ECE 16 Team K - Ultimate Frisbee Development

Norberto Torres, Praveen Swaminathan, Tianhao Yan

Spring 2023

Customer Need Request

Customer: Max Gibson

Need: A device that can produce the spin rate and angle of the disc.

Why? A device will make it easier to numerically break down what newer members of the team are doing wrong, hopefully in turn teaching them to throw much faster.

Need Assessment

Use Case: The device will only be used during practices, with the thrower standing still.

Location: Device at center of the bottom of the frisbee, with 2 - 2.5 inches distance from edge.

Functionality 1: Record the maximum spin rate of the frisbee when thrown right out of the hand

Functionality 2: Record the angle of which the frisbee is leaving the hand

Background Research

Frisbee Dimensions:

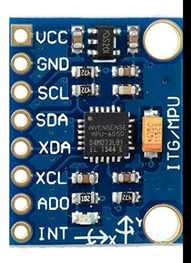
- Mass: 175 grams
- Diameter: 10.5 inches
- Height 1.31 inches

What Makes Spin and Angle are Important to a Frisbee Throw:

The spin and angle determines the flight of the frisbee.
HIgher Spin, higher stability
Angle determines the trajectory of the throw

Components of Device:

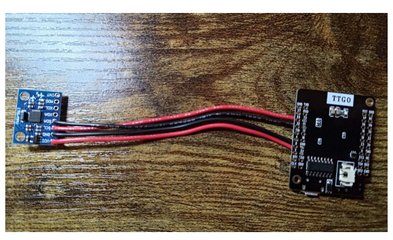
A gyroscope and accelerometer will be needed to record spin and angle, respectively. Will use MPU6050



Design Alternatives

Bluetooth considered, but given the need of our customer, **NOT essential** to final design.

Use of **TTGO T7 V1.3** instead of Nano, and a **3V LiPo Battery** to make overall device lighter



Solution Proposal

Features For The Device That Was Proposed Based On The Customer Needs:

- Will be mountable and can be detached on the frisbee
- Will be light to not affect the throw and also circular to not alter the hand placement and not give discomfort to the thrower.
- Will have an OLED display to show the maximum spin and instant angle of throw.

Development Plan

Week	Due Date	Task
8	Wed.	Soldering of Device (ESP32, OLED, Gyro)
8	Sun.	CAD Design of Device
8	Sun.	Base Code for Angle and Spin of Gyroscope
9	Wed.	3D Print Finished
9	Wed.	ICA 8: Project Update
9	Fri.	HW6 Challenge 1/2 Documentation
9	Sun.	Testing of Gyro Spin, Finalization of Spin code (HW6 Challenge 3)
10	Mon.	ICA 9: Customer Check-in
10	Wed.	Code for calculating spin and angle at the instance of throw (BUILD COMPLETE)
10	Thurs/Fri.	FINAL TESTING (Testing of angle, as well as overall accuracy)
10	Sat.	HW7 Documentation
10	Sun.	Poster
Finals	Wed/Thurs	Final Report

System Testing & Validation

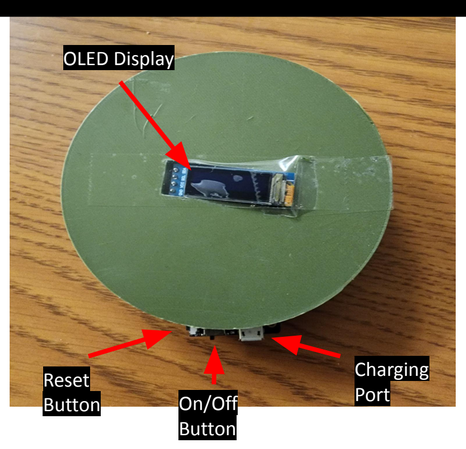
Angle Calculation:

- A protractor is used to calculate the angle of the frisbee when stationary. Then the display on the OLED is compared with the result from the protractor.

Max Spin:

- We put a marker on the frisbee and use a slow motion camera to film the throw. Since the spin slows down over time, we calculate the time it takes to complete the first two revolutions, and convert the result into RPM in order to comparing to the displayed max spin on the device.

Final Design



Device Dimensions:

- Mass: 0.76 grams
- Diameter: 3.94 inches
- Height: 0.89 inches

Device in Action

Challenges and Limitations

Challenges:

- The main challenge we faced was calculating the angle of throw, with finding an equation that calculates the tilt angle from the sensor parameters, to also readjusting the code for each iteration to account the limitation of the sensor when calculating the angle.

Limitations:

- The first is that in order to receive the most accurate result, the throw can't be made in a fluid motion. Rather, the user needs to go into throwing position, before the angle is detected.
- Secondly, the device cannot measure more than 333 rpm, because the gyroscope itself can only detect 2000 deg/s of rotation.

Unfortunately, we learned that most commercial gyroscopes are within this range, and nothing more.