Asana

Wireless Weight Distribution Scale

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Presentation Outline

- Purpose
- Individual Roles
- System Overview
- High Level System Design
- Business Approach
- Timeline and Budget
- Individual Achievements
- Conclusions and Future Work
- Sources of Information and Acknowledgements
The Wireless Weight Distribution Scale is designed to log the progress of an individual's weight while monitoring weight distribution in a standing position.

Beneficial in monitoring:
- Stroke patient recovery
- Scoliosis
- Short leg syndrome
- Muscular atrophy
- General posture
- Overall weight
Roles in Project

- **Sam Leung – Chief Executive Officer**
  - Project manager
  - PC application development

- **Wil Gomez – Chief Technical Officer**
  - Microcontroller application development and testing
  - LCD implementation

- **Sasan Naderi – Chief Financial Officer**
  - Allocated funds
  - Component research and hardware design

- **Gurpal Sandhu – Chief Operations Officer**
  - Wireless communications
  - Hardware design and testing
The user steps onto the scale to turn it on.

The weight of the user is calculated and displayed on the LCD.

The data is received on a nearby PC and graphically displayed on the screen.

Meanwhile, the user’s weight distribution is also calculated.

The scale transmits calculated information wirelessly.
## High Level System Design

<table>
<thead>
<tr>
<th>Differential Pressure Sensors</th>
<th>Linear Variable Differential Transformer Sensors (LVDT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Determines pressure applied across liquid or gas</td>
<td>- Electrical transformers used to measure linear displacement</td>
</tr>
<tr>
<td>- Measure weight by taking the difference between two pressures applied to unit</td>
<td>- Displacement determined by movement of armature – magnetic coil in-between primary and secondary transformer</td>
</tr>
<tr>
<td>- Accurate but temperature dependent and difficult to integrate</td>
<td>- High precision and accuracy but only suitable for lower mass measurements</td>
</tr>
</tbody>
</table>
Load Cell Sensors

Measures changes in electrical resistance when external force is applied.

A load cell consists of a wheatstone bridge and a strain gauge sensor.

Our implementation requires four load cells – located in each corner of the scale.

Sufficiently accurate and reasonably priced.
Business Approach

- **Competition**
  - Nothing exactly
  - Withings Internet connected body scale
  - Nintendo Wii Balance Board
  - Professional force platforms
    - Measures ground reaction forces generated by a body standing or moving on it

- **Marketing**
  - Health-conscious individuals
  - Constant access to technology
  - Professional use
    - Physiotherapists
    - Kinesiology research
  - Personal use
Business Approach (cont’d)

- **Cost**
  - Prototype cost: $549.55

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF radio transceiver</td>
<td>2</td>
</tr>
<tr>
<td>Load cell</td>
<td>4</td>
</tr>
<tr>
<td>Relay</td>
<td>2</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>1</td>
</tr>
<tr>
<td>USB Microcontroller</td>
<td>1</td>
</tr>
<tr>
<td>Graphic Serial LCD</td>
<td>1</td>
</tr>
<tr>
<td>Variable Voltage Regulator</td>
<td>1</td>
</tr>
<tr>
<td>Operational Amplifier</td>
<td>4</td>
</tr>
<tr>
<td>5V Voltage Regulator</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantity for Different Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Units</td>
</tr>
<tr>
<td>$101.76</td>
</tr>
</tbody>
</table>

- **Financing**
  - Funding from venture capitalist company
  - Private investors
  - Relevant companies interested in our product
• Revised Gantt chart
• Project schedule maintained
## Project Budget

<table>
<thead>
<tr>
<th>Item Name</th>
<th>Description</th>
<th>Quantity</th>
<th>Total Cost ($CAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anyload ES300 Digital Scale</td>
<td>Digital Scale consisting of 4 load cells and aluminum housing</td>
<td>1</td>
<td>115.50</td>
</tr>
<tr>
<td>Arduino Duemilanove</td>
<td>Development board with Atmel ATmega328P</td>
<td>2</td>
<td>67.92</td>
</tr>
<tr>
<td>Toshiba LCD</td>
<td>LCD with serial backpack</td>
<td>1</td>
<td>76.62</td>
</tr>
<tr>
<td>Xbee Wireless Module</td>
<td>Zigbee 802.15.4 with wire antenna</td>
<td>2</td>
<td>46.21</td>
</tr>
<tr>
<td>Arduino Xbee Shield</td>
<td>Expansion board for Xbee module on Arduino development board</td>
<td>1</td>
<td>27.33</td>
</tr>
<tr>
<td>Maxstream Board</td>
<td>Zigbee development board (used)</td>
<td>1</td>
<td>40.00</td>
</tr>
<tr>
<td>Atmel RZUSBSTICK</td>
<td>USB powered Zigbee transceiver</td>
<td>1</td>
<td>47.50</td>
</tr>
<tr>
<td>Shipping</td>
<td>All shipping charges on ordered components</td>
<td>5</td>
<td>55.21</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Small items</td>
<td>n/a</td>
<td>56.55</td>
</tr>
</tbody>
</table>

