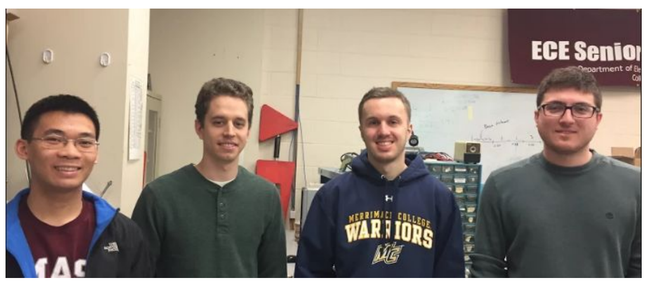
LASERef

Sam Auwerda, Josh Setow, Tim Freitas, Josh Gallant
Faculty Advisor: Prof. Russell Tessier

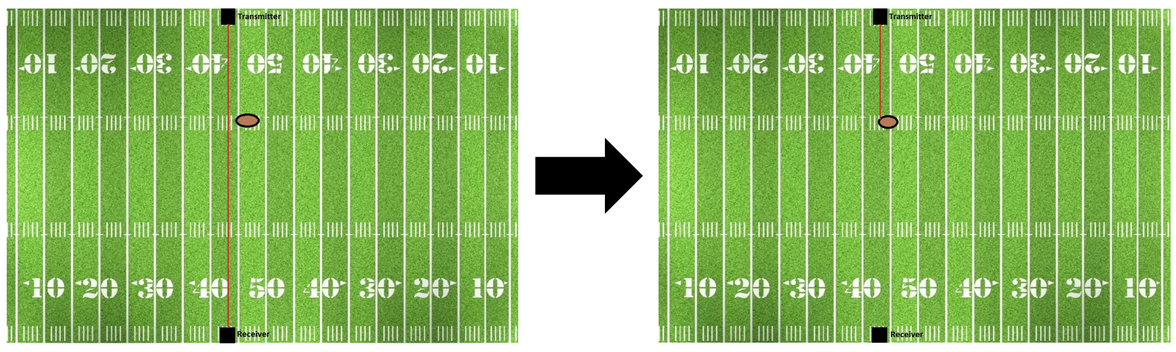


Abstract

Currently, on close calls during football games when the ref can't clearly see if the ball has crossed the first down line or not, the game is stopped and the chain crew brings the markers out on the field to measure. In doing so, the game clock is stopped and accuracy is lost when the chains are carried out. The LASERef system eliminates these shortcomings by quickly shooting a laser across the field to see if the football has crossed the first down plane. In addition the system can update fans on the game by updating a Twitter with current down, game time, and an on field picture of the ball's current location.

