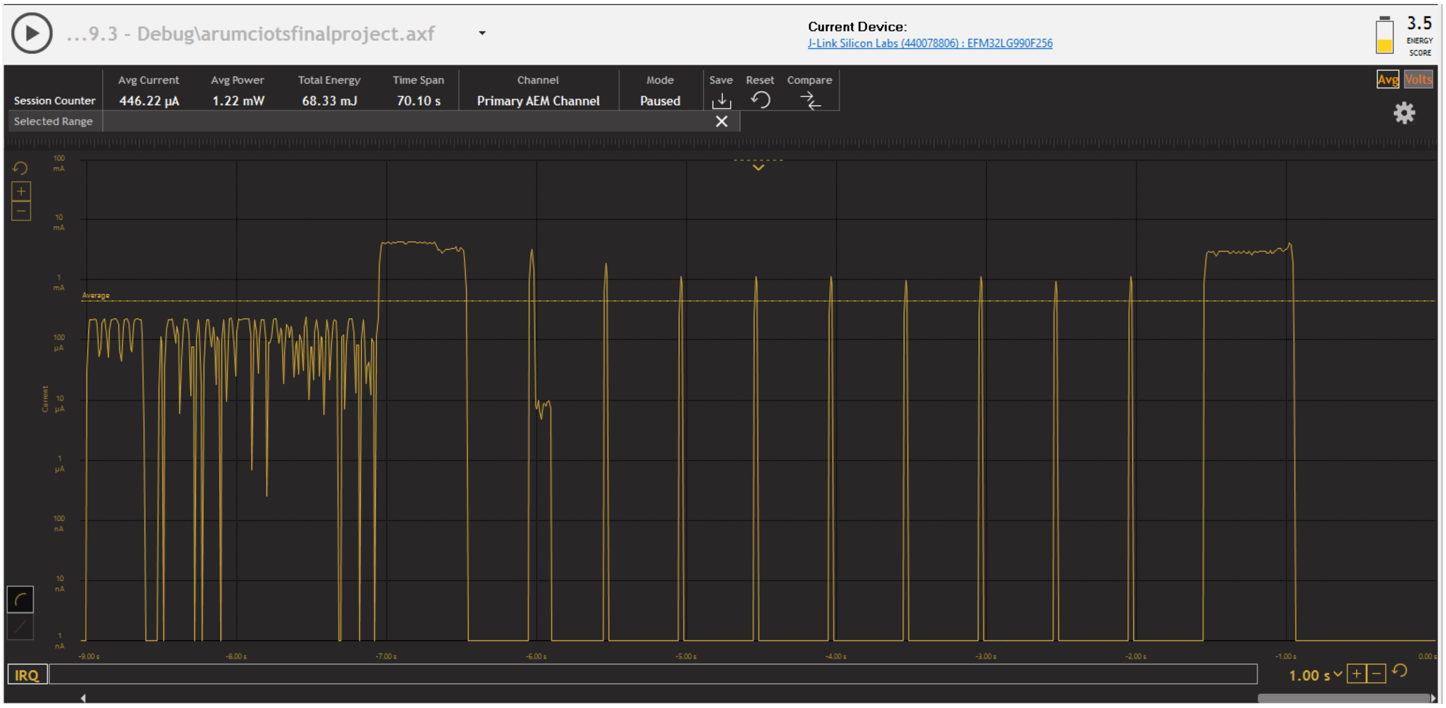
1. Touch Sense values are attained on the app.
2. Fluid Level Values are attained appropriately.
3. Weight Sensor Functionalities are attained appropriately.
4. MIC functionality is appropriate.
5. Both Profiles work appropriately.
6. Leopard Gecko is able to receive values from the SAMB11 to toggle an external LED.
7. Conn Interval and TX Power have been adjusted.