**Total:** 549.55

**Total amount awarded through ESSEF:** 425.00

**Unfunded project cost:** 124.55
Individual Achievements

- **Sam Leung**
  - Project management
  - Development in C#

- **Wil Gomez**
  - Embedded software development
  - Testing and troubleshooting

- **Sasan Naderi**
  - Reliability hardware design
  - Research and development

- **Gurpal Sandhu**
  - Wireless communications
  - Testing and troubleshooting
Conclusions and Future Work

- Encase everything into the scale chassis
- Use a more compact receiver on the PC side
- Create a website so the data can be accessed remotely
- Refine power consumption
- Show more data on the LCD
  - Weight distribution percentage
- Percent body fat measurement
- Real-time data measurement and transmission
Information Sources/Acknowledgements

- Edwin Leung – Anyload
  - Customer Service Manager
- Mehrdad Rastan – SFU Physics
  - Teaching Assistant, Network Administrator
- Dr. Ash Parameswaran – SFU Engineering
  - Professor
- Tony Leyland – SFU Kinesiology
  - Senior Lecturer
- ESSEF for project funding
Questions?
Hardware Implementation

- **Instrumentation Amplifier**
  - Buffered differential amplifier
  - Attached to each load cell
  - Provides total voltage gain of 201
Hardware Implementation (cont’d)

- Variable Voltage Regulator
  - Regulates 9V to 6V to power LCD
  - Controlled by digital pin of microcontroller through optical relay
LCD Implementation

- **160x128 Serial Graphic LCD**
  - Connected to MCU via Digital pins
  - Custom font was created to show weight value
  - Power was controlled via Relay connected to MCU
  - Baud rate of 115200 was used
Wireless Implementation

- **Xbee 802.15.4 Transmitter/Receiver:**
  - Low-cost and low-power RF modules that operates within the ISM 2.4 GHz frequency
  - UART interface for serial communication
- **XBee Setup:**
  - Unique address pairing
    - PAN ID
    - Source ID
    - Destination ID
    - Channel ID

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor/Urban</td>
<td>Up to 100’ (30 m)</td>
</tr>
<tr>
<td>Outdoor line-of-sight</td>
<td>Up to 300’ (100 m)</td>
</tr>
<tr>
<td>Transmit Power</td>
<td>1 mW (0 dBm)</td>
</tr>
<tr>
<td>Receiver Sensitivity</td>
<td>-92 dBm</td>
</tr>
<tr>
<td>TX Current</td>
<td>45 mA @ 3.3 V</td>
</tr>
<tr>
<td>RX Current</td>
<td>50 mA @ 3.3 V</td>
</tr>
</tbody>
</table>
Wireless Implementation (cont’d)

- **Transmitter Protocol:**
  - Arduino serial API to establish communication and send data
  - Transmits a finished packet after transmitting data

- **Receiver Protocol:**
  - C# serial API to establish communication and receive data
  - Receives and verifies the finished packet
  - Received data captured on the serial port is written to a text file for post analysis
Weight Calculations

- **Load cell characterization**
  - Created a table of ADC values corresponding to a known weight
  - Plotted the data to obtain the line of best fit
  - Obtain the line equation to gather a ADC to weight relationship

- **Weight distribution**
  - Weight distribution is measured by keeping individual load cell measurement values
  - Weight from each corner’s load cell is totaled in the MCU to produce the total weight
Weight Calculations (cont’d)

ADC Value vs Weight

Digital Output vs Weight (kg)

- Load Cell 1
- Load Cell 2
- Load Cell 3
- Load Cell 4

Linear (Load Cell 1)
Linear (Load Cell 2)
Linear (Load Cell 3)
Linear (Load Cell 4)

Equations:
- Load Cell 1: $y = 14.311x + 46.75$
- Load Cell 2: $y = 14.315x + 88.459$
- Load Cell 3: $y = 14.193x + 14.452$
- Load Cell 4: $y = 14.256x + 86.026$
GUI Implementation

- Developed using C#
  - Microsoft Visual Studios 2008
  - Weight distribution graph done using ZedGraph
    - Free charting class library
  - Editable fields for name and comment only
- Microsoft Access Database
  - Used to store and organize all data entries
- Code was frequently backed up using Perforce
Questions?