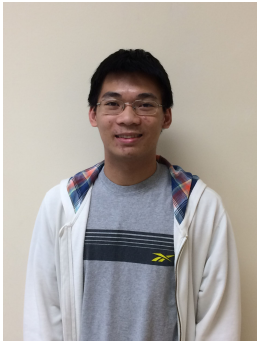
LASERef

Team 18

Midyear Design Review

Meet the Team

Advisor:
Professor Tessier



Josh Setow
EE

Tim Freitas
EE

Sam Auwerda
EE

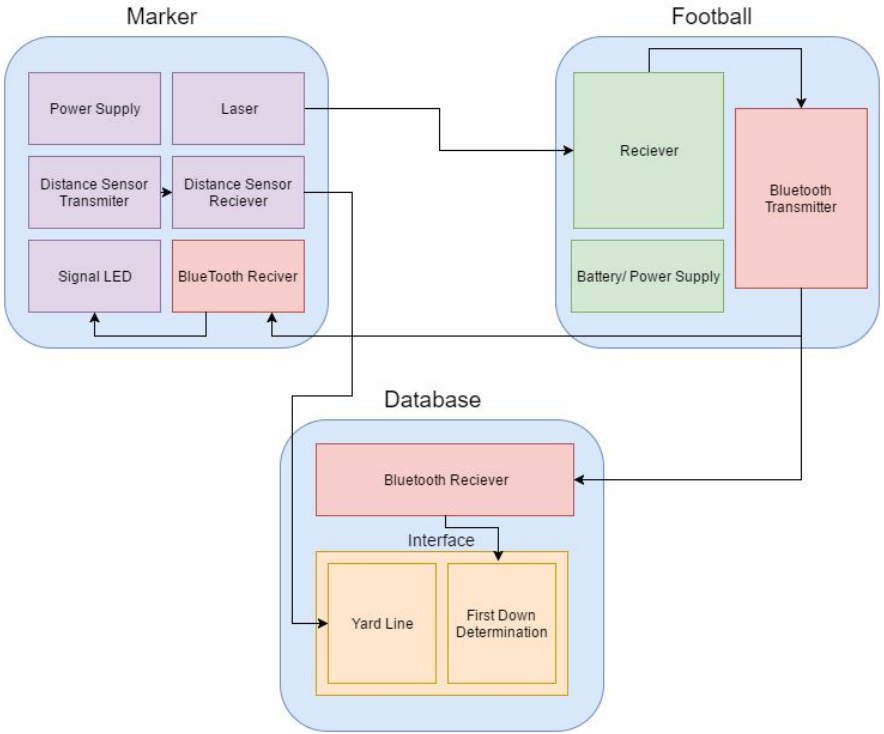
Josh Gallant
EE

The Problem

- Current marker system is prone to human error, slows down gameplay, and is not very accurate.

- LASERef is a quicker and more accurate way of determining whether or not the ball crossed the first down marker

Previous Solution: Block Diagram



Instrumenting the ball is not feasible

- Trying to dissect the football and put it back together was too messy
- Components wouldn’t fit properly inside of the ball and ran the risk of being damaged
- Integrity of the football was greatly compromised

Reflections of Ball

- Football must be placed exactly in the right position in order for reflections to come back
  - A lot of margin for error
- Reflections come back scattered and have reduced light intensity
  - Nearly impossible for a receiver to pick up
- Possibility of scattering laser can end up in other places besides the receiver
  - Safety concerns

Surveying Equipment

- Cumbersome process
  - Requires many tools that would take too long to measure
- Too expensive
  - Surveying equipment generally between $5k - $25k

