

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

(Team 10 - Spring 2008)

- ❖ 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

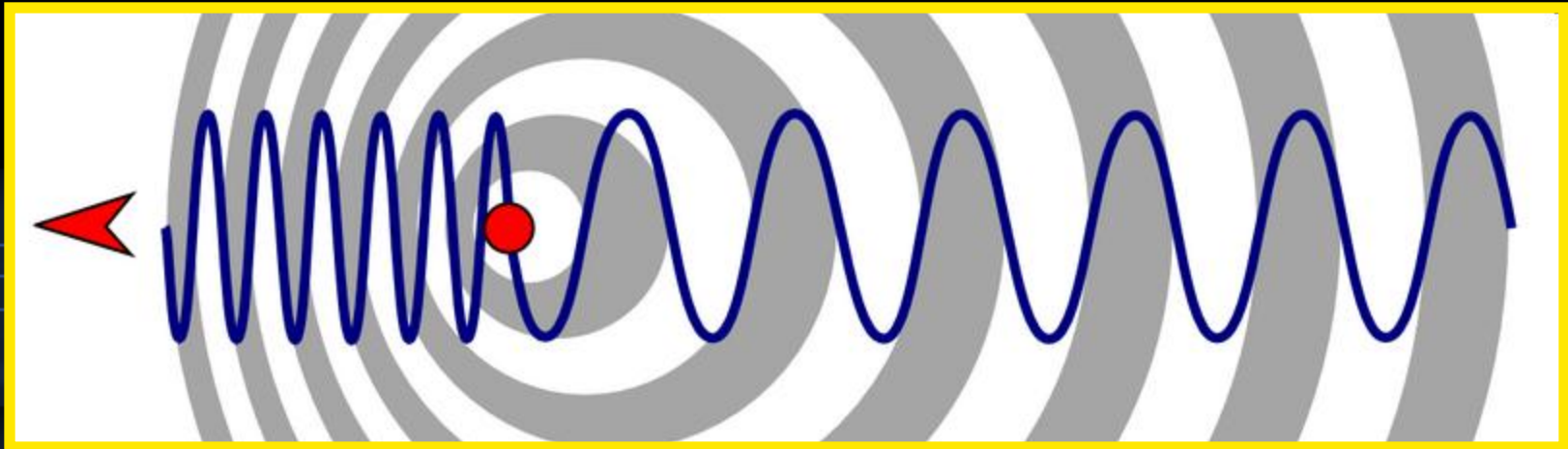
- ❖ **End Result:** Not enough time to implement

Doppler Radar

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

$$f = \left(1 - \frac{v_{s,r}}{c}\right) f_0 \quad \Delta f = -\frac{v_s - v_r}{c} f_0 \quad v_s = 0$$

