ECE 441 Senior Design
Technology Research Report

Cell Phone Audio Controlled Point of Sale

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Group 9
10-19-08
1. Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>10-18-08</td>
<td>Introduction and Requirements drafted</td>
</tr>
<tr>
<td>10-19-08</td>
<td>Remaining parts drafted</td>
</tr>
<tr>
<td>10-20-08</td>
<td>Report finalized</td>
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</tbody>
</table>
2 Introduction

The purpose of this project is to accomplish a very simple transaction such as purchasing an entrance ticket; paying for a parking meter, by using a handy mobile phone instead of credit card or cash, although this type of technology has already been out to the market for a while.

An existing technology would be NFC (Near Field communication), touching your mobile phone to a NFC credit card reader, after a conformation tone is being heard, your purchase has made. While our project would step back to the simple world of audio interfaces, the idea is that we will decide on a tone-generator application that will need certain amount of money or credit to be operated (not yet finalized), instead of paying with credit card, we will use our own cell phone to pay for it.

To do so, we will first need to dial an 1800 number from our cell phone. To determine our own 1800 number for this project, we will register an account. After dialing the 1800 number, an IVR (Interactive Voice Response) system will ask the user to enter a numerical identifier or serial number for the tone-generator application using the cell phone keypad. The user will be prompted for entering “yes” or “no” to either agree or disagree on the of money needed to pay for the application to operate. The user is instructed to hold the phone speaker really close to the application, and the cell phone uses audio tones to communicate with the application. The application confirms the transaction with an audio tone, and the call will be terminated.
2.1 Customer Requirements & Project Background

The target customer of this project would be anyone that carries a mobile phone in any country around the world.

Cell phone was initially designed for calling purpose only, then digital camera function was added to it, then following that, 3G (3\textsuperscript{rd} generation) was added to it. Now cell phone is becoming a type of credit card that people can use it wisely.

In this modern technology world, people tend wanting things to become as easy as possible. From cash to credit card, now it is time for mobile phone credit card. It is a great idea for people whom do not always have cash around.

For cell phone service providers, this kind of subscription services would increase the company’s ARPU, as well as bringing more partner companies and more customers.

Customers would want to use this product only if it is easy to function, takes equal or less time than previous paying methods.

But on the other hand, there are only limited device yet uses mobile phone as credit card. There isn't yet a critical mass of contactless readers and go-anywhere, buy-anything transacting possible via contactless cell phones. That’s where the value to the consumer breaks down.

Requirements for this project:

- The tone-generator application must be able to encode and decode from the cell phone.
  
  In telephone system, the DTMF(Dual Tone Multi-Frequency) signaling is used extensively for telephone call signaling. A DTMF signal, which consists of the sum
of two sinusoids is generated. Whenever a key is pressed, a DTMF signal containing two frequencies is generated. One frequency corresponds to the row and the other to the column of the digit dialed. Decoding a DTMF signal involves extracting these two frequencies, which reveals the digit that was dialed.

- The tone-generator application must be able to make a final confirmation tone to terminate the operation.
- Be able to remove noise, the application most likely will be generated outside, it is critical to be able to reduce and to remove the noise around, so the application will generate properly.

**Desired features if time allows:**

- Making the “tone-generator application” a desirable purchasing device.
- Display LED to indicate the application is in use

### 2.2 Competitive Analysis: part 1

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Power Source</th>
<th>Card read/write Speed</th>
<th>Operating Frequency</th>
<th>Operating Distance</th>
<th>Supply Voltage</th>
<th>Supply Current</th>
<th>dimensions</th>
<th>Typical applications</th>
<th>Memory capacity range</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARC 122</td>
<td>From USB</td>
<td>9600 - 115200 bps</td>
<td>13.56 MHz</td>
<td>Up to 50 mm</td>
<td>Regulated 5V DC</td>
<td>200mA (maximum)</td>
<td>98mm(L) 65 mm(w) 12.8 mm(H)</td>
<td>Vending machines and more</td>
<td>N/A</td>
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</tr>
<tr>
<td>ISO 15693</td>
<td>N/A</td>
<td>26.69k b/s max</td>
<td>13.56 MHz</td>
<td>One meter</td>
<td>+12V</td>
<td>350mA</td>
<td>12 X 10.5 X 3 cm</td>
<td>Parking garage</td>
<td>256 and 2K bytes</td>
</tr>
<tr>
<td>ISO 14443</td>
<td>N/A</td>
<td>106kb/s max</td>
<td>13.56 MHz</td>
<td>3.94 inches</td>
<td>5 - 9 VDC</td>
<td>N/A</td>
<td>135x75x15 mm</td>
<td>Vending machines</td>
<td>64 to 64K bytes</td>
</tr>
<tr>
<td>125 kHz Technology</td>
<td>N/A</td>
<td>4 Kbps</td>
<td>125KHz</td>
<td>Up to 3.3 feet</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Door Reader</td>
<td>8 to 256 bytes</td>
</tr>
<tr>
<td>ViVOpa y Kiosk</td>
<td>DC power supply</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>7.5 – 45VDC</td>
<td>700 mA</td>
<td>107.4mm(mH) 31.5mm(W) 78mm(Depth)</td>
<td>Parking meters and more</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Part 2: Felica technology products:

<table>
<thead>
<tr>
<th>Model</th>
<th>Communication distance</th>
<th>Operating frequency</th>
<th>Communication speed</th>
<th>Operating temperature/humidity</th>
<th>Mass/dimensions</th>
<th>Modulation band width</th>
<th>Communication method</th>
<th>Modulation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC-S8 60</td>
<td>10 cm (when using RC-S460C/S44 1C)</td>
<td>13.56 MHz</td>
<td>212kbps</td>
<td>0°C - 40°C / 20%RH - 90%RH / 40°C - 50°C / 50% RH or less</td>
<td>5g/ 54.0*85.</td>
<td>6*0.76 mm</td>
<td>N/A</td>
<td>ISO/IEC 18092 (212kbps Passive mode)</td>
</tr>
<tr>
<td>RC-S8 85</td>
<td>100mm (when using RC-S460C/S46 2C)</td>
<td>13.56 MHz</td>
<td>Supports automatic 212kbps, 424kbps switching</td>
<td>-0°C ~ 40°C*(32°F~104°F) /20%RH <del>90%RH /-40°C ~ 50°C*(104°F</del>122°F)/50%RH or less</td>
<td>5g</td>
<td>N/A</td>
<td>Compliant with ISO/IEC 18092 (212kbps, ASK Modulation)</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>Communication distance</td>
<td>Operating frequency</td>
<td>communication speed</td>
<td>Operating temperature/humidity</td>
<td>Mass/ dimensions</td>
<td>Modulation method</td>
<td>Communication System</td>
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<tr>
<td>RC S8 80</td>
<td>30 mm (when using RC-S460/S490)</td>
<td>13.56 MHz</td>
<td>Supports automatic 212kbps/ 424kbps switching</td>
<td>-0°C - 40°C/20%RH - 90%RH -40°C - 50°C/50%RH or less</td>
<td>5g 54.0×85.6×0.76 mm</td>
<td>N/A</td>
<td>Compliant with ISO/IEC 18092 (212kbps/424kbps Passive mode)</td>
<td>ASK Modulation</td>
</tr>
</tbody>
</table>

5mm (when using RC-S320/S(GC))
### 2.2.1 Product Space Analysis

**ACR122/ISO14443:**

The ACR122 is a PC-linked Contactless Smart Card Reader/Writer developed on the 13.56MHz Contactless Technology. It is the world’s first CCID Compliant Contactless Card Reader/Writer that follows both ISO14443 and ISO18092.

This device is designed to support not only MiFare and ISO14443 Type A and B Cards but also FeliCa and NFC tags. By making use high-speed card access and full USB speed of 12 Mbps, read and write operations are faster and more efficient.

<table>
<thead>
<tr>
<th>RC-S4 93B</th>
<th>30mm (when using RC-S860 series/RC-S880/RC-S833)</th>
<th>13.56 MHz</th>
<th>212kbps/424kbps</th>
<th>-10°C~+40°C* (14°F<del>104°F) /20%RH</del>90%RH 40°C<del>60°C(104°F</del>140°F)/50%RH or less</th>
<th>110g/Approx. 71.8×12×63.6mm</th>
<th>±300kHz (at -30dB carrier level)</th>
<th>Compliant with ISO/IEC 18092 (212kbps/424kbps Passive mode)</th>
<th>ASK</th>
</tr>
</thead>
</table>

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*Note: *The specifications and features may vary depending on the specific model and version of the ACR122.
Furthermore, this reader acts as a Plug and Play (PnP) device so there is no need to provide drivers to users. With its compact size and trendy design and with the various features the ACR122 offers, you can experience the convenience in using ACR122 for applications of payment, mass transit, physical access control, time attendance and much more.

**ViVOpay Kiosk:**

ViVOpay Kiosk is an add-on contactless payment module that can easily bolt onto existing and new Kiosk systems to enable contactless functionality. The ViVOpay Kiosk designed for indoor and outdoor environments is compatible with all major worldwide contactless payment programs and works with upcoming NFC mobile phone payment technologies for ticketing, promotions, and coupons redemption applications.

For our own project, we will have to consider the battery life part, charging with USB port seems a good idea. And if we want to make it a “point of sale” application, we will need to make our device as portable as possible.

We would further consider security protection method for our project. We will make the operating distance for our project in between 2 inches to 3 inches. We will search more information on the Dual Tone Multi-Frequency technology as described above, hopefully it will help us with our project.
Also as our mentor mentioned, we will also be studying for more of the microcontroller with Fourier Transfer algorithms that will generate the frequencies. As well as searching for microphones that will record the tones that come from the cellphone keypads.

2.3 Feature set

**Absolute Minimum Requirements**

- Be able to demonstrate tone decoding at a distance of 2 inches from Cell phone speaker. 3 inches of operating distance would be better, but we will make a minimum of 2 inches first and improve from there.

- A working prototype that must be able to encode and decode different tones. This is the most critical part of the entire project.

- A confirmation tone that indicates the operation has accomplished.

- A working prototype that must be able to filter out the noise around that might be affecting the signals, so we will have the clean and current frequencies that we want.

- A working prototype for senior expo where anyone not on the project can use their own cell phones, place a 1800 call, hold their speaker next to the prototype within the indicated distance, send a tone that contains some number of bits of information (the number of bits has not finalized), and see the resulting decoded information on the display.

- Microphone for the device so that it can record the tones that comes from the cellphone keypad.
• System must be cost effective.

2.3.1 Desired Feature

• On and off LED

• Portable device in good shape and appearance

• Be able to use microcontroller with DSP algorithms for audio filtering, tone decoding and audio noise rejection.

References

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**Naming conventions used**

ARPU – Average Revenue Per User

IVR – Interactive Voice Response

NFC – Near Field Communication

DTMF – Dual Tone Multi-Frequency