AccuTag by PRECISION WIRELESS

WIRELESS DIGITAL E-INK PRICE TAG SYSTEM

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SFU SIMON FRASER UNIVERSITY THINKING OF THE WORLD
Overview

- **Background**
  - Introduction to Precision Wireless Team
  - Project Motivation

- **Product Functionality**
  - Proposed Product
  - E-Ink
  - Radio Frequency Communication
  - Final Hardware Design

- **Conclusion**
  - Questions

- **Project Demo**
Background

There are many flaws in utilization of paper price tags:

- Updating traditional paper price tags is time consuming and labour intensive.
- The tags are most likely not recycled.
- Updating the prices on the daily basis is not possible nor efficient.
To develop a pricing system that is more efficient and reliable.
To increase the feasibility of frequent price updates.
To make the process more eco-friendly and power efficient compared to existing solutions.
To Enable price updates from the headquarters using a synchronized database system.
To make the system easy to use and implement so it can be integrated in any store in the matter of days.
Making the display more flexible and user friendly depending on various applications.
Proposed Product

Wireless electronic price tag; AccuTag System:

Display Unit:
- E-paper Display (Pervasive Display)
- Atmel single-chip transceiver solution for use as a MCU and RF transmission unit.

Transmitter Unit:
- Transmitter prototype
- Synchronized database
Hardware Design

High Level Block Diagram

- **Price Tag**
  - Receives signals
  - Updates E-Ink display
  - Sends ACK

- **Central Transmitter Unit**
  - Broadcasts prices to tags
  - Awaits ACK responses

- **Host Computer**
  - Checks for price changes
  - Controls transmitter according to our protocol

- **Price Catalog/Database**
  - MS SQL database
  - No custom written software

![Diagram Image]
The standalone RCB does not support user programming interfaces. It has to be mounted on a development platform such as the STB in order to give the user a method for programming the microcontroller on the RCB.

There are two supporting interfaces that provide optional methods for programming and debugging the host application on the microcontroller. They are AVRISP and JTAGICE mkII.

When using the AVRISP programming interface, the user has access to a 6-pin header that allows the fuses and the flash of the Atmel ATmega1281V to be programmed. The AVRISP does not support application level debugging. See Figure 5-6 for the proper connector orientation between the STB and the AVRISP.

The ISP pin location for the Atmel ATmega128RFA1 differs from the ATmega1281V. Therefore the AVRISP can only be used with 1281V-based RCB boards.

In order to provide extra developmental features beyond simple fuse and flash programming, such as application-level debugging, the JTAGICE mkII should be used. The STB also provides the required 10-pin header for proper JTAGICE mkII connection. See Figure 5-7 as a connection reference.
Schedule
E-Ink Integration
Electrophoretic Display

- Unlike conventional back lit displays; e-paper reflects light.
- Mimics the behaviour of conventional paper theoretically making it more comfortable to watch and giving a surface wider viewing angle.
- In addition, text and images will remain on the e-paper without power supply.
- Environmentally the solution is better as paper tags are substituted.
RF Communication

- **Data Transmission**
  - Packet format
  - Composing packets
- **Data Reception**
  - Parsing packets
  - Sending data to EPD
- **Database**
  - Set up of catalogue on SQL Server
  - Table schema
- **Host software**
  - Monitoring database
  - Sending messages to transmitter
# Packet Format

<table>
<thead>
<tr>
<th>Name</th>
<th>Size (Bytes)</th>
<th>Offset</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet Type</td>
<td>1</td>
<td>0</td>
<td>Indicates whether this signal is to update a price or retrieve a price.</td>
<td>“U” – update</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“R” – retrieve</td>
</tr>
<tr>
<td>Tag ID</td>
<td>1</td>
<td>1</td>
<td>Identifier of the price tag.</td>
<td>0x0019</td>
</tr>
<tr>
<td>Item Name</td>
<td>16</td>
<td>3</td>
<td>Name of the product.</td>
<td>“Welch’s Gummies”</td>
</tr>
<tr>
<td>Price Digits</td>
<td>5</td>
<td>19</td>
<td>Single byte digits of item price. Decimal point is placed before last 2 digits.</td>
<td>0x0000010709 (1.79)</td>
</tr>
<tr>
<td>Item Info</td>
<td>32</td>
<td>24</td>
<td>Misc. information related to the item.</td>
<td>“2 For 1 Sale”</td>
</tr>
</tbody>
</table>
Final Hardware Design
# Budget Breakdown

