



Vision Portal Workshop







Vision Portal

Vision Portal is a comprehensive new interface for vision processing introduced this year.



April Tags TensorFlow Webcam Controls





C Edit on GitHub

FTC Docs

FTC Docs has step-by-step instructions on how to use the Vision Portal.

VisionPortal Initialization	
VisionPortal Previews	
AprilTag ID Codes	
AprilTag Metadata	
AprilTag Reference Frame	
AprilTag Camera Calibration	
AprilTag Pose	
AprilTag Library	
VisionPortal CPU and Bandwidth	
VisionPortal Camera Controls	
Vision Multiportal	
AprilTag Advanced Use	
Webcams for VisionPortal	
Understanding AprilTag Values	
AprilTag Test Images	
TensorFlow Programming	
Vision Programming	
Advanced Topics	
Additional FIRST Website Resourc	es
APRILTAG RESOURCES	
AprilTag Introduction	
∃ VisionPortal Overview	
	n lot

A / Programming Resources / VisionPortal Overview VisionPortal Overview FIRST Tech Challenge introduces VisionPortal, a comprehensive new interface for vision processing. · For FTC Blocks and Java teams, VisionPortal offers key capabilities of AprilTag and EasyOpenCV, along with TensorFlow Object Detection (TFOD) - at the same time!

- · AprilTag detections include ID code and pose: tag location and orientation, relative to the camera.
- · Camera Controls, which can improve AprilTag and TFOD performance for webcam, are now fully available to FTC Blocks

Dual Preview with both AprilTags and TensorFlow

https://ftc-docs.firstinspires.org/en/latest/apriltag/vision_portal/visionportal_overview/visionportal-overview.html





Webcams

Logitech C270 HD



Logitech C920 HD Pro



Depstech DW49



Diagonal Angle of View: 55° 78° 80° Max. Resolution: 1280x720 1920x1080 3840 x 2160





FIRST Tech Challenge Computer Vision

FIRST designs the game to include features that lend themselves to computer vision processing.

In CENTERSTAGE computer vision can be used on

- Pixels
- Team Props
- April Tags on the front perimeter
- April Tags on each backdrop





Centerstage Autonomous

Navigating:

Parked In Alliance Backstage: 5 points

Randomization Tasks based on white Pixel:

Randomization Tasks based on Team Art:

Placed in Backstage:	3 points
Placed on Backdrop:	5 points





Autonomous Programs









The FTC Software Development Kit (SDK)

The FTC SDK is the software that runs on the Robot Controller.

Vision Processing features of the SDK:

- 1. TensorFlow
- 2. April Tags
- 3. Camera controls

Java programmers can use EasyOpenCV.





TensorFlow Concepts

Google created a machine learning software library called TensorFlow.



To use TensorFlow:

- Create a set of images with objects
- Put a label on bounding box on game objects
- Train the model to recognize game objects

TensorFlow Lite is designed to run on smaller devices like Phones or the android device in a Control Hub.





TensorFlow Inputs

FIRST has provided a TensorFlow model that recognizes the Pixel in this year's



TensorFlow Inputs:

- confidence level, default 75%
- cropping/zoom
- model to use

https://ftc-docs.firstinspires.org/en/latest/programming_resources/index.html#tensorflow-programming





TensorFlow Outputs

Camera Stream preview showing TensorFlow detection of a pixel



TensorFlow Outputs:

List of objects, each object will have

- Label e.g. Pixel
- bounding box
- confidence percentage





TensorFlow for CENTERSTAGE

By default TensorFlow can detect the pixel from above





https://ftc-docs.firstinspires.org/en/latest/programming_resources/vision/tensorflow_cs_2023/tensorflow-cs-2023.html





TensorFlow Advantages

- TensorFlow detects objects
 - in spite of different backgrounds
 - in varied lighting conditions
 - in varied orientation
- TensorFlow can distinguish between similar looking (but still distinct) objects





TensorFlow Disadvantages

- Training a TensorFlow model seems daunting
- TensorFlow is computationally intensive and has a low detection rate
- TensorFlow only detects objects





SDK TensorFlow Sample Blocks Programs

- **ConceptTensorFlowObjectDetectionEasy** easy to use sample program that displays what objects are detected.
- **ConceptTensorFlowObjectDetection** sample program with comments that show how to enable or set various parameters
- **ConceptTensorFlowObjectDetectionCustomModel** sample program where you provide your own TensorFlow model.





