NFC-Enabled Menu Ordering System

Project Proposal

ECE 445
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Team #47

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1. Introduction:

1.1 Title: NiFty (Near Field) Menu

There has been a push toward less dependence on waiters at restaurants. For example, Chili's and Old Chicago's currently support a product called "Ziosk" on every table; a fully-colored, multi-functional, touch-screen tablet that allows restaurant customers to pay the bill and play games from the convenience of their seat. Our idea is to take this idea in a different direction, and implement a low-cost solution to restaurants using an NFC-enabled menu. Since NFC technology is very low-profile (think sticker), the menus created would look and feel like any menu on the market; conversely, any menu would be compatible with our system. Our device will allow a customer to use our specifically-designed NFC-reader to select their menu items by hovering over the NFC tag (this can be placed underneath a picture of the item or beside the item). The menu will contain an RF module that will send the order directly to the kitchen, reducing the work that waiters need to do. This will allow the restaurant to hire less waiters and will also improve any miscommunication between server and patron. Imagine if you are in a foreign country where you do not speak a lick of the native language. Our solution will allow you to intuitively point and select the food items you want, keeping difficult communication between server and guest as minimal as possible. This product is not designed to completely replace wait staff--it is simply an additional feature that will allow orders to queue efficiently and a reduction in the total number of workers that a restaurant includes on its payroll.

1.2 Objectives:

1.2.1 Goals & Functions:

- Simple yet powerful menu interface (user experience is high priority)
- Small NFC Reader with 8 bits of memory (to store ~255 menu items)
- Fast wired communication between reader and menu microcontroller
- LCD display to aid order selection/confirmation
- Menu microcontroller can store up to 32 unique selections to transmit via RF to kitchen
- RF communication between menu and kitchen
- Computer user interface at RF-receiving end for use for kitchen workers

1.2.2 Benefits:

- Low-cost
- Reduce wait staff; take out orders can be processed more efficiently
- Simple integration with current menus (no overhaul required)
- Minimize communication between server and guest

- Enables precise queueing in the kitchen

1.2.3 Features:

- Sleek menu with intuitive point-and-select interface
- Backlit LCD module for use in dim restaurants
- Up to 255 unique tags (food items, sides, drinks, etc.)
- RF receiver in kitchen can process up to 100 menus at a time
- Battery lifetime up to one year on 4xAA batteries

2. Design:

2.1 Block Diagrams:

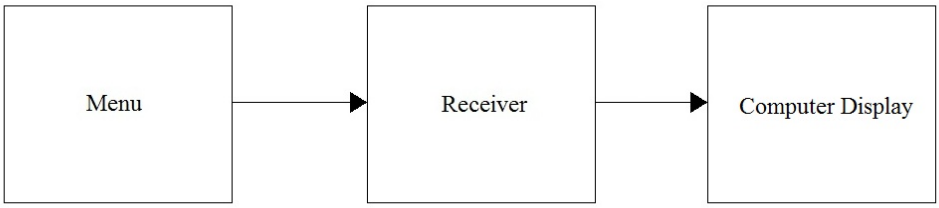

Figure 1: Top Level Layout.

