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DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

UNIVERSITY OF CENTRAL FLORIDA

EEL4914

Senior Design I

Team 5

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aLife - advanced Living Integration For Education

A) Project narrative description

Peoples lives are increasingly complicated, especially in managing their homes. You have to remember the shopping list, when to take the kids to soccer practice, whether you locked the front door, if the garage door is closed, when the dog needs more water, to turn off the lights when you're not using them, turn the coffee pot off, keep the AC at the correct temp, and a multitude of other things that eventually lead to some degree of information overload and stress. While there are devices that can increase our standard of living and give us more ways to be lazy (clap on lights), what would be far more useful is a way to make managing our lives more efficient, with respect to time, electrical energy, and mental energy. A "one stop shop" system of monitoring and control of all of the devices (and even some non electronics) in your home that only presents information to you when pertinent, allow you to set automatic settings for electronics such as lights, and even monitoring power consumption of electronics and disconnect them remotely, saving you money and stress when the electric bill comes. It's like autopilot for your home so you can focus more on living.

For our project, we will develop a prototype system with the potential to do all these things. It will consist of 3 major parts: An in home base station, wireless appliance control modules, and a remote user interface device such as a cell phone. The base station will act as a repository for all of the information about the status of devices in your house. It will pass information back in forth between the user interface and the modules that actually control your home appliances via ethernet, zigbee, and USB. The remote modules are designed to be simple, cost effective devices that monitor and control household appliances in a non intrusive way. They are designed to be as flexible as possible so they can be interfaced with a wide variety of common household items. They will each have a zigbee transceiver for communicating with the base station and basic I/O hardware to perform monitoring and control functions. The user interfaces will be a wall mounted touch screen LCD that is hard wired to the base station, as well as applications that run on any any Android equipped cell phone to allow remote control connection with the base station over the internet. The user interfaces will present the user with intuitive, concise menus that display information about items in your home and allow the user to change the operation of items in their home. Although there may be several items in your home that are connected, information about them will be integrated and displayed in a central Android app in order to keep the information organized. Some potential applications are:

- Monitor power consumption of appliances within the home and be able to physically disconnect them if they are using too much power (TV, coffee maker)
- Turn lights on and off, or set a lighting schedule if you're on vacation
- Monitor inside/outside temperatures and control heating/AC remotely
- Receive home security system status
- Use bar code scanner to add items to a common and synced shopping list
- Alert user if garage door is open after defined time
- Alert user if someone rings the doorbell
- Alert user if the pets food is running low for too long
- Lock or unlock pet door after pet enters the house after a defined time
- Alert user if entry doors are not locked after a defined time
- Alert user if the oven is on too long
- Turn on lights when client device comes into range
- Occupancy sensing to control energy savings
- Provide weather information from local sensors
- Alert user if sprinklers are running while its raining
- Alert user if client device leaves the range of the server
- Alert user to calendar events
- RFID tracking

There are an abundance of potential applications for managing your home life, and so in this project we will focus more on providing a flexible hardware and software foundation that allows the user to control almost whatever they want. We will pick some basic applications to demonstrate the system, but there is the potential to do much more.