TensorFlow Easy (Blocks)

Lists know objects (i.e. pixels) detected in the image from the webcam



blocks-TFOD

Allows user to set camera resolution and other parameters.

First, create a TfodProcessor.Builder.
set (myTfodProcessorBuilder • to new (TfodProcessorBuilder)
Create a TfodProcessor by calling build.
set myTfodProcessor • to call myTfodProcessorBuilder • . build
() call (TfodProcessor) . (setMinResultConfidence)
tfodProcessor (myTfodProcessor *
minResultConfidence 0.75
Next, create a VisionPortal.Builder and set attributes related to the camera.
set myVisionPortalBuilder • to new VisionPortalBuilder
if USE_WEBCAM
do 3 call (myVisionPortalBuilder •) setCamera • webcam named Webcam 1 •
else 2 call (myVisionPortalBuilder •) . setCamera C BuiltinCameraDirection . BACK •
else 2 call myVisionPortalBuilder . setCamera BuiltinCameraDirection BACK
else (2) call (myVisionPortalBuilder •). setCamera • BuiltinCameraDirection BACK • Logitech C270 at 1280x720 Logitech C920 at 1920x1080
else call myVisionPortalBuilder setCamera BuiltinCameraDirection BACK Logitech C270 at 1280x720 Logitech C920 at 1920x1080 Call myVisionPortalBuilder setCameraResolution
else (2) call (myVisionPortalBuilder •). setCamera • BuiltinCameraDirection BACK • Logitech C270 at 1280x720 Logitech C920 at 1920x1080 (2) call (myVisionPortalBuilder •). setCameraResolution width • 1920
else call myVisionPortalBuilder . setCamera BuiltinCameraDirection BACK Logitech C270 at 1280x720 Logitech C920 at 1920x1080 call myVisionPortalBuilder . setCameraResolution width 1920 height 1080
else (2 call myVisionPortalBuilder • . setCamera • BuiltinCameraDirection BACK • Logitech C270 at 1280x720 Logitech C920 at 1920x1080 (2 call myVisionPortalBuilder • . setCameraResolution width • 1920 height • 1080 Add myTfodProcessor to the VisionPortal.Builder.
else (2 call myVisionPortalBuilder • . setCamera • BuiltinCameraDirection BACK • Logitech C270 at 1280x720 Logitech C920 at 1920x1080 (2 call myVisionPortalBuilder • . setCameraResolution width • 1920 height • 1080 Add myTfodProcessor to the VisionPortal.Builder. call myVisionPortalBuilder • . addProcessor • myTfodProcessor •
else (call myVisionPortalBuilder • . setCamera BuiltinCameraDirection BACK • Logitech C270 at 1280x720 Logitech C920 at 1920x1080 (call myVisionPortalBuilder • . setCameraResolution width 1920 height 1080 Add myTfodProcessor to the VisionPortal.Builder. call myVisionPortalBuilder • . addProcessor (myTfodProcessor • Create a VisionPortal by calling build.

blocks-TFODcustom

Sample program using custom Tensorflow model.

Used for Team Props.

(c) (c) to initTfod
First, create a TfodProcessor.Builder.
set myTfodProcessorBuilder • to new TfodProcessorBuilder
call myTfodProcessorBuilder . setModelFileName redBlueDuplo.tflite
call myTfodProcessorBuilder . setModelLabels create list with blueDuplo redDuplo
Create a TfodProcessor by calling build.
set myTfodProcessor • to call myTfodProcessorBuilder • . build
call TfodProcessor . setMinResultConfidence
tfodProcessor myTfodProcessor *
minResultConfidence 0.6
Next, create a VisionPortal.Builder and set attributes related to the camera.
set myVisionPortalBuilder • to new VisionPortal.Builder
if USE_WEBCAM ·
do 🕡 call myVisionPortalBuilder setCamera 🕻 webcam named Webcam 2 -
else Call myVisionPortalBuilder . setCamera BuiltinCameraDirection BACK
() call myVisionPortalBuilder . setCameraResolution
width (1920)
height 🕽 (1080)
Add myTfodProcessor to the VisionPortal.Builder.
call (myVisionPortalBuilder •) addProcessor (myTfodProcessor •
Create a VisionPortal by calling build.
set myVisionPortal > to call myVisionPortalBuilder > build

blocks-RobotAutoDriveTFODpixel

TensorFlow Autonomous

blocks-RobotAutoDriveTFODpixel

Team Prop

See section 7.4 Team Game Element Construction Rules in the game manual part 1

https://ftc-docs.firstinspires.org/en/latest/programming_resources/vision/tensorflow_cs_2023/tensorflow-cs-2023.html