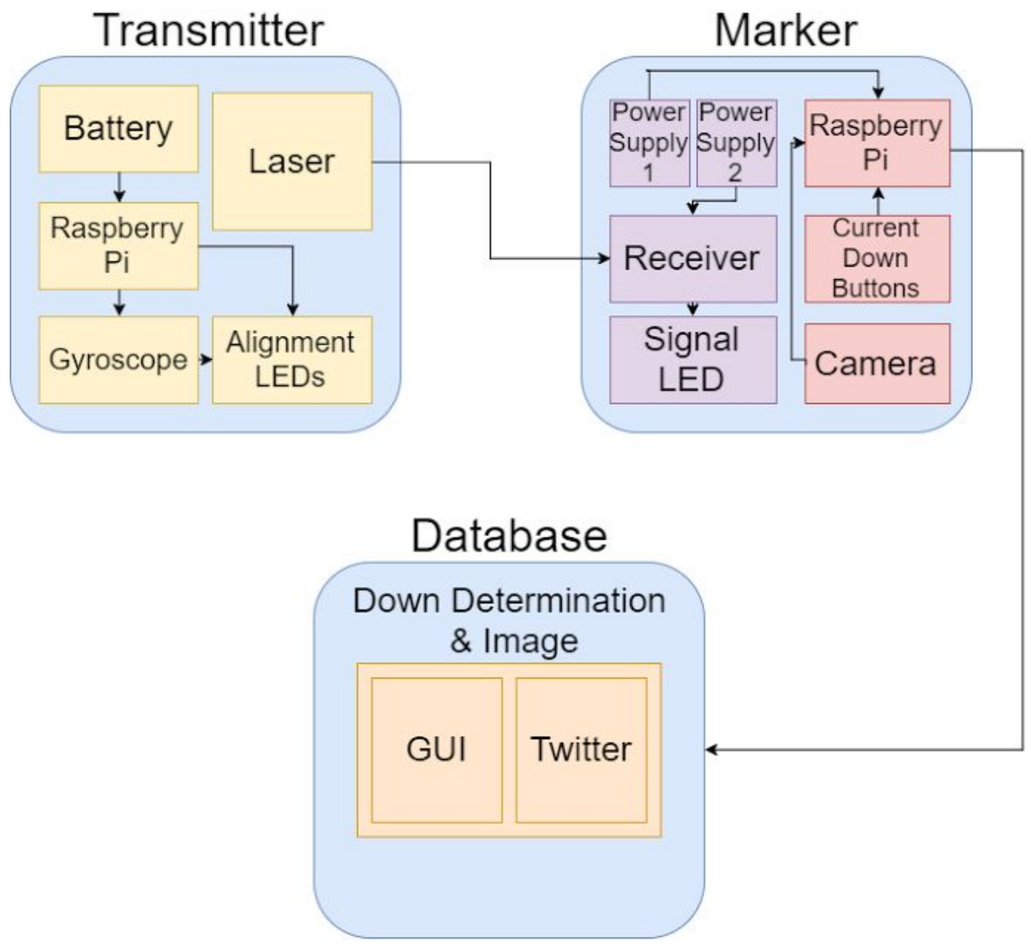
System Overview

Ball is detected when beam is broken



- **LED on receiver signals if first down has been achieved**
- **Receiver equipped with push pad and camera to update Twitter**
- **Transmitter equipped with angle detector for faster alignment**

Block Diagram



Results

- **System is most successful on professional, college, or high-end football stadiums with flat turf fields.**
- **The transmitter and receiver are light and mobile enough to easily be transported up and down the field with the current markers.**
- **Alignment time of the transmitter and receiver take an acceptable amount of time to configure.**
- **Battery life for each part of the system lasts beyond the average time of a football game.**
- **Receiver can successfully receive the transmitter's laser in most conditions.**

Specifications

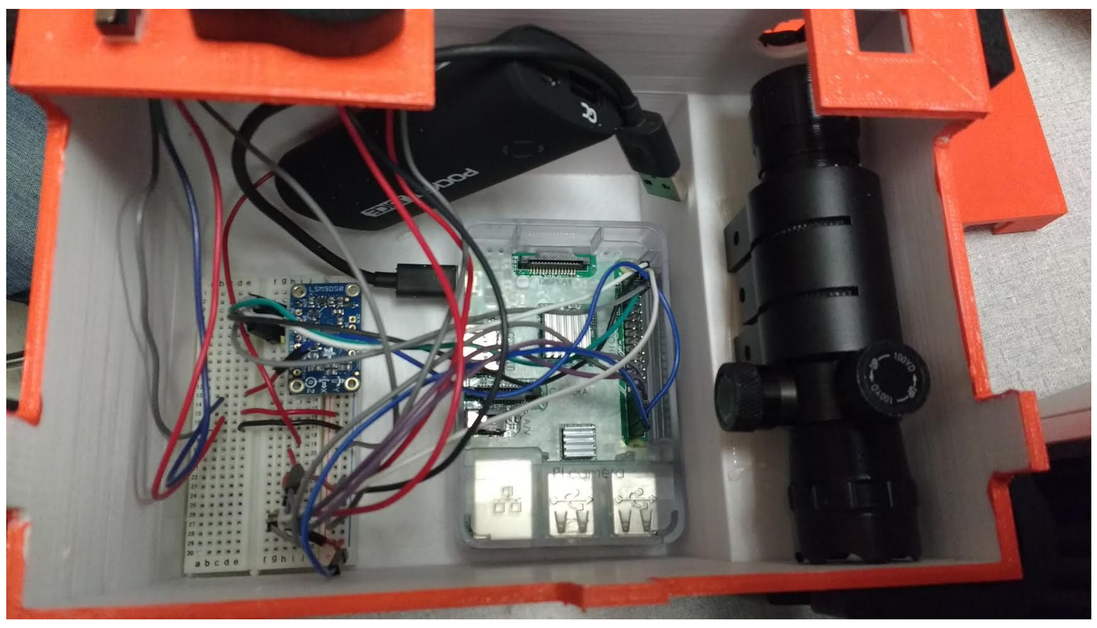
Specifications	Value
Transmitter Unit Weight	1.96 lbs
Transmitter Unit Dimensions	5.5" x 7.5" x 7.5"
Receiving Unit Weight	6.2 lbs
Receiving Unit Dimensions	12" x 5.5" x 13"
Battery Life	Approximately 5 hours
Alignment Time	~4-5 seconds
Receiving Distance	> 50 yards