B) Specifications and Requirements

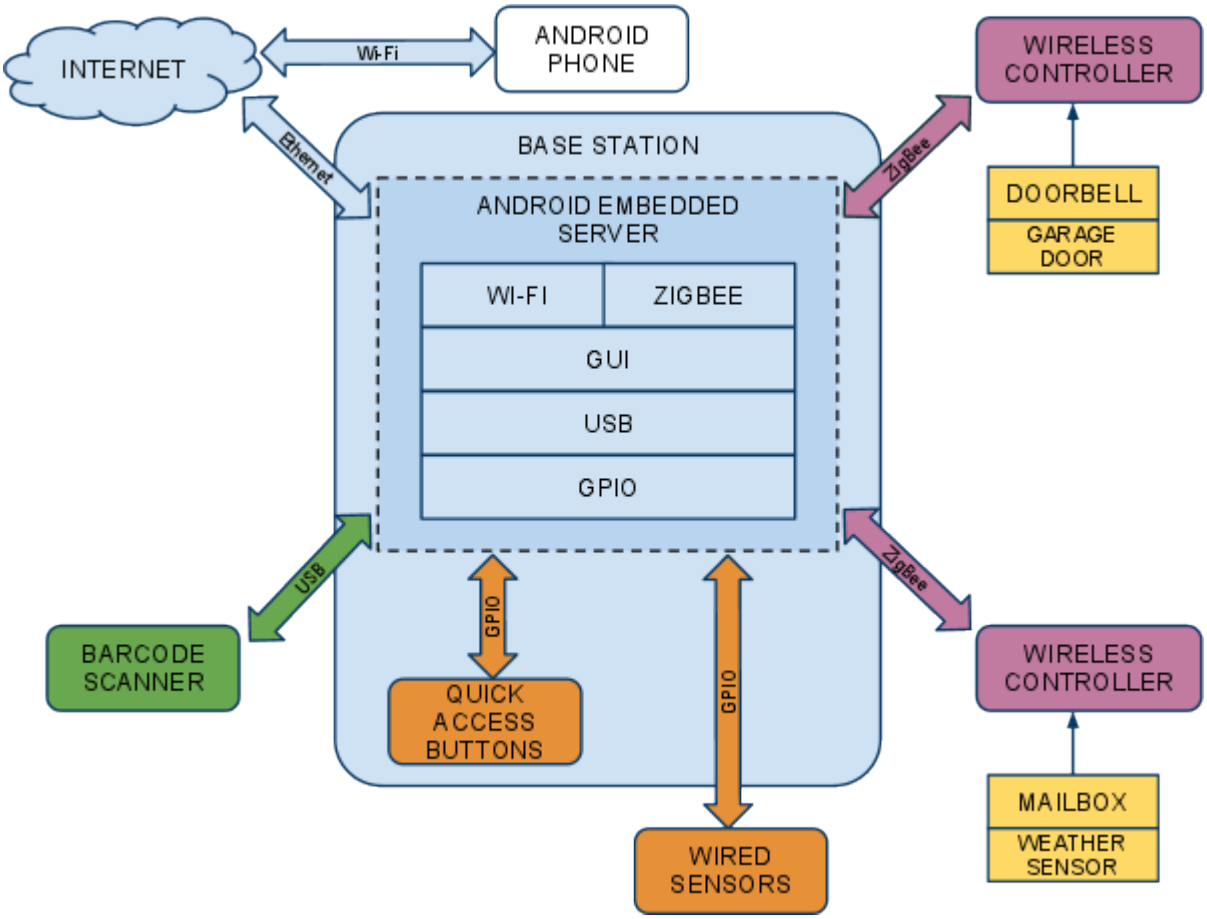
1. Base Station/Server - Embedded Artists NXP LPC3250 development board
    - Hardware:
        - NXP LPC3250 32bit 208MHz processor
        - 128kB RAM
        - 128kB FLASH
        - Ethernet, USB, UART connectivity
        - Breakouts for GPIO and other LPC3250 on chip peripherals
        - Color TFT LCD with resistive touchscreen
        - Freescale MC13213 8 bit MCU with built in Zigbee transceiver
        - Zigbee antenna with >25ft transmission range
    - Software
        - Linux kernel with Android GUI manager
        - Linux drivers to communicate with MC13213, as well as any external hardware connected to LPC3250 breakout GPIO
        - Android apps that implement the following basic functionality:
            - Receive input data from wired and wireless control units, display to the LCD as well as send to remote Android devices (cell phones)
            - Accept user commands from the built in touch screen LCD interface or from the remote Android device, and then send the corresponding control data to wired or wireless control units
            - Be able to create hardware control profiles that automatically send control data to the wireless remote controllers (ex turn off lights after midnight)
            - Multiple user accounts and allow connection to multiple remote Android clients simultaneously
            - Minimum bandwidth usage for connection to Android clients
            - Help menus for apps
        - Base station communicates with remote Andoid clients over the internet
        - Freescale *BeeStack* Zigbee communications stack for MC13213
        - Secure Zigbee communications protocol
        - MC13213 firmware that pipes data between Zigbee connection with sensors and UART connection with LPC3250
        - Able to plug and play additional Zigbee remote control units
2. Wireless Remote Controller Units
    - Hardware
        - Freescale MC13213 8 bit MCU with built in Zigbee transceiver
        - Zigbee antenna with minimum operating range of >25ft
        - 3.3VDC power supply derived from 120VAC wall outlet
        - Male 120VAC input power plug and female 120VAC output power plug
        - Op amps for GPIO drive stage and DAC's
        - 120VAC pass through outlet with in series relay and current sense resistor for electric appliance power consumption monitoring and physical power disconnection
        - At least: 2 analog inputs, 2 analog outputs and 4 digital GPIO for monitoring and controlling household appliances
        - Switches for unit power and 120VAC pass through
        - All hardware can operate in temperatures up to 110° F
    - Software
        - Firmware in MC13213 that reports status of GPI's and controls GPO's as commanded by the base station
        - Freescale *BeeStack* Zigbee communications stack

- Secure Zigbee communications protocol

3. Remote Android Clients
    - Run similar or same apps as base station on any Android device (with compatible versions of Android)
    - Provide secure data communication with base station over the internet
    - Apps use minimum processor power consumption
    - Software must not be invasive or annoying
    - Provide help menus
    - User interface must load in < 1 second