Program

TensorFlow FIRST Machine Learning Toolchain (FTC-ML)

https://ftc-docs.firstinspires.org/en/latest/ftc_ml/index.html

FTC-ML Videos

- One hour to set up and take videos.
- One hour to upload and the videos to the FTC ML website and label the Team Props
- FTC ML model training step will take another hour.

TensorFlow Summary

TensorFlow can be a useful way to recognize objects on the field.

It's not good for navigating, April Tags are designed for that.

TensorFlow should do a good job recognizing Team Props at the start of the autonomous period.

Questions?

April Tag Concepts

Developed at the University of Michigan.

AprilTag is like a 2D barcode or a simplified QR Code.

Contains a numeric ID code and can be used for location and orientation.

Camera Ready

==== (ID 0) Nemo XYZ -6.6 24.9 -5.7 (inch) PRY 2.0 0.1 4.9 (deg) RBE 25.7 14.8 -12.8 (inch, deg, deg)

==== (ID 1) Jonah XYZ -1.5 25.5 -5.7 (inch) PRY 0.7 -0.0 5.0 (deg) RBE 25.6 3.3 -12.6 (inch, deg, deg)

key: XYZ = X (Right), Y (Forward), Z (Up) dist. PRY = Pitch, Roll & Yaw (XYZ Rotation) RBE = Range, Bearing & Elevation

https://ftc-docs.firstinspires.org/en/latest/apriltag/vision_portal/apriltag_intro/apriltag-intro.html

April Tag Pose

"pose" is the combination of:

- relative position from the camera to April Tag; and
- orientation of the April Tag

The SDK also calculates Range, Bearing and Elevation

Camera Ready

==== (ID 0) Nemo XYZ -6.6 24.9 -5.7 (inch) PRY 2.0 0.1 4.9 (deg) RBE 25.7 14.8 -12.8 (inch, deg, deg)

==== (ID 1) Jonah XYZ -1.5 25.5 -5.7 (inch) PRY 0.7 -0.0 5.0 (deg) RBE 25.6 3.3 -12.6 (inch, deg, deg)

key: XYZ = X (Right), Y (Forward), Z (Up) dist. PRY = Pitch, Roll & Yaw (XYZ Rotation) RBE = Range, Bearing & Elevation

CENTERSTAGE April Tags

April Tag Advantages

- Fast detection rate
- Provides accurate, relative position information
- Is less prone to fluctuating or varied lighting conditions on the field.

April Tag Disadvantages

- The entire April Tag must be in the camera view
- April Tags must be included in the tag library
- Cameras require calibration data

April Tag Webcam Calibration

To provide good pose estimates, each webcam requires calibration data, for each specific resolution you use.

The SDK includes calibration for some webcams.

Logitech often creates new versions of their webcams with the same name but different firmware so the SDK can't recognize them.

C270 should be calibrated.

https://ftc-docs.firstinspires.org/en/latest/apriltag/vision_portal/apriltag_camera_calibration/apriltagcamera-calibration.html

Calibrating with 3DF Zephyr

Allow about an hour to do this.

- 1. Download and install 3DF Zephyr Free Edition. <u>https://www.3dflow.net/3df-zephyr-free/</u>
- 2. Create an OpMode from the sample UtilityCameraFrameCapture
- 3. Use 3DF Zephyr to display the calibration target and take pictures
- 4. Copy the captured frames to your computer
- 5. Add the images to 3DF Zephyr
- 6. Run the calibration target analysis in 3DF Zephyr, save calibration values

Start Calibration

Calibrating with 3DF Zephyr

Calibration Target

Take at least 10 captures using the Utility Camera Frame Capture program

April Tags

April Tag Coordinate System

The green star is the centre of the webcam image, the yellow star is at the April Tag centre.