Discrepancies Observed:

1. Duplex communication from SAMB11 to Atmel Smart Connect App stops after a service change to HTP.
2. Energy Profiler shows erratic currents.
3. Problems in synchronicity.
4. Integrating multiple profiles on SAMB11 is difficult to get to work.

LEOPARD GECKO STATS

Energy Profiler:



…9.3 - Debug\arumciotsfinalproject.axf

Current Device:
J-Link Silicon Labs (440078806) : EFM32LG990F256

3.5 ENERGY SCORE

	Avg Current	Avg Power	Total Energy	Time Span	Channel	Mode
Session Counter	446.22 µA	1.22 mW	68.33 mJ	70.10 s	Primary AEM Channel	Paused
Selected Range						

Energy Score: 3.5 – 3.6 in EM2

MILESTONE CALENDER

PROJECT MODULES	TENTATIVE COMPLETION DATE	PROGRESS
PIR SENSOR, AMBIENT LIGHT SENSOR	25th March,2017	COMPLETED
TEMPERATURE SENSOR [TMP36]	29th March 2017	COMPLETED
LEUART WITH CIRCULAR BUFFER	4rd April 2017	COMPLETED
CAPACITIVE TOUCH SENSOR USING LESENSE	9th April 2017	COMPLETED
LEUART USING DMA	11rh April 2017	COMPLETED
MICROPHONE SENSOR	13th April 2017	COMPLETED
FLUID LEVEL SENSOR	15th April 2017	COMPLETED
FORCE SENSITIVE RESISTOR (food weight sensor)	23th April 2017	COMPLETED
INTEGRATION OF ALL SENSORS	23h April 2017	COMPLETED
EXTRACTING DATA FROM BOARD TO SMART PHONE VIA BLUETOOTH	25th April 2017	COMPLETED
FINAL TESTING	27th April 2017	COMPLETED

STRETCH GOALS AND EXPANSION IDEAS

After completing the base model of this project, we will be trying to accomplish a few extra goals stated as below:

1. Data from these sensors will be pushed to the cloud so dog owners can monitor this information remotely. This will be accomplished by connecting the gecko to the Intel Edison board. A standard User interface will be developed for the same.
2. A kennel of appropriate scale will be built using 3D printing or Legos so all the sensors can be placed and a working model can be presented.
3. Using a speech to audio breakout board in conjunction with either the leopard gecko or the Edison board which will help the owner send commands such as “SIT” or “ROLL” through a speaker placed within the kennel.

CHALLENGES, DIFFICULTIES AND LESSONS

1. Getting 6 sensors to work simultaneously without incurring erroneous data
2. PIR sensor has a very specific range of operation in terms of area covered and is extremely sensitive. Filtering out bulk data to get useful results will be a challenge.
3. Managing the right energy modes while allowing all sensors to work.
4. Emulating and testing for an actual dog's speed of movement and presence will be challenging.
5. Positioning of sensors in the prototype to provide minimum wiring needs.
6. Pressure sensor we decided to user before is not sensitive enough to measure weight between the ranges of 00 gm to 500 gms. A force sensor that works as a variable resistor will be used instead to measure small weights.
7. Analog sensors draw power with floating pins that look like a capacitor charge-discharge routine on the Profiler.
8. Analog Sensors should be set with input disabled to get clean analog signals.
9. Integrating LESENSE Cap sense was difficult as it required switching clocks from LFA to LFB for the LEUART. It also impeded functioning of the dev kit in EM3 due to requirement of LFXO and gave erratic values if clocks were changed.
10. On the SAMB11 side of things, order of function and service initialization is as important as the service initialization itself.
11. Integrating multiples profiles is a hard task and debugging for these programs is extremely difficult due to limited opportunity for changing the codes.

CONCLUSION

This project was undertaken with a definite aim in mind. The aim was largely met and with enough time we hope to implement all the extensions that are mentioned above and develop this project into a complete IoT application with appropriate security measures as well .

Many thanks to Prof. Keith and the TAs – Shiva and Omkar for all their patience and perseverance in helping us.

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