C) Block Diagrams

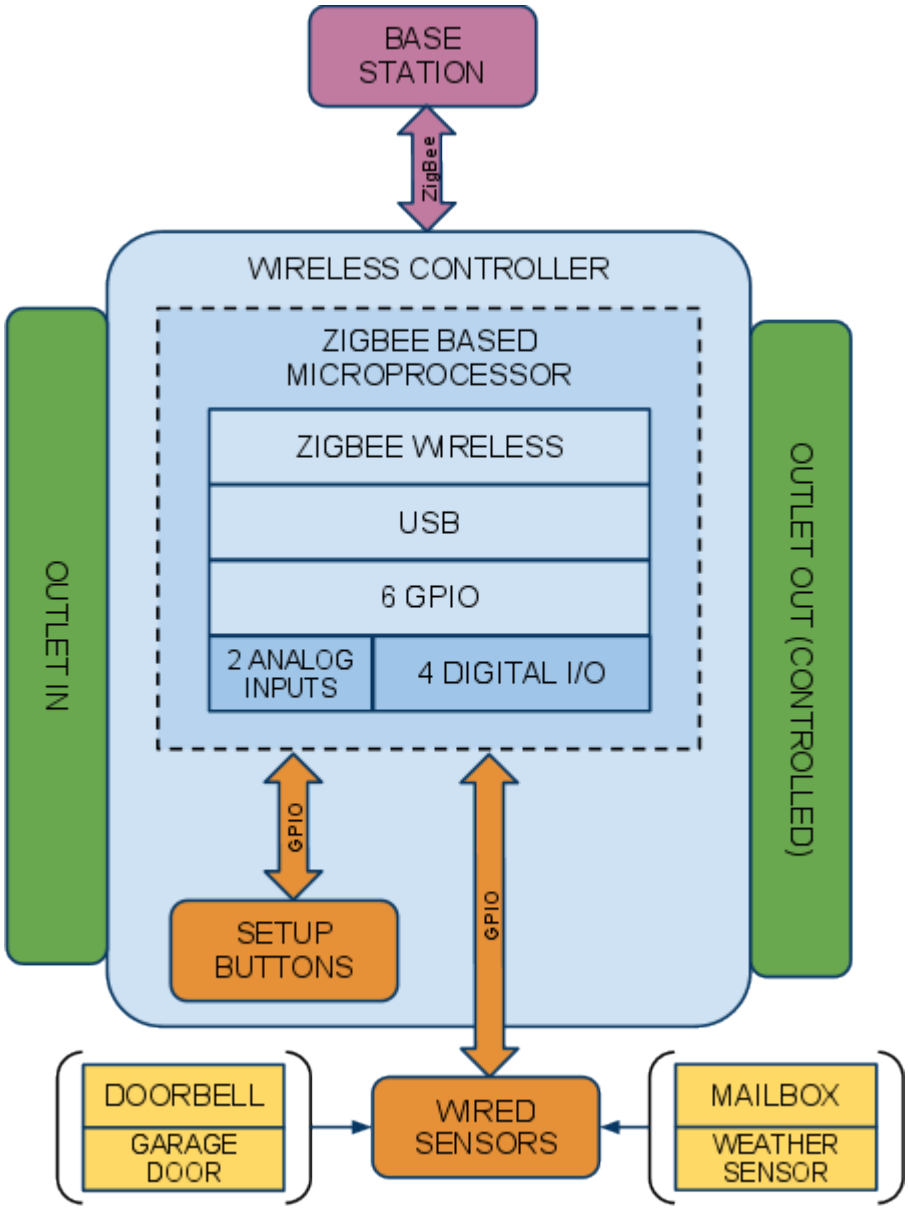
aLife Base Station



Legend:
GPIO - General Purpose Input/Output
GUI - Graphical User Interface
ZIGBEE - IEEE802.15.4 Wireless device

DEVICE	GROUP MEMBER	STATUS
Android Embedded Server	Jake	Acquired
Wireless Control Modules	Jake	Research
Barcode Scanner	Amos	To be acquired
Expansion Module	Amos	Research
Android Phone	Amos	Acquired