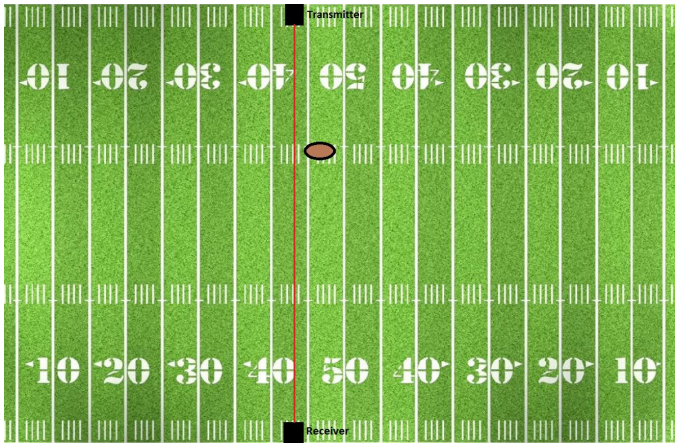
Total Station

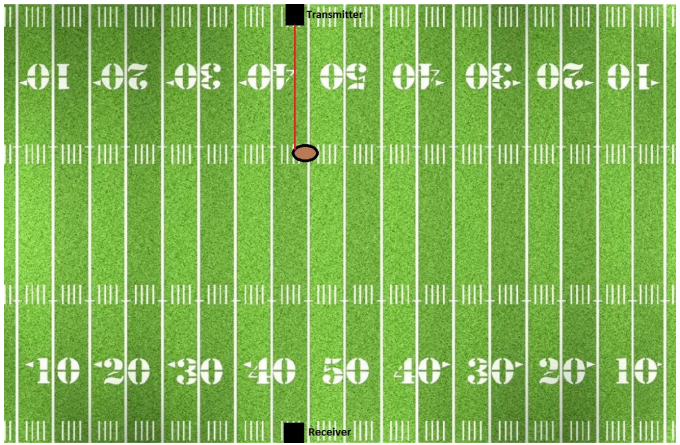
- Distance Measurement
  - Emits infrared light at varying frequencies and measures the time in which it takes for the infrared light to reflect off the object (usually a reflective prism) and return to the total station
- Coordinate Measurement
  - With the use of triangulation, trigonometry and absolute line of sight, exact coordinates of a reflective prism can be determined with reference to the total station
- Infrared Light
  - Using infrared light would increase the time it takes to align the laser and the receiver due to the fact that it is not visible to the human eye - Operator would be aligning it based on feel not vision

Our New Method

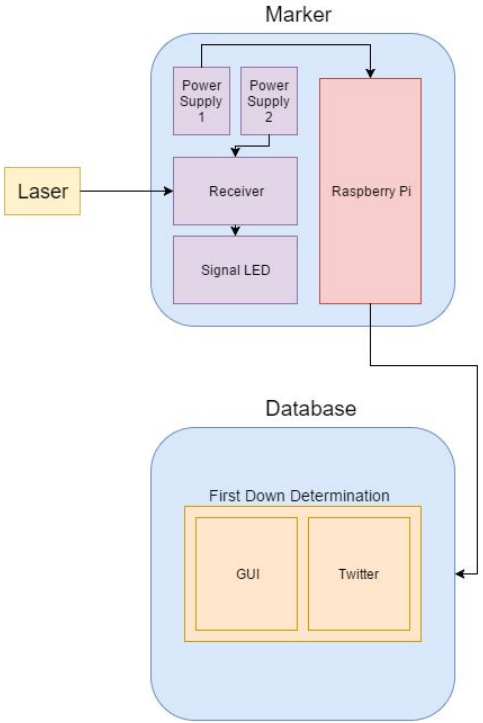
Laser Break Beam Detector

- Ball is detected when laser between the transmitter and receiver is broken





Redesigned Solution: Block Diagram



MDR Deliverables

- Demonstration that marker can detect the nose of the football up to 25 yards
- Distance sensor can detect how far down the field the marker is placed
- Bluetooth modules in football and marker to relay information to control software system

Updated MDR Deliverables

- Demonstration that the photodiode can detect the laser from 50 yards
- A Raspberry Pi in the marker that can relay first down information to Twitter

System Requirements

- Detect the laser at long distances
  - Photodiode needs to sense the laser from across the field (50 yards)
- Fast & Accurate
  - Needs to determine a first down accurately and quickly
- Information relay
  - First down determination needs to be relayed to the referees, announcers, and viewers