$$v_r = c \cdot \frac{\Delta f}{f_0}$$



Tech 40 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

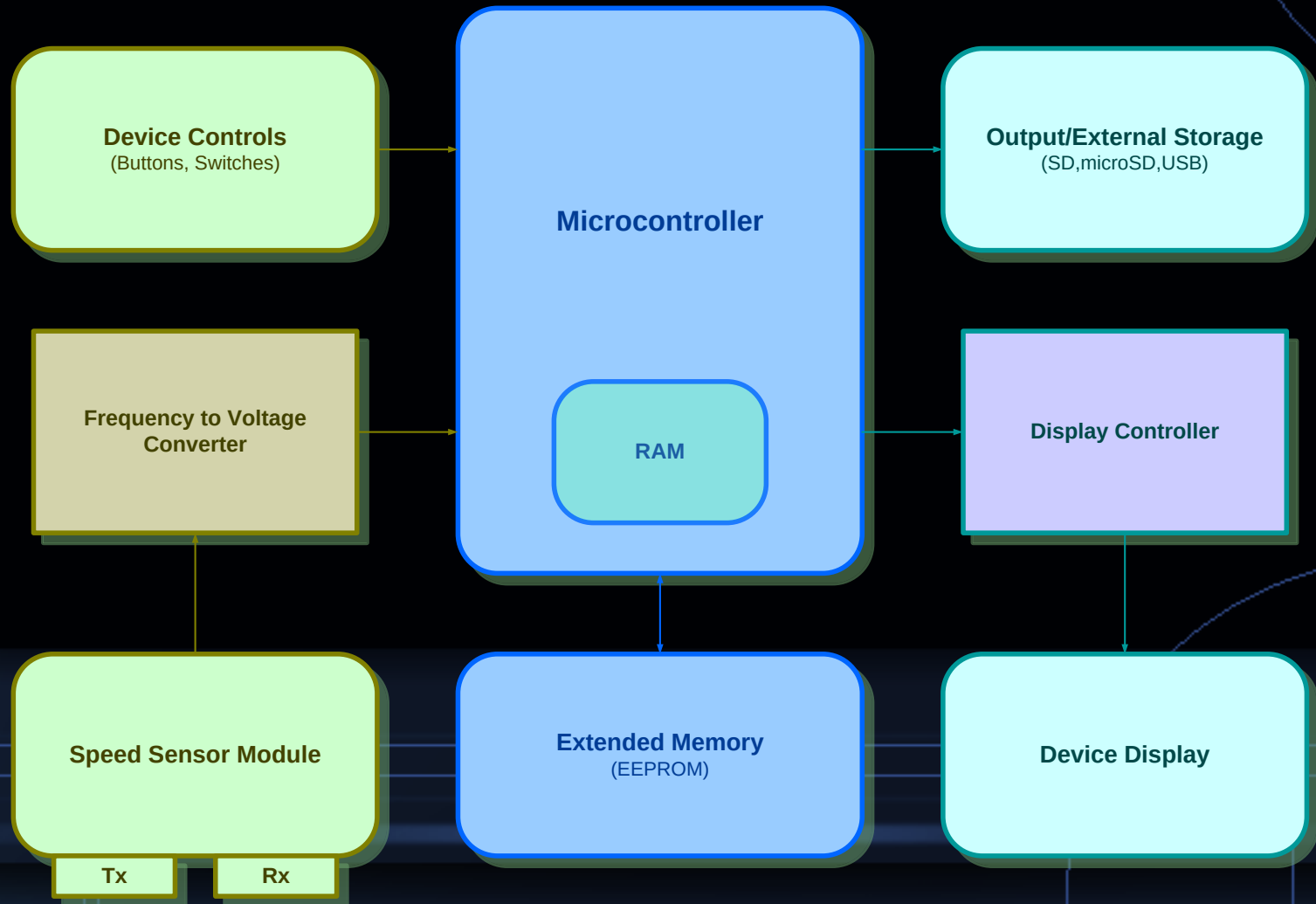
Our design has several requirements that must be met:

- **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

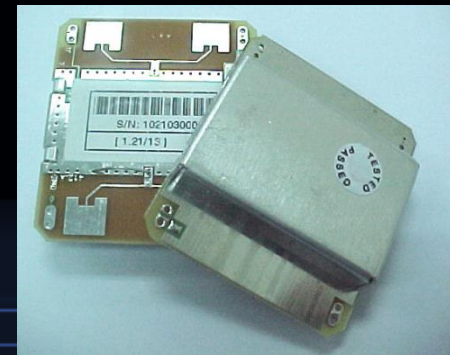
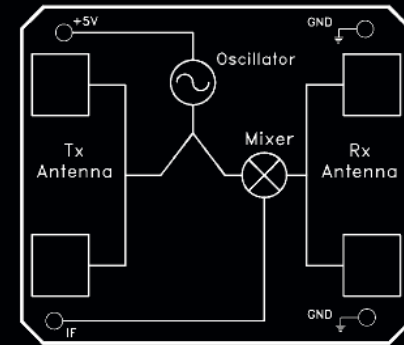
- **Radar Device**
 - Sends and receives EM waves off the ground
 - Produces output voltage dependent upon frequency shift in the returning wave
 - Prefab Doppler radar module (easy to replace)
- **Control System**
 - Microprocessor (PIC) based implementation
 - Handles interaction with the user interface
 - 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



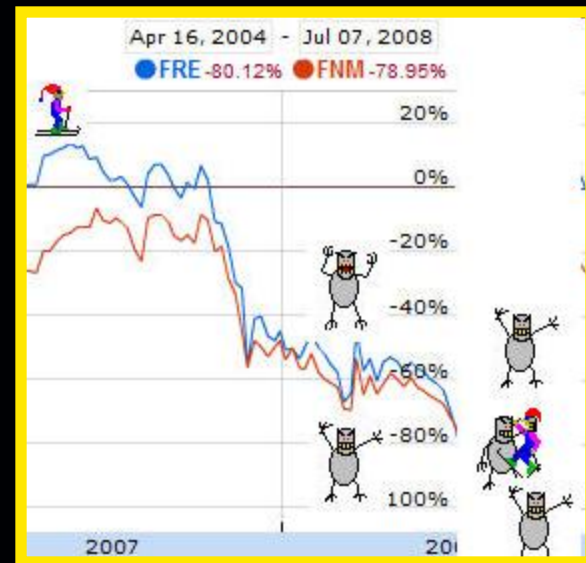
Project Development

- 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	
Item	Cost
Microcontroller	\$4.00
LCD Display	\$20.00
Motion Sensor	\$15.00
EEPROM	\$5.00
Batteries	\$10.00
Project Box	\$10.00
Total Cost	\$64.00



Questions?