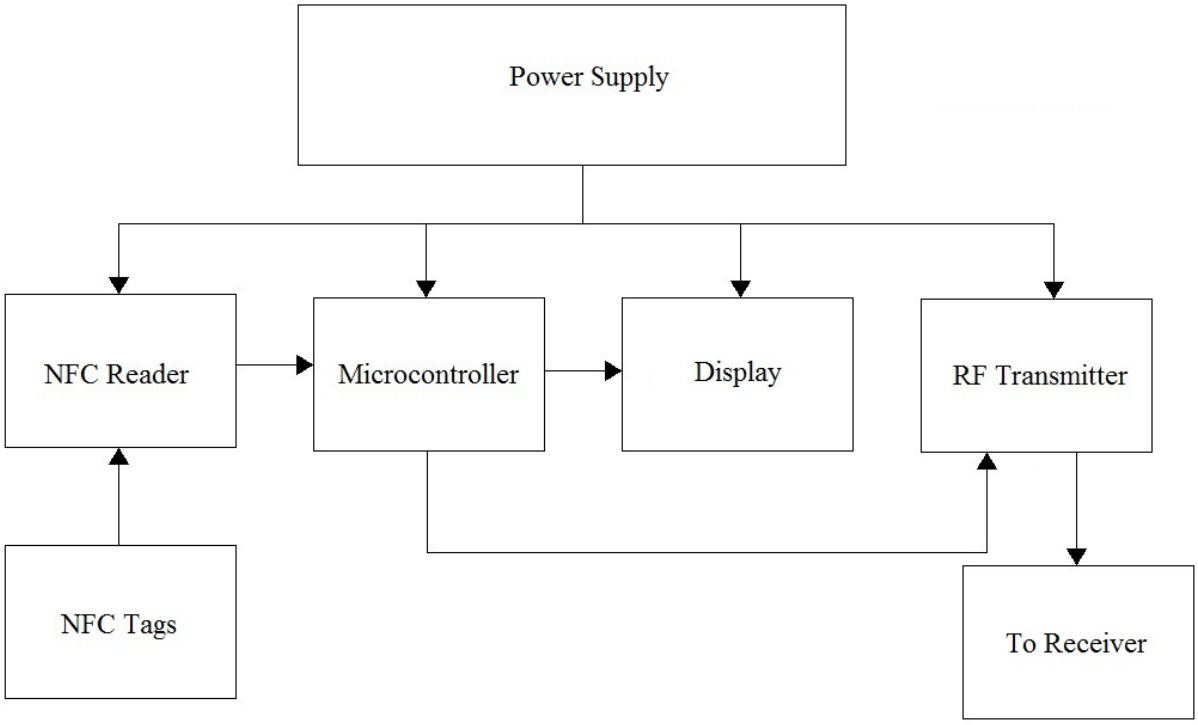

Figure 2: Menu Block Diagram.

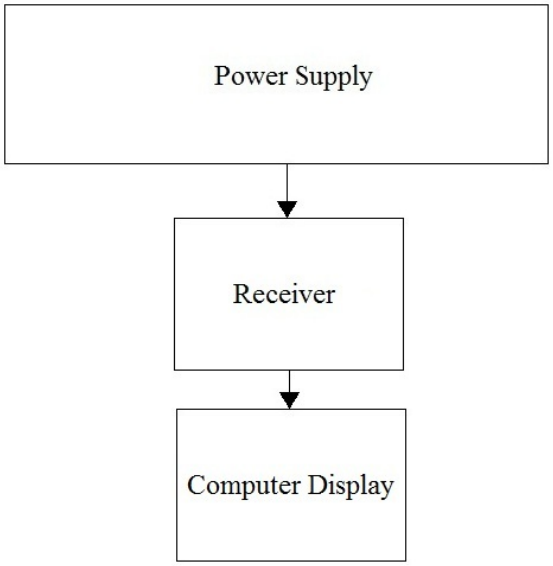

Figure 3: Receiver Block Diagram.

2.2 Block Descriptions:

2.2.1 Overall:

To create this NFC ordering system we will use a menu that acts as an interface for the user. The menu has a RF transmitter that will wirelessly transmit data of the customer's order to a receiver which will transmit the data to a computer via USB port. For our prototype, the computer will translate the data into English and display the order.

2.2.2 Menu:

2.2.2.1 Power Supply:

This will supply power to all the components that require power. The only component that does not require the power supply to function is the NFC tags. The power supply will be created using an array of AA batteries.

2.2.2.2 NFC Tags:

These tags are small and easily programmable via computer software. The tags do not require power and will be stuck inside the menu to represent various items to order. When a customer scans a picture of the item they want to order, they will actually be scanning the NFC tag underneath the picture. When scanned by the NFC reader, the NFC tags will transmit the data that represents an item to the reader using near field communication technology.

2.2.2.3 NFC Reader:

The NFC reader will read the NFC tags and transmit the data to the microcontroller. This consists of the a circuit that can use NFC to read the data from the tags and then send that data directly to the microcontroller. The reader will be hardwired to the microcontroller to ensure that the reader cannot be stolen and for a fast response. Ideally, the NFC reader will be as small as a keychain to allow easy use by a customer.