SDK April Tag Programs

AprilTagEasy - start here

AprilTag

UtilityCameraFrameCapture - for calibration

ConceptAprilTagEasy

Detects and displays all April Tags in the camera view with their position information.

ConceptAprilTag

Similar but allows you to set calibration and resolution parameters.

2 to (initAprilTag)	
First, create an AprilTagProcessor.Builder.	
set myAprilTagProcessorBuilder T to new AprilTagProcess	sor.Builder
call (myAprilTagProcessorBuilder *). setLensIntrinsics	
fx	1439.42
fy	1439.42
cx	970.514
Cy	537.613
call Telemetry . (addLine)	
text 🚺 Lens Intrinsics set for Logited	ch c920
Create an AprilTagProcessor by calling build.	
set myAprilTagProcessor to call myAprilTagProcessor	rBuilder 🔹 . build
Next, create a VisionPortal.Builder and set attributes related to	the camera.
set myVisionPortalBuilder v to new VisionPortal.Builder	
if USE_WEBCAM •	
do eall (myVisionPortalBuilder). (setCamera) we	ebcam named Webcam 2
else 📀 call (myVisionPortalBuilder 🔹). (setCamera) 🕻 Bu	uiltinCameraDirection BACK
() call (myVisionPortalBuilder ▼). (setCameraResolution)	
width	1920
height 🖡	1080
call Telemetry . addLine	
text text text text text text text text	20x1080

RobotAutoDriveToAprilTagOmni Program

Combines April Tag Detection and Driving.

NOT a sample program.

RobotAutoDriveToAprilTagOmni

April Tag Summary

An April Tag is like a 2D barcode or a simplified QR Code. It contains a numeric ID code and can be used for location and orientation.

With a calibrated camera and a tag of known size you get:

- X,Y,Z distances to the tag
- Roll, Pitch, Yaw rotations of the tag
- Range, Bearing and Elevation calculated values

The CENTERSTAGE field has tags at the front and back of the field.

Questions?

Vision Portal - Part 3 - Webcam Controls

Vision Portal also allows some control over webcams

- Exposure
- Gain
- Switch between two webcams
- Virtual pan, tilt, zoom function

Webcam Sample Programs

- ConceptAprilTagOptimizeExposure.java adjust the exposure and gain values
- Concept Double Vision control switching between TensorFlow and April
 Tag processing
- April Tag Switchable Cameras (blocks) switch between 2 webcams
- Concept TensorFlow Object Detection Switchable Cameras (blocks)

Questions?

FTC Team Resources

Start here: https://firstroboticsbc.org/ftc/ftc-team-resources/

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Robot Wiring Guide – highly recommended guide to wiring your robot. Teams should follow best practices when wiring their robots. This will help to ensure that the placement, connections, and security of their wires will lead to improved robot performance eliminate intermittent electrical problems and allow for easy troublesbonting and resolution of electrical and/or signal-

Sample programs at: https://github.com/acharraggi/Centerstage-Blocks

Appendix - extra material

- 1. Demonstration Robot
- 2. Known Vision Processing Issues
- 3. Java Autonomous Programs
- 4. Good Programming Practices
- 5. Programming Tools

A1 - Demonstration Robot StudicaBot2

This demonstration robot uses mecanum wheels and four motors. It's based on the Studica robot kit which we recommend.

- It has two webcams, one points down for Pixel detection, one points forward for April Tag detection.
- It has a small arm that can attempt to place the yellow pixel on the backdrop. It is not able to pick up pixels.
- It has a hanging arm that can be released and used to hang the robot
- It also has a drone launcher

A2 - Known Vision Processing Issues

https://github.com/FIRST-Tech-Challenge/FtcRobotController/issues

The GitHub repository is where issues with the Robot Controller can be found. There are a couple of vision related issues, one that is guite serious.