Demo

- Football Detection via Laser and Photodiode

- Information uploaded to Twitter

Alignment

Time to Laser and Receiver Alignment in Seconds

12.93	5.21
3.22	3.33
4.12	3.10
3.20	4.47
1.67	3.44

Average Time: 4.225 seconds

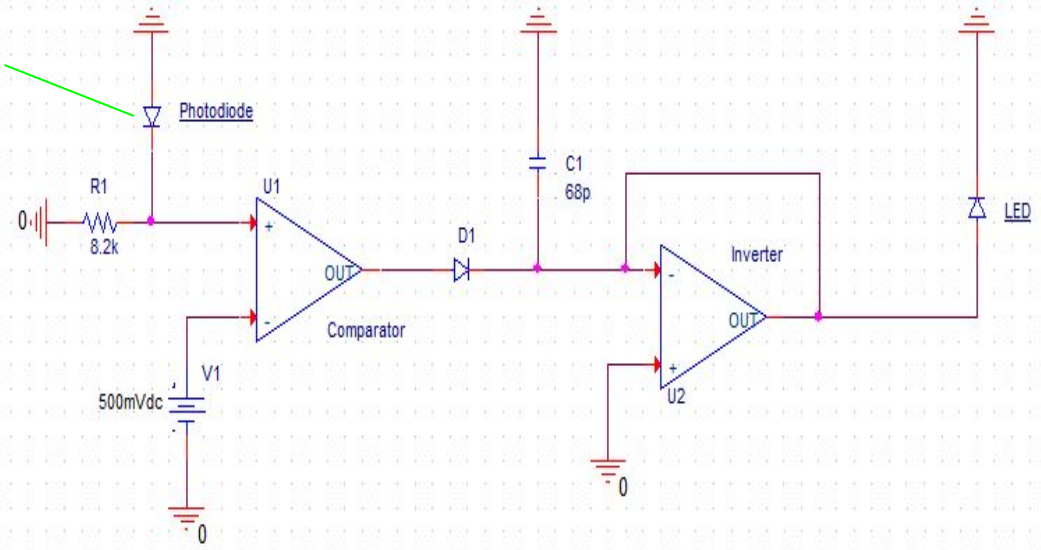
Distance

- Receiver able to receive transmitted signal from up to 90 yards away

- In a football game the maximum distance necessary is 55 yards

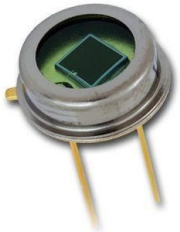
The Receiver Circuit

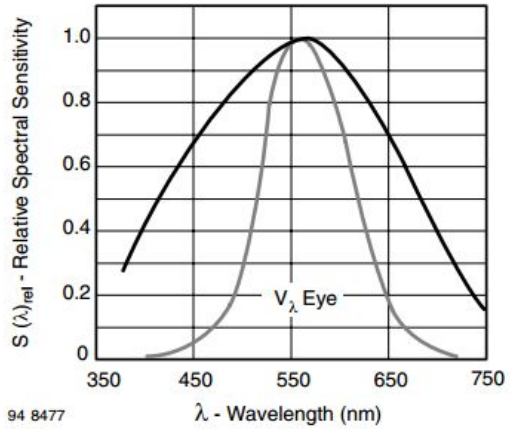
LED is illuminated when the photodiode is not excited by the laser



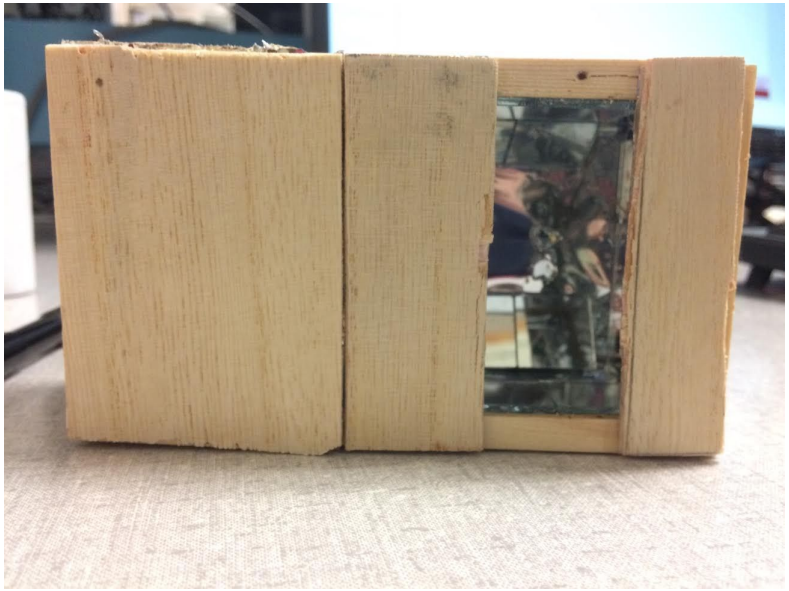
The Photodiode Receiver

- Vishay BPW21R
  - Peak sensitivity: 565 nm
  - Operating temps: -55C - +125C





The Photodiode Receiver



Mirrored
Box

Cone

The Photodiode Receiver

- Prevents sunlight and stadium lights from exciting photodiode
- Eliminates possibility of fans shining a laser into the cone - only light perpendicular to receiver could be received

Receiving Box Design

- Dimensions:
  - 6.5″ x 6.5″ x 14.5″
- Top of Box
  - Signal LED
  - First Down Switch
  - Temporary Battery
- Easy mobility

Future Box Improvements

- Weatherproofing
  - Snow, rain, etc.
- Padding
  - Player safety
  - Protection of box
- Lighter box frame
- Better/more durable light shield

GUI

- GUI (Graphical User Interface) was original software system
- Eduroam and UMASS wifi not friendly with accessing information via IP address

- GUI Demo

Information Relay from Pi to Twitter

- Twitter is a better solution
- With Twitter anyone following the game can access the information
- Raspberry Pi receives input (on or off) from switch into GPIO pin
  - Sends either “Disconnected” + Time or “Connected” + Time
- A Python script on the Pi makes use of Twython
  - Twython is an API that allows for user to update Twitter via Python code using Twitter Apps

