University of Illinois at
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Mail Notification System

ECE 445 Senior Design Project
Spring 2013
Project Proposal

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1. Introduction

1.1 Title: Mail Notification System (MNS)

The project was selected because a majority of residents, whether it is an apartment, townhouse, house, etc., experience annoyance when they take a trip to the mailbox to check for mail and it is empty. We are motivated to develop a device to make our lives more expedient in various ways. With a mail notification system, a notification message will be sent to both home and mobile phone to inform the homeowners that there is something in their mailboxes.

1.2 Objective

1.2.1 Goal

The goal for this project is to make our lives more convenient by providing an efficient device. Hopefully with our Mail Notification System, we will reduce time and energy wasted checking empty mailboxes and picking up expected items as soon as they arrive.

1.2.2 Functions

- The Mail Notification System device detects the mail.
- The Postman selects the method of delivery (ex. Left on porch, at the post office, etc.)
- If no option is selected, MNS sends a default message with time to LCD.
- The Message will include the arrival time and status.
- MNS sends a text or email to the user.
- The user receives the mail.
- The user pushes the reset button on the LCD.

1.2.3 Benefits

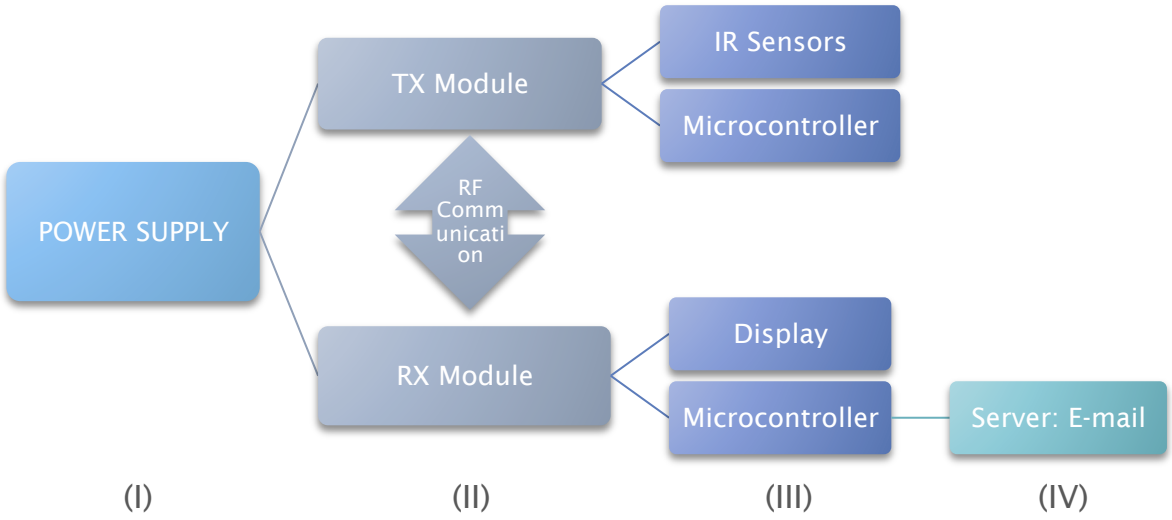
- Save unnecessary time and energy to check an empty mailbox.
- Ability to retrieve important and/or expected mail as quickly as possible.
- Portable and can be placed in any mailbox (single household, townhouses, apartments, offices, etc.).
- Inexpensive for a practical device.
- Ensure no missing mail by keeping track of the arrival of each mail

1.2.4 Features

- Email notification to accommodate user whom are away from house frequently
- Screen displays when and where the mail and package is located
- Device powered by battery and durable
- Lightweight and portable
- Suitable for any type of mailbox

2. Design

2.1 Block Diagram



2.2 Block Description

(I) Power Supply

4 AAA Batteries will be used to supply power to the transmitting side since all the sensors, controllers and RF transmitter will operate between 3 Volt and 5 Volt and each component will be connected in parallel. The receiving side will be located inside the house where wall outlet power is available.

(II) TX Module

The TX Module will consist of 3 main components, IR Sensors, a controller and an RF Transmitting unit. The TX Module will also operate only if the mailbox door is opened while a postman is placing mail to prevent unnecessary power drainage. That is, an analogy of refrigerators' light systems

will be applied, so whenever the door is closed, then the circuit switch will break the circuit and vice versa.

(II.I) IR Sensors

9 IR Sensors will be located appropriately to detect any type of mail. Sensors' output will be either high or low which will act as a signal to the controller unit. This digitized output will be coded into the controller unit for further action.

(II.II) Microcontroller

The controller unit will be programmed and operated to relay the signal to the transmitting unit. Output from the sensors and different options that was selected by a postman will be consolidated and react accordingly. Options will include 1. Left on porch, 2. at the post office, etc.. If the mail was simply put in without any option selected, then it will process as a default.

(II.III) Transmitting Unit

KST-TX01 will be used as an RF Transmitting module, which operates between 3V and 5V. Temperature tolerance is wide enough to cover any where in the US. Also, the output power is 1W and will cover up to 1500m. Once it receives the signal from the controller unit, then it will transmit different signal accordingly.

