

Project 4B

Edison Sensors

INTRODUCTION:

One of the things that makes small, low-power-consumption systems interesting is ability they give us to create software that interacts with people in the physical world. The input side of those interactions is via a variety of local sensors (e.g. for sound, light, temperature, position, motion, pressure). The output side can be sensory (e.g. sound, lights, low power displays) or physical (e.g. mechanical actuators), or (through digital and analog outputs) any other controllable device. Building interactive personal appliances requires us to be able to communicate with the types of sensors, indicators and actuators that can be connected to such systems.

In this project we will create applications that run in an embedded system, read data from external sensors, and log the results.

RELATION TO READING AND LECTURES:

This project is an introductory exploration of technologies and services not covered in the reading and lectures.

PROJECT OBJECTIVES:

- Primary: Demonstrate the ability to design, build and debug interactive applications on an embedded system.
- Primary: Develop the ability to work with embedded system sensors and actuators through standard tool kits.
- Primary: Gain experience with the processing of Digital and Analog inputs on an embedded system.

DELIVERABLES:

A single compressed tarball (`.tar.gz`) containing:

- C source files for an embedded application that builds and runs (with no errors or warnings) on an Edison.
- A `Makefile` to build and test your application. The higher level targets should include:
 - `default` ... build your program
 - `check` ... execute an automated smoke-test of your application to see if it runs and can talk to its sensors/actuators.
 - `clean` ... delete all generated programs and output
 - `dist` ... (runnable on a Linux desktop or server) create the deliverable tarball

Note that this `Makefile` is intended to be executed on an Edison.

- a `README` file containing:
 - descriptions of each of the included files and any other information about your submission that you would like to bring to our attention (e.g. research, limitations, features, testing methodology, use of slip days).
 - any other comments on your submission (e.g. references consulted, slip days, etc.).

PREPARATION:

- If you have not already done so, look at the documentation for the [poll\(2\)](#) system call or the `O_NONBLOCK` option used with the [open\(2\)](#) system call or [fcntl\(2\)](#) `F_SETFL` operation.
- Read the documentation on the [Grove Temperature Sensor](#), and the algorithm for converting a reading into a temperature.
- Review the Intel documentation for the [MRAA](#) library (an open source, platform independent library for embedded system I/O), and the [Analog I/O](#) and [General Purpose I/O](#) classes in particular. These are the functions you will be using to read from the temperature sensor and button. (note that to link with this library you will have to add `-lmraa` to your library search list).
- Read the instructions that came with your Grove Starter Kit. They include information on all of your sensors and instructions on where to plug each in to the Base Shield.
- Attach your Grove Base Shield (a plug-on daughter-board with connectors for all of your sensors) to your Edison/Arduino board.
- Attach your Grove Temperature Sensor to the A0 connector on your base shield.
- Attach your Grove Button to the D3 connector on your base shield.
- Power-up your Edison and confirm that you can still log in and transfer files to it.

PROJECT DESCRIPTION:

Write a program (called `lab4b`) that:

- builds and runs on your Edison
- uses the AIO functions of the MRAA library to get readings from your temperature sensor
- samples a temperature sensor at a configurable rate (defaulting to 1/second, and controlled by an optional `--period=#` command line parameter that specifies a sampling interval in seconds).
- converts the sensor value into a temperature. By default, temperatures should be reported in degrees Fahrenheit, but this can be controlled with an optional `--scale=C` (or `--scale=F`) command line parameter.
- creates a report for each sample that includes
 - time of the sample (e.g. 17:25:58) the local timezone
 - a single blank/space
 - a decimal temperature in degrees and tenths (e.g. 98.6)
 - a newline character (`\n`)
- writes that report to the stdout (fd 1)
- appends that report to a logfile (which it creates on your Edison) if that logging has been enabled with an optional `--log=filename` parameter.
- uses the GPIO functions of the MRAA library to samples the state of the button (from your Grove sensor kit) and when it is pushed ...
 - logs a final sample with the time and the string `SHUTDOWN` instead of data values.
 - exits
- Your program can assume that the sensors are connected as recommended by the Grove documentation:
 - The temperature sensor to Analog input 0.
 - The push-button to Digital input 3.

Note that we want you to use MRAA AIO/GPIO functions to access your sensors, and not the (more powerful and convenient) Grove library functions. The Grove library hides all of the details of embedded I/O, sampling and signal interpretation, but only works for the Grove Sensors. We want you to get experience with direct control of and access to the digital and analog I/O pins.

Many people have observed that the recommended calibration constants appear to be off by ten degrees or more. Every sensor (including the ones that will be used when we grade your submissions) seems to read differently.

Extend your program to (in parallel with generating reports) accept the following commands from stdin:

- **OFF**
This command should, like pressing the button, print a time-stamped `SHUTDOWN` message and exit.
- **STOP**
This command should cause the program to stop generating reports, but continue processing input commands. If the program is not generating reports, merely log receipt of the command.
- **START**
This command should cause the program to, if stopped, resume generating reports. If the program is not stopped, merely log receipt of the command.
- **SCALE=F**
This command should cause all subsequent reports to be generated in degrees Fahrenheit.
- **SCALE=C**
This command should cause all subsequent reports to be generated in degrees Centegrade
- **PERIOD=seconds**
This command should change the number of seconds between reporting intervals.

All received commands will be terminated by a new-line character ('\n').

If logging is enabled, all received commands should be appended to the log file (exactly as received, with no timestamp) but not displayed to standard output.

You could implement this program with separate threads for sensor polling and command processing, but the computation associated with each operation is so small that you may find it much simpler to use a single thread (and polling or non-blocking I/O) to avoid hanging on standard input for commands that only rarely arrive.

To facilitate development and testing I wrote my program to, if compiled with a special (`-DDUMMY`) define, include mock implementations for the `mraa_aio_` and `mraa_gpio_` functionality, enabling me to do most of my testing on my desktop. I then modified my Makefile run the command `"uname -r"`, check for the presence of the string "edison" in that output, and if not found, build with a rule that passed the `-DDUMMY` flag to `gcc`.

SUBMISSION:

Your tarball should have a name of the form `1ab4b-studentID.tar.gz`. You can sanity check your submission with this [test script](#) (which should run on your Edison as well as on your usual Linux development environment).

Your **README** file (and all source files) must include lines of the form:

NAME: *your name*
EMAIL: *your email*
ID: *your student ID*

GRADING:

Points for this project will be awarded:

value feature

Packaging and build (10% total)

- 3% un-tars expected contents
- 3% clean build of correct program w/default action (no warnings)
- 2% Makefile has working `clean`, `check`, `dist` targets
- 2% reasonableness of `README` contents

Sensor Functionality (25% total)

- 10% samples and reports temperature

- 5% reports Fahrenheit temperature (by default)
- 5% reports Centegratde temperature (w/--scale= parameter)
- 5% samples button and exits

Control Functionality (40% total)

- 10% command and data logging
- 10% START/STOP commands
- 10% PERIOD=# command
- 5% SCALE=C/F commands
- 5% OFF command

Code Review (25%)

- 10% use of AIO functions to read temperature
- 10% use of GPIO functions to read temperature
- 5% general readability and understandability