Acknowledgements

We would like to thank our faculty advisor, Professor Tessier, for all the help and advice he has given us. We also like to acknowledge our faculty evaluators Professor DeFonzo, Professor Gong, and Professor Teneja for all of their suggestions and support. Finally we also want to thank Michael Scire, the UMass Football Equipment Manager, for donating a first down marker.

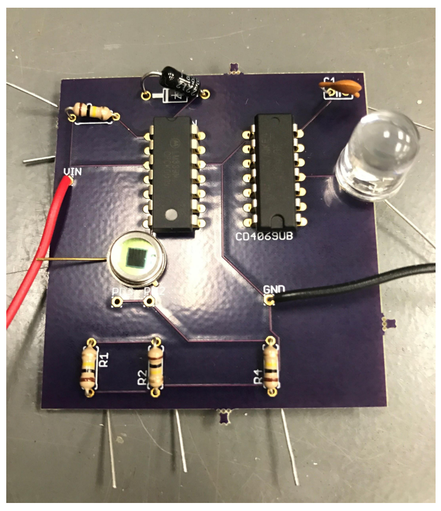
Transmitter

- 3D printed housing
- 5mW, 560nm, green laser for laser transmission
- LSM9DS0 gyroscope used for angle detection
- Raspberry Pi to configure and control angle detection



Receiver

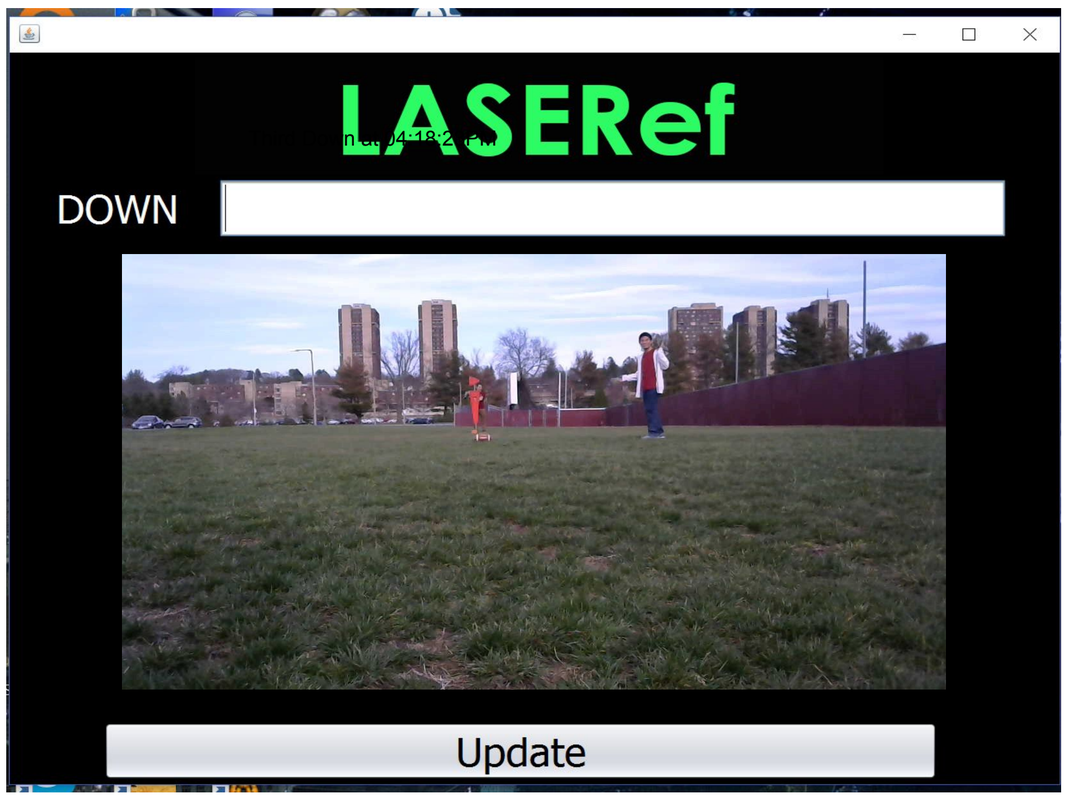
- Wood housing and easily attachable to current first down marker
- Protective padding for players
- 3 photodiode receiver array
- Receiver circuit controls LED illumination when photodiode is exciting by laser
- Equipped with light shields around photodiodes to prevent tampering and limit exposure to high intensity sunlight



