Sensors and Computer Vision

How our team uses these tools to improve robot performance in Ultimate Goal

The Winsor Wildbots
FTC #13620
Coding Team

PRESENTED BY Qualcomm

Distance Sensors

How they work

- We use the Rev 2m Distance Sensor
- Measure the distance to the nearest object, with a range of 5-200cm
- Can be used to sense distance to field walls or game objects like rings
- Are plugged in to the I2C ports on the Rev Hub

```
Rev2mDistanceSensor distanceSensor;
```

This code initializes a new distance sensor

```
distanceSensor.getDistance(DistanceUnit.CM);
```

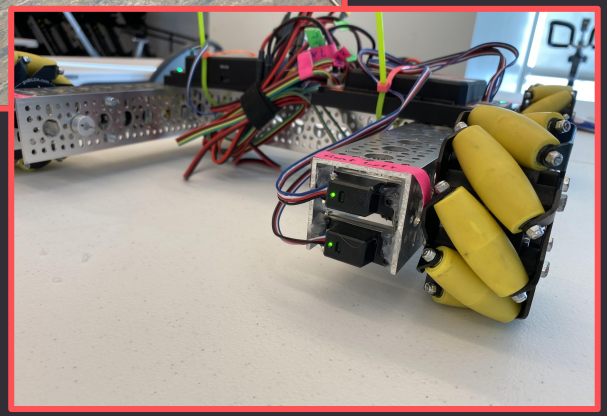
This code uses the distance sensor to check the distance to the nearest object

Distance Sensors

Autonomous without sensors

Distance Sensors

How we use them in Ultimate Goal



- Ring stack height: How it works for
  - Zero rings
  - One ring
  - Four rings
- Needed to test distance sensor angles

Color Sensors

How they work

- We use the Rev Color Sensor V3
- Measures red, green, and blue values as well as brightness
- Are plugged in to the I2C ports on the Rev Hub

```
RevColorSensorV3 colorSensor;
```

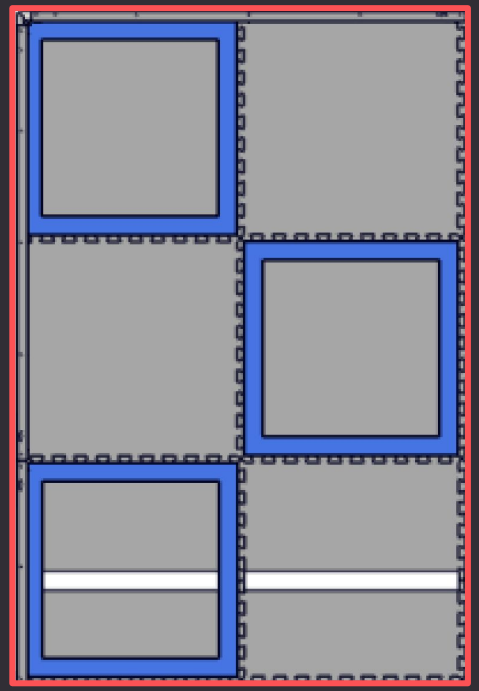
This code initializes a new color sensor

```
colorSensor.red();
colorSensor.green();
colorSensor.blue();
colorSensor.getLightDetected();
```

This code reads the red, green, and blue values as well as the amount of light detected from the color sensor

Color Sensors

How we use them in Ultimate Goal

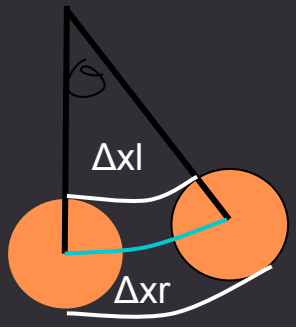


- Mounted to the chassis, facing the ground
- Detects tape lines on the field
- Tested ranges of values for grey squares, blue tape, and white tape
- We're working towards using these to ensure we're reaching the wobble goal scoring zone in autonomous

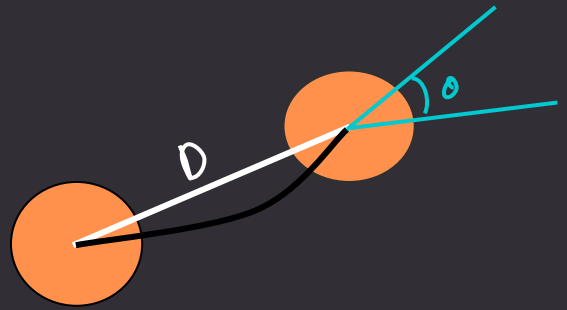
Encoders

How they work/how we plan to use them

- Able to accurately measure distance a robot has travelled → unit = ticks
- Circumference of wheel/ticks per revolution = distance per tick
- Map (x,y) position using math!



$$\theta = \frac{\Delta x_r - \Delta x_l}{L}$$



$$D = \frac{\Delta x_c}{\theta} * \sqrt{1 - cos(2\theta)}$$

Rev Hub IMU

How it works and how we use it

- Includes gyroscope and accelerometer
- Already included in every Rev Control Hub or Expansion Hub
- Our uses include rotating to a specific angle, adjusting the angle for launching, and strafing in straighter lines

```
// get current robot angle (radians)
public double getIMUAngle() {
    angles = imu.getAngularOrientation(AxesReference.INTRINSIC, AxesOrder.ZYX, AngleUnit.RADIANS);
    return angles.firstAngle;
}
```

This code uses the gyroscope of the IMU to get the direction in which the robot is facing

Vuforia Navigation Targets

What they are and how we use them in Ultimate Goal

- Located in three locations across the half field
- Requires either a webcam (if the robot uses a Control Hub) or a robot controller phone
- FIRST provides sample code that is able to recognize these images and print the robot's position and rotation on the field
- We're working on using these targets to line up with the goal for launching

Sensor Integration

Experimenting with combining sensors for optimal performance

- Taking values from several sensors to increase accuracy
  - Vuforia and encoders both give us x and y positions
  - Vuforia and the Rev Hub IMU both give us the robot angle
- Using multiple sensors in succession to complete different elements of one task
  - For example, scoring the wobble goal in autonomous using both distance and color sensors

Thank you for listening!!
We'd love to answer any questions

Further Resources

Where to learn more about these tools

- REV Distance Sensor Documentation
- Rev Color Sensor V3 Documentation
- Aluminum Cobblers Odometry Tutorial Part 1
- Aluminum Cobblers Odometry Tutorial Part 2
- Odometry Slideshow by Princeton
- Rev Hub IMU Documentation
- Sample OpMode using Vuforia Navigation Targets
  - Located in the examples within the FTC SDK for Ultimate Goal

If there are any further questions, we'd love to help! You can reach us by email at winsorwildbots@gmail.com

You can also find us on social media:
@winsorwildbots.ftc on Instagram
Winsor Wildbots on Youtube

We also keep all of our code in a public Github repository, which you are welcome to look through and ask us about