(III) RX Module

This module will consist of an RF receiving unit, microcontroller and LCD Display unit. The module will be installed inside house at users' discretion.

(III.I) Microcontroller

Microcontroller will be responsible for recording arrival time, and relaying information to the central server for email notification.

(III.II) Receiving Unit

KST-RX806 receives RF Signal from TX Unit and synchronizes it with the PIC microcontroller. Operating environment and specification is same as transmission unit.

(III.III) Display

CFA533 series LCD Display will be used. LCD Display unit itself has data storage to save pre written messages to display.

(IV) Server: Email

Server storage provided by EWS and National Instruments' Labview would be used to send a notification of mail via email.

3. Block Level Requirements and Verifications

3.1 Requirements

- **Sensors:** sensors have to be able to send relatively high voltage when there is an object blocking them. When there is no object detected, the sensors will send relatively low / zero voltage.

- **Control unit:** this unit has to be able to decide which signal to send to the receiving end based on the output of the sensors and the button pressed.

- **Transmitter:** this unit has to be able to transmit the bits received from the control unit, and transmit them to the receiver without any error in the message.

- **Receiver:** this unit has to receive and forward the signal received to the display module to decode it into the corresponding message

- **Display:** this module has to be able to display the message along with the date and time of the message's arrival

- **Microcontroller:** this module will be responsible for requesting the email address from the database to send the email notification to.

- **Power supply:** the power supply has to be able to supply enough power for the whole circuit.

3.2 Verifications

Sensors

1. Check if they output low voltage when there is nothing in front of the sensors, and
2. Check if they output relatively high voltage when something is blocking the sensor

Control unit

1. Upon receiving 1 from sensors, take input from the button
2. Perform the correct manipulation to output the corresponding signal for each button pressed as follows

00: there is no mail / package
01: there is mail in the mailbox
10: package is left on the porch
11: mail / package needs to be picked up

Transmitter, Receiver

Transmitter and receiver have to be tested as a pair. For whatever message is sent by transmitter, receiver has to ensure that it receives the same signal.

Display

1. Upon receiving non-zero signal (01,10,11), it has to save the time and date of arrival from the microcontroller.
2. Display the right message along with the time and date of arrival

Microcontroller

1. Access the database to make sure it is up.
2. Insert and delete dummy email to see if insertion and deletion from database works properly.
3. Verify if there is any email address corresponding to the receiver device.
4. Verify that the system actually sent the message along with time and date of arrival to the email address retrieved from the database.

Power supply

Check if the output voltage doesn't go significantly off the required range (3-5 Volt).

3.3 Tolerance Analysis

The output voltage has to stay within 3 to 5 volt for the whole circuit to work. The output from IR sensors have to be from 0 to 2 volt for it to be considered 0 bit, and anything larger than 2 volt will be considered bit 1.

4. Cost and Schedule

4.1 Cost Analysis

Parts

Part name	Qty	Price	Total
LCD display screen Crystalfontz CFA533-YYH-KU + cover and cables	1	$ 76.10	$ 76.10
433MHz Superheterodyne RF Link transmitter and receiver kits 3400 for ARM / MCU	1	$ 11.50	$ 11.50
PIC16F877A 8 bit Microcontroller	2	$ 3.99	$ 7.98
Solar Group E1600B00 Large Premium Steel Rural Mailbox	1	$ 15.21	$ 15.21
Plastic sheet	1	$ 25.00	$ 25.00
Total			$ 135.79

Labor

Name	# of week	# of hours per week	Cost / Hour	Total Cost
Dickson Salim	12	12	$ 12.00	$ 1728.00
Ethan Ahn-Kang	12	12	$ 35.00	$ 5040.00
Ryan Park	12	12	$ 35.00	$ 5040.00
			Total	$ 11808.00

Labor	Parts	Total
$ 11808.00	$ 135.79	$ 11943.79

4.2 Schedule

Time	Dickson Salim	Ethan Ahn-Kang	Ryan Park
2/11	Create the user interface for email registration	Assemble the sensor unit	Create and debug the control unit logic
2/18	Build the database / Labview	Learn eagle for PCB and design PCB	Learn eagle for PCB and edit PCB
2/25	Program the pre-loaded message into LCD display	Design transmitter's PCB	Design receiving end microcontroller PCB
3/4	Send the PCB design to Electronic and Machine Shop, pick-up PCB	Integrate the transmitter's PCB to the sensor unit	Integrate receiving microcontroller PCB to database
3/11	Integrate the date and time acquiring from the microcontroller	Test the transmitter receiver communication	Debug PCB
3/18	Spring Break Prepare presentation slides	Spring Break Prepare presentation slides	Spring Break Prepare presentation slides
3/25	Mock-up demo	Mock-up demo	Mock-up demo

4/1	Mock presentations Debug	Mock presentations Debug	Mock presentations Debug
4/8	Fill up database for final demo, and make changes if needed	Prepare sensors for final demo, and testing LCD display, and make changes if needed	Finalize the wireless communication functionality, and make changes if needed
4/15	Individual demo test	Individual demo test	Individual demo test
4/22	Final Demo	Final Demo	Final Demo
4/29	Final paper, checkout	Final paper, checkout	Final paper, checkout