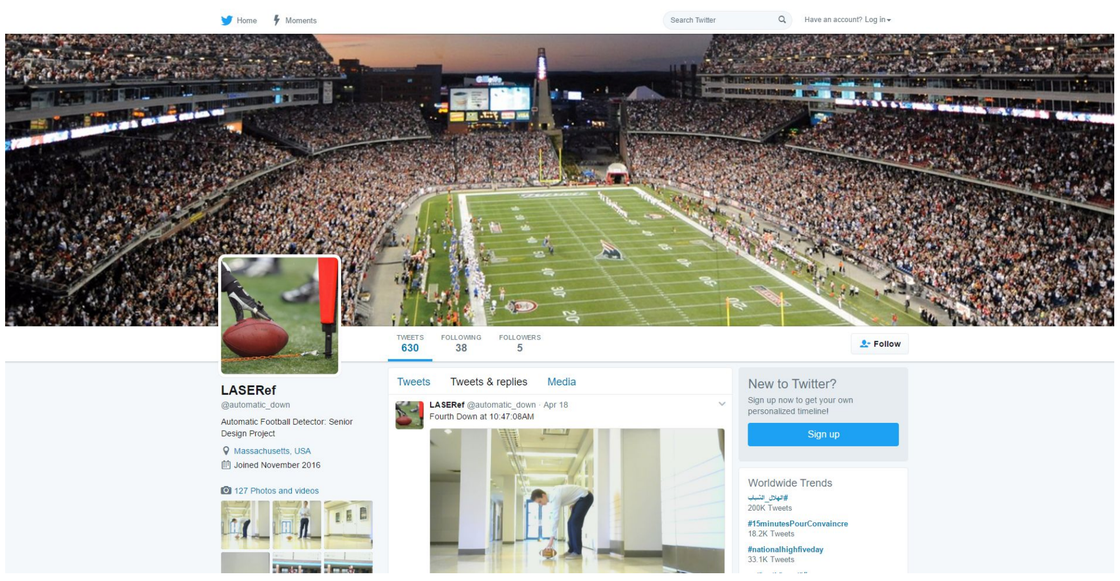
Cost

Part	Quantity	Prototype Cost	Production cost
Power Supplies	3	$30	$10
Photodiodes	3	$30	$21
Raspberry Pi	2	$70	$50
Receiving Box	1	$25	$10
PCB	3	$22.95	$5
Laser	1	$21	$10
Gyroscope	1	$22	$10
Total		$220.95	$115

Twitter and GUI



- Raspberry Pi controller uses Twython API to update Twitter via Python code using Twitter Apps
- GUI (Graphical User Interface) extracts information from latest Twitter upload to get current status.
- Current game time, down, and picture of the ball on the field is uploaded to Twitter and GUI
- Raspberry Pi controller connects to WiFi and is controlled with push buttons on the receiver



Uses Beyond Football

- Home/Building surveillance systems
  - Can notify owner when someone has entered the property and can take picture of them
  - Does not require massive amounts of storage like most surveillance cameras which are constantly recording
- Traffic
  - Useful in toll collection
  - Can keep track of how many cars may be on the road