2.2.2.4 RF Transmitter:

The transmitter will take the data that was picked up by the reader after the order is verified through the microcontroller. Once the order is confirmed, the transmitter will wirelessly transmit the data to a receiver component which will be in the kitchen of the restaurant.

2.2.2.5 Display:

This will display the order and acts as an interface that allows the customer to view and then confirm or cancel their order. The display will be a backlit LCD module that receives the data to display from the

microcontroller.

2.2.2.6 Microcontroller:
The microcontroller will take the data it receives from the NFC reader and will translate the data into the desired item to display on the display module. It will also be able to receive input from the customer in order to confirm or cancel the order. If confirmed, the microcontroller will transmit the data from the NFC reader to the transmitter. Some memory will be required to store up to 32 unique selections made by the user.

2.2.3 Receiver:

2.2.3.1 Power Supply:
This will supply power to all the components that require power. Because the RF Receiver will be connected to the computer display through a USB port, the power will come from the computer.

2.2.3.2 RF Receiver:
This will receive the data from the transmitter and will be transferred into a computer via a USB port. The receiver will be placed in the kitchen to allow communication from the customer directly to the cooks.

2.2.3.3 Computer Display:
The computer display will consist of a program that will take the data from the receiver and translate it into english to be displayed on a simple and powerful GUI for the kitchen workers to see.

3. Requirements and Verification:

3.1 Requirement	3.2 Verification
1. Menu Power Supply: ● Must be able to draw power from batteries and provide regulated power to the microcontroller, RF transmitter, display module, and the NFC reader	1. We will find out the amount of power our modules draw using the bench voltage source and a multimeter. With this, we will create a load that we will test our power supply on.
2. Menu NFC Tags (Passive Element): ● Must be able to provide NFC Data Exchange Format (NDEF) messages to the NFC Reader	2. Since these are the passive ends of NFC (they do not need to be powered), we can verify their functionality with a smartphone ap (i.e. NFC Task Launcher) on a NFC-enabled phone.

3. Menu NFC Reader: ● Must be able to receive NDEF messages from the NFC reader ● Must be able to forward the received NDEF messages to the microcontrolle ● Must be able to transmit NDEF messages to an NFC-enabled smartphone	3. We can test the signal transmission with a NFC-enabled smartphone using an NFC app. that will send a message in NDEF and display the message on the LCD module. This will als test the transmission of NDEF messages to the microcontroller.
4. Menu RF Transmitter: ● Must be able to interface with the microcontroller and transmit the appropriate signals to the receiver. ● Must work within a specified frequency range given by the transmitter chip.	4. Oscilloscope's frequency sweep function to test range and ensure the transmitter and receiver are in the same frequency range.
5. Menu Display: ● Must be able to display proper messages from the NFC tags	5. The functionality can be individually tested using an arduino microcontroller.
6. Menu Microcontroller: ● Must be able to interface with the NFC reader, display module, RF transmitter, and power supply; performing the intended calculations accurately	6. The functionality of this can be tested separately on a breadboard with a bench setup using LEDs.
7. Receiver Power Supply: ● Must be able to draw power from the computer through the USB ● Must be able to provide drawn energy to power the Receiver	7. We will connect this power supply to a bench voltage source, following the same procedure as the Menu power supply.
8. Receiver RF Receiver: ● Must be able to accept signals from th RF transmitter and send them through the USB ● Must work within a specified frequency range given by the receiver chip.	8. Oscilloscope's frequency sweep function to test range and ensure the transmitter and receiver are in the same frequency range.

9. Receiver Computer Display (software) ● Must be able to parse the signal and display the appropriate messages from the NFC tag	9. Software will test corner cases/simultaneous entry to make sure that it is robust enough for busy restaurant environment. Verification through real data being shown on the computer screen. This software will help show proof of concept.

3.3 Tolerance Analysis:

The most critical part of the project is ensuring that the proper order reaches the kitchen. There are two components that make this possible -- the signals fed from NFC reader to menu microcontroller, and also the RF signal that is sent from the menu to the kitchen. For our tolerance analysis, we will focus on ensuring that the signals sent from NFC reader to menu microcontroller are quick and precise.

