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ECEN 5013
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Project 2: Multi-Controller System

Product Description

~~Proximity Detection and Image Capture (PDIC) is a multi-controller system consisting of a BeagleBone Green running the standard Debian Linux distribution as the controller node, and a TIVA C Series TM4C1294XL development board as the remote node. The TIVA board shall perform periodic remote sensing of its environment using an APDS-9960 Digital Proximity, Ambient Light, RGB and Gesture Sensor, a TMP102 Low Power Digital Temperature Sensor, and an LMV234 Sound Detector. The remote node shall use the outputs of these sensors to determine the presence of foreign objects in proximity. If an object is detected, if there is enough ambient light, the remote node shall take an image capture of the object using an OV2640 Arducam image sensor and transmit the image to the controller node. In addition, the remote node shall periodically report the temperature to an 8-digit LED display. The remote node shall use additional LED displays to report operational status and events, i.e. if an object is detected, a message will be shown on one of the LED displays.~~

Hardware Components

- ~~ArduCAM Mini (SPI)~~
- ~~APDS-9960 (I2C/SPI)~~
- ~~LMV324 (GPIO AIN)~~
- TMP102 (I2C)
- APDS9301 (I2C)
- ~~NRF24L01 – Wireless RF Transceiver (SPI/GPIO)~~
- MAX7219 – LED Display (SPI)

Requirements

- The remote and controller nodes shall communicate using two NRF24L01 Wireless RF Transceivers.
    - Communication via NRF240L01 could not be established – used UART interface instead.
- The remote node shall be capable of reporting its operational status to an LED display.
    - The remote node shall be capable of reporting its operational status on-change.
- The remote node shall be capable of sensing temperature and report the temperature to an LED display.
- The remote node shall be capable of detecting an object in proximity.
    - APDS9960 could not be integrated with TIVA board, so proximity detection could not be implemented.
- The remote node shall be capable of detecting the ambient light levels.
- The remote node shall be capable of capturing an image of the detected object if ambient light levels are high enough.
- The remote node shall be capable of transmitting the image of the foreign object to the controller node.
- The remote node shall maintain activity logs.

- The remote node shall be capable of transmitting the logs to the controller node, if it is present.
- If the controller is not present, the remote node shall store its activity logs somewhere (TBD) and be capable of transmitting the logs to the controller once connection is established.