CDR Deliverables

- More information to be relayed to Twitter
  - Current down, game time, etc.
- Design the other marker holding the laser
  - Stabilization and levelling
  - Laser stays still
- Alignment of the markers on the field
  - Laser and photodiode need to be aligned
  - Less time spent manual aligning it

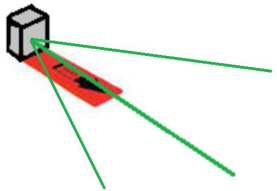
Current Stabilization And Alignment

- Laser can be calibrated to change height if field is not perfectly level

- Once calibrated, laser alignment takes about 4-5 seconds to align

Future Ideas For Alignment

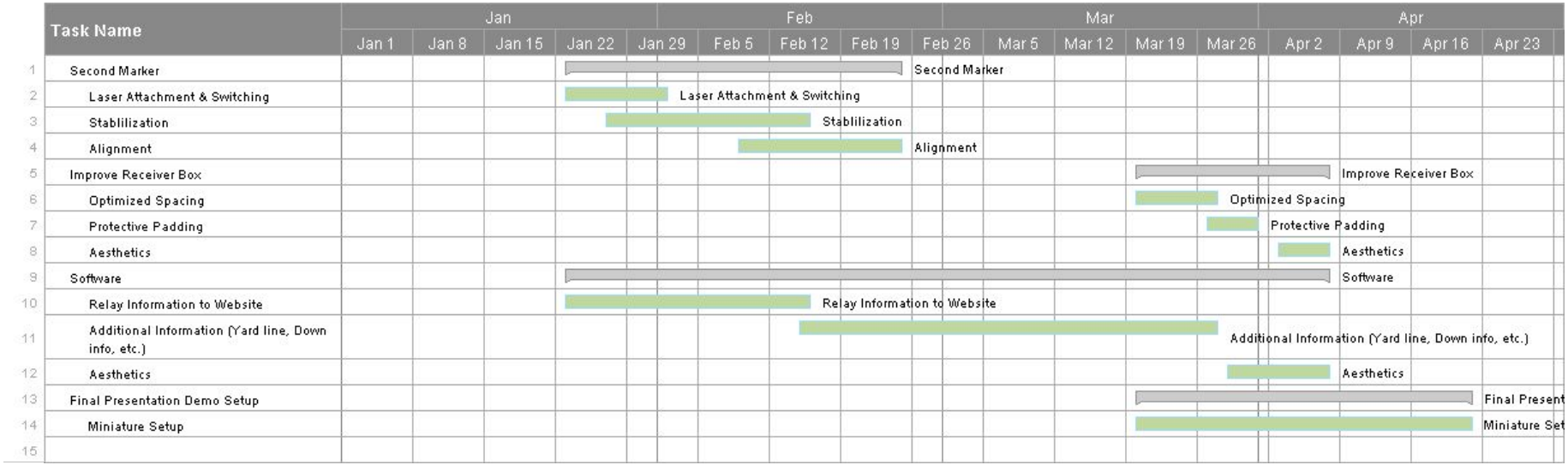
- Laser will be built on the first down marking mat
  - Won't have any inconsistencies in vertical direction
- Increased receiver module
  - A longer receiver module will be easier to hit with a point laser
- Diffraction laser plane method
  - Plane laser beam can hit the single receiver module more accurately



MDR Deliverables

- Receiver can detect the laser from 50 yards ✓
- A Raspberry Pi in the marker that can relay first down information to Twitter ✓

Gantt Chart


Task Name
Jan
Feb
Mar
Apr
Jan 1
Jan 8
Jan 15
Jan 22
Jan 29
Feb 5
Feb 12
Feb 19
Feb 26
Mar 5
Mar 12
Mar 19
Mar 26
Apr 2
Apr 9
Apr 16
Apr 23
1 Second Marker
2 Laser Attachment & Switching
3 Stablilization
4 Alignment
5 Improve Receiver Box
6 Optimized Spacing
7 Protective Padding
8 Aesthetics
9 Software
10 Relay Information to Website
11 Additional Information (Yard line, Down info, etc.)
12 Aesthetics
13 Final Presentation Demo Setup
14 Miniature Setup
15
Second Marker
Laser Attachment & Switching
Stablilization
Alignment
Improve Receiver Box
Optimized Spacing
Protective Padding
Aesthetics
Software
Relay Information to Website
Additional Information (Yard line, Down info, etc.)
Aesthetics
Final Present
Miniature Set

Team Contributions

- Josh G
  - Developed the GUI and Raspberry Pi Twitter script
- Josh S
  - Designed the blueprints for the box and programmed the website
- Sam
  - Researched and tested best ways to reflect laser and programmed the website
- Tim
  - Constructed the box and the photodiode circuit

Thank You

Questions