Team 5

Small, Lightweight Speed and Distance Sensor for Skiers/Snowboarders

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Introduction
Consumers' Requests

- Simple to Use
- Speed and Distance Recording
- Safe/Robust Design
- Inexpensive
- Long Battery Life
- Easy Data Retrieval
Background

- Ski Speed Sensor has been designed 2 previous times
  - GPS System
  - GPS and INS System
- A Different Approach: Doppler Radar
- Current Market Place Devices
GPS: Global Positioning System

*Use Satellites to sample position over time*

- **Pro:** Receiver is cheap and portable
- **Con:** Signal inconsistency due to structural obstruction

**End Result:** Large error in turning accuracy.
GPS and INS

(Team 6 – Fall 2009)

- INS: Inertial Navigation System
  Accelerometers track the velocity and position

- Pro: More accurate than GPS alone
- Con: More processing

- End Result: Not enough time to implement
Doppler Radar

- Signal is sent out at a fixed frequency
- Received signal has a shifted frequency from the reflection
- Calculate speed using frequency deviation

\[ f = \left( 1 - \frac{v_s}{c} \right) f_0 \quad \Delta f = -\frac{v_s - v_r}{c} f_0 \quad v_s = 0 \]

\[ v_r = c \cdot \frac{\Delta f}{f_0} \]
Tech 4 O SI- Ski 1
Speedometer

What it offers:

• Simple and Safe Display
• Ground Speed, Max Speed, Pace, Distance, Total Distance, and Elapsed Trip Time
• Two components:
  – Stop Watch Display
  – Radar Module
Design Specifications

Our design has several requirements that must be met:

- **Measurements** (minimum one minute intervals)
  - Average speed
  - Max Speed
  - Distance Travelled
- **Safety**
  - Lightweight (< 2 lbs.)
  - Disabled display during recording
  - Weather resistance
  - Low temperature operation (-10F)
- **Power and Efficiency**
  - Auto-off after 10 minutes of operation
  - At least 2 hours of battery life
- **Operation**
  - Data storage requirement for at least 10 minutes of run data
  - Data report on LCD or data export to external device
Conceptual Design

• Radar Device
  – Sends and receives EM waves off the ground
  – Produces output voltage dependent upon frequency shift in the returning wave
  – Prefab Doppler radar module (easy to replace)

• Control System
  – Microprocessor (PIC) based implementation
  – Handles interaction with the user interface
  – Performs calculations and storage of data from radar device

• User Interface
  – Will consist of an LCD display and controls
  – Layout will allow for easy manipulation of controls and high visibility
Project Development

Device Controls
(Buttons, Switches)

Frequency to Voltage Converter

Speed Sensor Module
(Tx, Rx)

Microcontroller

RAM

Extended Memory
(EEPROM)

Output/External Storage
(SD, microSD, USB)

Display Controller

Device Display
Project Development

• Design and Simulation
  – Display Programming
  – Doppler Module
  – Signal Processing
  – Exploratory Experiments

• Prototyping
  – Circuit Layout
  – Power System Design
Project Development

• Testing
  – Benchmarking
  – Device Evaluation
  – Calibration

• Final Build
  – Custom PCB
  – Device Housing
Project Development

Current Progress

• AgilSense HB100 Doppler Module Testing
  – Velocity Testing Apparatus
• Display Programming
• Backup Doppler Module Design (10GHz)
  – Antenna Design
  – RF Design
• Component Research
Work Distribution

• Team Member Design Roles:
  – Doppler Module and Analog Design
    • Kunal Verma
    • Justin Erskine
  – Microcontroller Programming and Interface Design
    • Tim Ross
    • Temika Cage
    • Ben Guild
# Budget

## Cost Breakdown

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontroller</td>
<td>$4.00</td>
</tr>
<tr>
<td>LCD Display</td>
<td>$20.00</td>
</tr>
<tr>
<td>Motion Sensor</td>
<td>$15.00</td>
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<tr>
<td>EEPROM</td>
<td>$5.00</td>
</tr>
<tr>
<td>Batteries</td>
<td>$10.00</td>
</tr>
<tr>
<td>Project Box</td>
<td>$10.00</td>
</tr>
</tbody>
</table>

**Total Cost** $64.00
Questions?