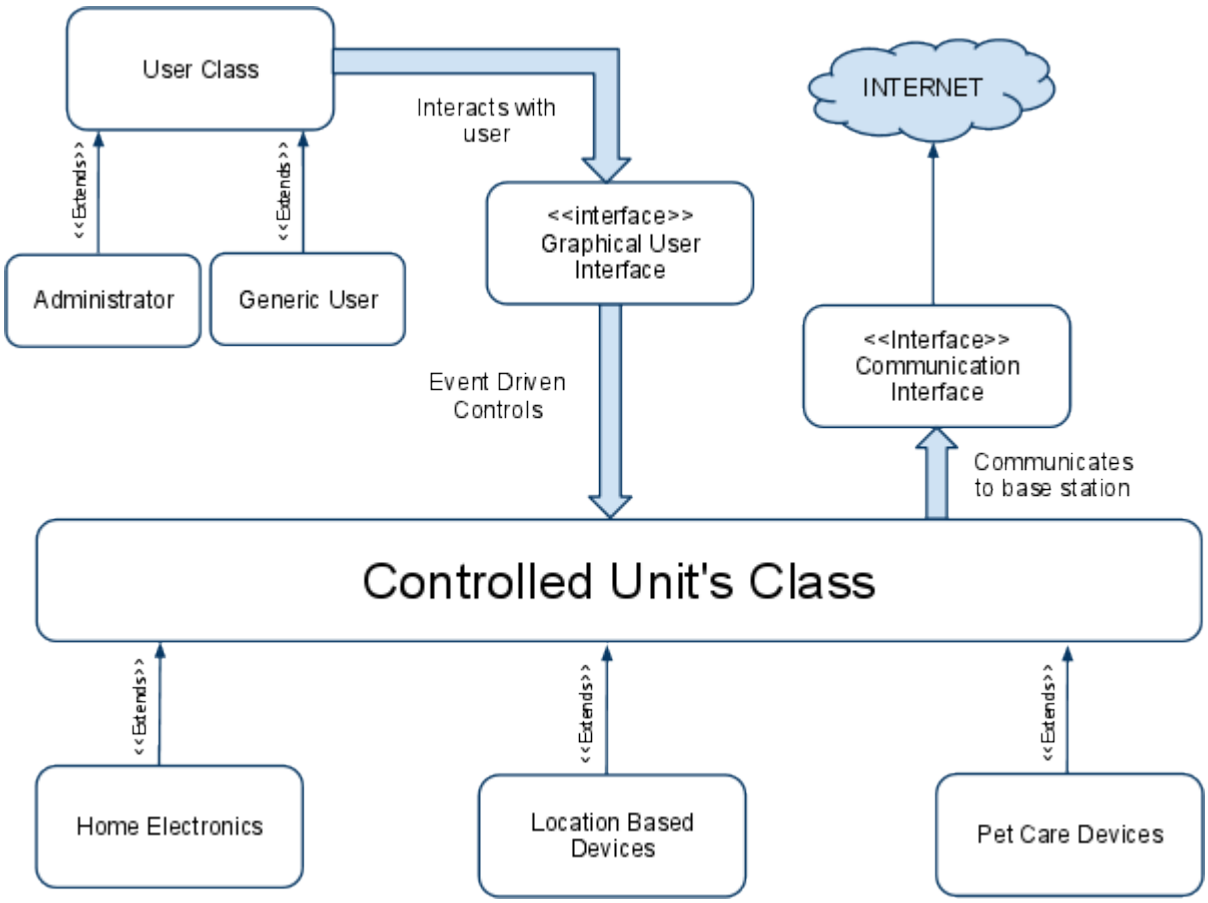
aLife Expansion Module



Legend:
GPIO - General Purpose Input/Output
ZIGBEE - IEEE802.15.4 Wireless device

DEVICE	GROUP MEMBER	STATUS
Expansion Module	Todd	Research
Sensors	Amos	Research
ZigBee Wireless Board	Tim	Research

aLife Server Software



Module	GROUP MEMBER	STATUS
GUI	Todd	Research
User Class	Todd	Research
Controlled Unit's Class	Tim	Research
Communication Interface	Tim	Research

D) Project Budget and Financing

Base Station/Server - Infrasafe, Inc has loaned us free of charge the Embedded Artists NXP LPC3250 demo board which includes all hardware listed for the base station except for the Freescale MC13213 processor and antenna. It is the same device as the remote Zigbee control units listed below but with some components depopulated (see below for budgetary info).

Wireless Remote Controller Units - These modules make up the bulk of the cost of this project since we will have to make them ourselves.

Estimated component cost per module: $20
Estimated PCB production cost per module (bare board production only): $35
Component assembly cost per module: $0 (we're going to solder on the components ourselves)

Total estimated cost per module: $55
Number of modules expected: 4 (1 base transceiver, 3 remote controller units)
Total expected investment per prototype rev: $220
** We will try hard to keep it to only 1 rev of boards to keep cost down

Remote Android Client Device - One of the members of the group has a smartphone that runs Android that we will use for implementing our remote Android client apps.

Total estimated project cost: $220

Total project budget: $500

E) Project milestones