NFC technology is relatively quick--we would like the time delay between selecting a menu item and having it appear on the LCD display in ~1.5 seconds. However, the tradeoff is power consumption. We will be balancing speed vs power consumption of the device to make sure that selections feel intuitive, natural, and lag-free to the user, while minimizing the amount of power that the NFC reader draws from the battery module.

To test this feature, we will have the NFC reader draw various amounts of power from the battery pack. We will test for an upper-bound and lower-bound of the power drawn and how it correlates to a 0.5 - 2.5 second response time. We hope to find a fair compromise between a high-speed circuit and long battery life.

4. Cost Analysis

4.1 Labor

Name	Hourly Rate	Total Hours Invested	Total = Hourly Rate x 2.5 x Total Hours Invested
Patrick Ding	$35.00	180	$15,750
Yau Chan	$35.00	180	$15,750
Patric Takagi	$35.00	180	$15,750
Total Labor Costs		**540**	**$47,250**

4.2 Parts

Item (P/N)	Unit Cost	Quantity	Total Cost ($)
LED's	$0.42	15	$6.30
MOSFET's	$0.78	15	$11.70
PCB's	$10.00	3	$30.00
4xAA Battery Holder (BH-341)	$1.23	2	$2.46
RLC Components	variable	variable	$30.00
Backlit LCD Display (LCD-00790)	$15.00	1	$15.00
RF Transmitter (WRL-10534)	$5.00	2	$10.00
RF Receiver (WRL-10532)	$5.00	2	$10.00
NFC Tags (NTAG203)	$0.75	50	$37.50
Misc. NFC-reader costs	$20.00	1	$20.00
Misc. Menu Design Costs (housing, etc.)	$30.00	1	$30.00
Total Parts Costs			**$202.96**

4.3 Grand Total

Section	Total
Labor	$47,250
Parts	$202.96
Total	**$47,452.96**

5. Schedule:

Week	Responsibility	Member
2/04	Finalize and hand in proposal	Patrick
	Research and design NFC tags. Order parts.	Yau
	Research and design NFC reader. Order parts.	Patric

2/11	Design in-menu microcontroller. Design PCB and order parts.	Patrick
	Research LCD display requirements and support Patrick with microcontroller task. Order parts.	Yau
	Design RF interface between menu and receiver.	Patric
2/18	Prepare for Design Review	Patrick
	Design RF receiver -> computer interface (kitchen)	Yau
	Support Yau on RF receiver task. Order parts	Patric
2/25	Assemble power supply, NFC reader, and RF transmitter for testing	Patrick
	Assemble power supply, NFC tags, and LCD display for testing	Yau
	Design RF interface	Patric
3/4	Assemble power supply and RF receiver for testing	Patrick
	Test NFC reader, tags, microcontroller	Yau
	Test LCD display, RF transmitter/receiver	Patric
3/11	Integrate entire menu system (reader + tags + microcontroller + LCD + transmitter)	Patrick
	Order parts for housing of electronics. Integrate RF receiver system (receiver + USB interface + computer GUI)	Yau
	Prepare for mock-up demo	Patric
3/18 (Spring Break)	Design sleek menu interface and support Yau + Patric + Individual Progress Report	Patrick

	Design housing for menu & electronics + Individual Progress Report	Yau
	Design housing for RF receiver + Individual Progress Report	Patric
3/25	Verification of specifications	Patrick
	Tolerance analysis	Yau
	Completion of computer GUI and any other modules	Patric
4/01	Fix remaining issues	Patrick
	Fix remaining issues	Yau
	Finalize prototype	Patric
4/08	Last chance for final PCB design	Patrick
	Refine prototype	Yau
	Integrate refined prototype	Patric
4/15	Test fully integrated system	Patrick
	Prepare for final demo	Yau
	Last-minute revisions/improvements	Patric
4/22	Prepare for final demo	Patrick
	Prepare final presentation	Yau
	Complete final presentation	Patric
4/29	Complete final written report + Check in supplies	Patrick
	Complete final written report	Yau

	Complete final written report	Patric