<table>
<thead>
<tr>
<th>Projected Costs</th>
<th>Actual Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dot Matrix Displays</td>
<td>ATMEGA256RFR2-XPRO Eval kit (Rx side)</td>
</tr>
<tr>
<td>E-ink display</td>
<td>ATM256RFR2-EK Eval kit (Tx side)</td>
</tr>
<tr>
<td>Tx/Rx Evaluation kit (with mcu₅)</td>
<td>Seeedstudio -Eink display</td>
</tr>
<tr>
<td>Circuit Components</td>
<td>Pervasive EPD display 2.7”</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Miscellaneous (Batteries, Headers, Regulators)</td>
</tr>
<tr>
<td><strong>Total projected costs = $810</strong></td>
<td><strong>Total Costs = $592</strong></td>
</tr>
<tr>
<td><strong>Total Funding from ESSEF = $600</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Remaining surplus = $8</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Estimates of the Annual Menu Costs Per Store for Each Chain (in 1991–92 dollars)

<table>
<thead>
<tr>
<th>Menu cost component</th>
<th>Chain A</th>
<th>Chain B</th>
<th>Chain C</th>
<th>Chain D</th>
<th>Average of chains A–D</th>
<th>Chain E (item pricing law)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost of price changes</td>
<td>61,414</td>
<td>53,149</td>
<td>40,027</td>
<td>53,748</td>
<td>52,084 (49.2%)</td>
<td>52,944</td>
</tr>
<tr>
<td>Labor cost of sign changes(^a)</td>
<td>16,411</td>
<td>22,183</td>
<td>22,183</td>
<td>27,955</td>
<td>22,183 (20.9%)</td>
<td>22,183</td>
</tr>
<tr>
<td>Costs of printing and</td>
<td>4,110</td>
<td>10,018</td>
<td>3,048</td>
<td>6,879</td>
<td>6,014 (5.7%)</td>
<td>7,644</td>
</tr>
<tr>
<td>delivering price tags</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mistake costs(^b)</td>
<td>19,135</td>
<td>20,593</td>
<td>20,692</td>
<td>20,140</td>
<td>20,140 (19.0%)</td>
<td>20,799</td>
</tr>
<tr>
<td>In-store supervision costs(^c)</td>
<td>4,241</td>
<td>6,692</td>
<td>5,466</td>
<td>5,466</td>
<td>5,466 (5.2%)</td>
<td>5,466</td>
</tr>
<tr>
<td><strong>Total annual menu cost</strong></td>
<td><strong>105,311</strong></td>
<td><strong>112,635</strong></td>
<td><strong>91,416</strong></td>
<td><strong>114,188</strong></td>
<td><strong>105,887 (100%)</strong></td>
<td><strong>109,036</strong></td>
</tr>
</tbody>
</table>
## One Time Costs

**Components**
- E-INK Display: $3.83
- Cost of LCD Controller: $3.00
- Atmega 256F8R2: $7.00

**Assembly/Marketing**
- Marketing: $2.00
- Fabrication & Assembly: $10.00

- Cost of Each Tag: $25.83
- **Cost of 1,000 Tags**: $25,830

**Initial Capital**: $1000

## Yearly Costs

- Labor Costs: $10,920
- Software Maintenance (IT Service): $1000
- Battery Replacement (per 5 years) (Duracell 395/399 & 5V Watch Battery per price tag): $1000
- Miscellaneous (per 5 years): $3000

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**Total Initial Cost for Buying 1000 AccuTags**: $37,350
Future Improvements

- ACK Handling
- Variable Packet Size
- Item Info
- Barcodes
- Move to 802.11.n Technology
- Expand bitmap library
Questions