Architecture Description

Architecture Diagram

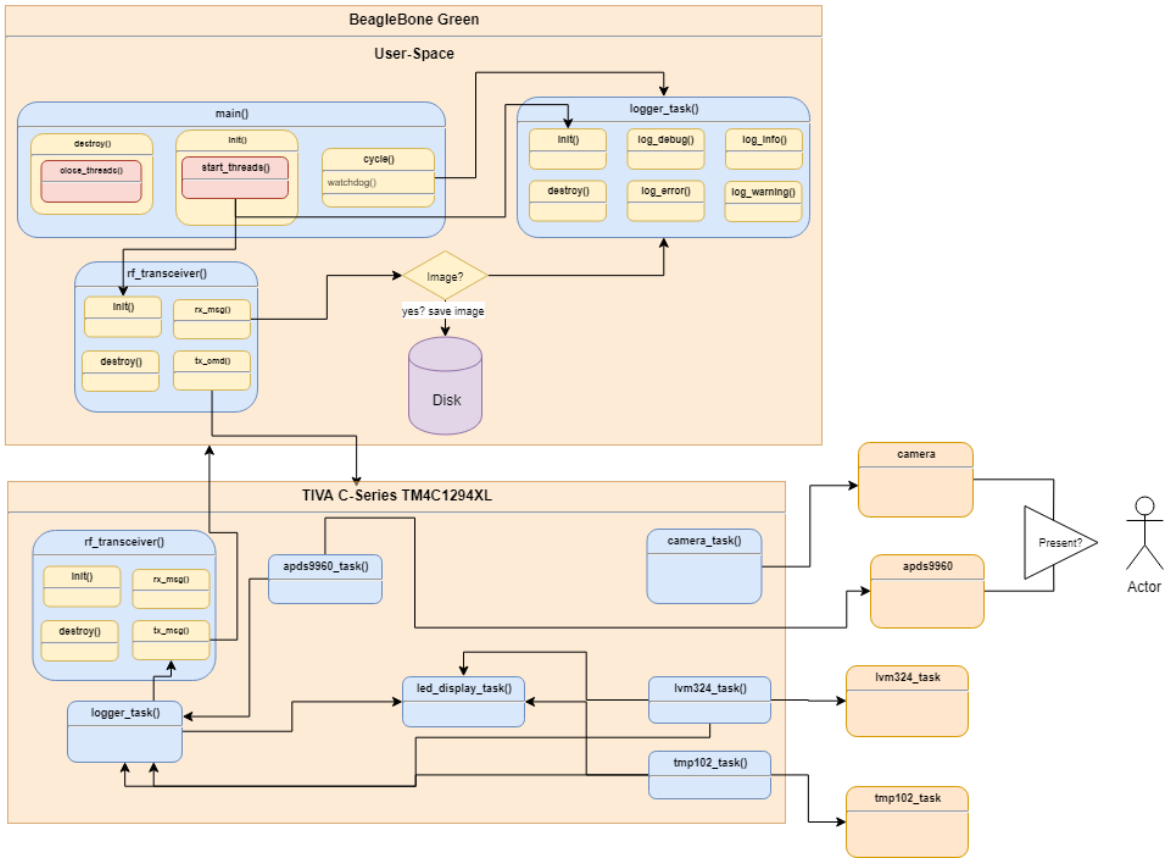

Figure 1: Architecture Diagram – Communications between the TIVA and BeagleBone are done though the RF Transceiver module. On the TIVA board, each task will log using custom logging APIs supporting different logging levels. The TIVA board senses the environment using the three external sensors and uses an LED display and a camera as "outputs".

On the controller node (BeagleBone Green), the standard C library will be used, in addition to:

- `stdio`
- `pthread`
- `mqueue (for thread communication)`

On the remote node (TM4C1294XL), FreeRTOS V10.2.0 will be used in order to manage tasks via scheduling, timers, etc. In addition, the TivaWare Firmware packaged drivers for I2C, GPIO and SPI interactions will be leveraged where possible.

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Application Program Interface

```
Used in conjunction between the TIVA board and the BBG for initialization and communication
tiva_comm_init();
bbg_comm_init();
tiva_tx_msg();
tiva_rx_msg();
bbg_tx_msg();
bbg_rx_msg();
tiva_detect_controller();
bbg_detect_remote();
Used on the TIVA board to communicate with sensors
tmp102_task_init();
tmp102_get_config();
tmp102_get_temp();
apds9960_task_init();
apds9960_get_config();
apds9960_detect();
apds9960_get_lum();
led_task_init();
tmp102_write_led();
remote_node_status();
```

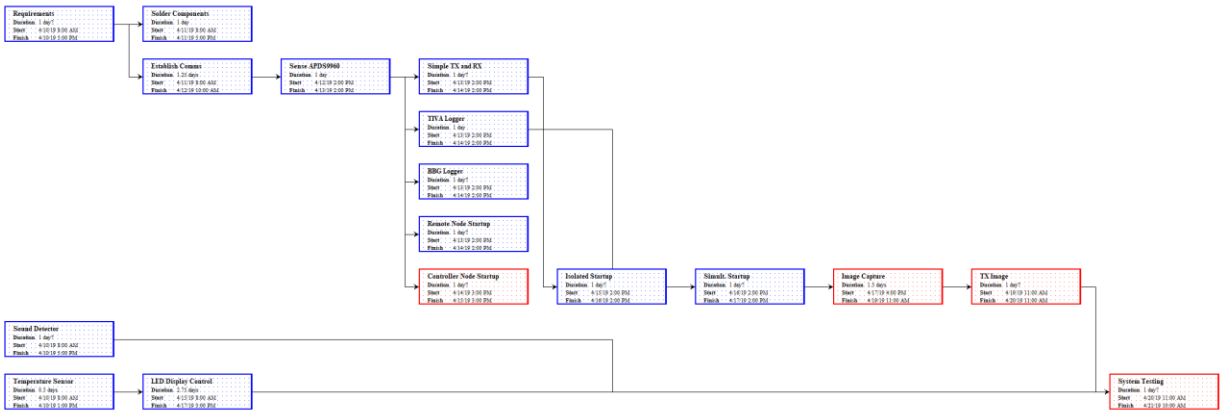

Figure 2: Project Plan (Tentative)