- loss of robot control due to internal vision error Note: this also results in a short driver hub disconnect. This appears to be an fairly frequent a problem running an autonomous program with vision processing when using switchable cameras, Gain control returns a NULL pointer
- •

https://ftc-docs.firstinspires.org/en/latest/programming_resources/vision/tensorflow_cs_2023/tensorflow-cs-2023.html

Autonomous Programs

CENTERSTAGE autonomous programs likely need to use a webcam and vision processing

- inspect the spike marks to determine which has the pixel or team prop
- navigate from your starting position to the backdrop
- if your quick enough doing that you might be able to go to the front wall and pick up a couple of pixels that you can score backstage

A3 - Java Autonomous Programs

AutoPixel1

AutoPixel1

[show Java Program] - discuss structure

https://github.com/acharraggi/Centerstage-Samples/blob/main/AutoPixel1.java

AutoPixelFront

AutoPixelFront

[show Java Program] - discuss structure

https://github.com/acharraggi/Centerstage-Samples/blob/main/AutoPixelFront.java

A4 - Good Programming Practices

- add comments
- save your program often, create backups or even versions.
- provide Telemetry to the driver station
- write to the Robot Controller log
- autonomous programs should always do something. Don't get stuck in a loop waiting for something that might not happen.

Backups

- Select Download to save each program in your PC's downloads folder.
- Use the Rev Hardware Client to save a zip file of all programs and your config files.

Telemetry

Initialization

- Display message indicating progress of Vision Portal or IMU start up
- You could display warnings e.g Voltage too low, or errors in initialization
- should indicate initialization is complete with a Ready message

Autonomous Telemetry

- You might want to indicate what step or state the program is in.
- probably key points in the autonomous program like where did it find the pixel or what April Tag is currently being tracked.

Driver Control Telemetry

- You might want to indicate the position of an arm or gripper or whether or not you collector has picked up a game element.
- commonly things like the motor power levels are displayed

Telemetry

here's how to do telemetry in blocks

Robot Controller Log

🔞 REV Hard	lware Client			-	×
FTC L	Utilities Downloads	About			\otimes
		Filte	View Chart Select Lo rs: Y Error × Warning × Info Selected Columns: ✓ Line ✓	g File Loaded Control Hub StudicaBot2-RC - robotControllerLog.txt	
#.	TIMESTAMP	TYPE	TAG	MESSAGE	
8763	10-13 12:37:20.827	Error	DbgLog	test DbgLog, write error message to Robot Controller log	20
8764	10-13 12:37:20.833	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/JavaBridge - waitForStartForBlocks - start	[23]
8801	10-13 12:39:32.376	Error	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/OpModeThread - runOpMode - caught InterruptedExcepti	52
8802	10-13 12:39:32.377	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/JavaBridge - waitForStartForBlocks - end	23
8803	10-13 12:39:32.383	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/JavaBridge - scriptFinished	53
8804	10-13 12:39:32.383	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/OpModeThread - runOpMode - after while !scriptFinished	53
8805	10-13 12:39:32.383	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/OpModeThread - runOpMode - end - 7ms after Interrupte	53
8806	10-13 12:39:32.383	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/main - run2 - before clearScript	53
8809	10-13 12:39:32.392	Info	RobotCore	BlocksOpMode - "ConceptAprilTagBlocks" - main/main - run2 - after clearScript	53
8811	10-13 12:39:32.453	Warning	cr_BindingManager	Cannot call determined/visibility() - never saw a connection for the pid: 2920 Repo	

call DbgLog . [msg message] " test DbgLog, write message to Robot Controller log " call DbgLog . error message] " test DbgLog, write error message to Robot Contro... "

Rev Hardware Client - Log Viewer program

A5 - Programming Tools

The FTC robot controller is essentially an Android phone application. There are three programming tools provided:

- 1. The Blocks Programming Tool
- 2. The OnBot Java Programming Tool
- 3. Android Studio

The Blocks Programming Tool

FIRST: robot Blocks	OnBotJava Mai	nage		Help
Save Op Mode Export to J	ava Download Op Mod	e Download Image of Blocks		
Op Mode Name: My Tank Dr	rive TeleOp 🔹	Group:	Enabled	Show Java
→ LinearOpMode			Java Code:	
 Gamepad Actuators Sensors Other Devices Android Utilities Logic Loops Math Text Lists Variables Functions Miscellaneous 	C C to runOpModC Reverse one of the drive in o set fight drive in 0 of call My Tank Drive wait o if call My Tank Dri do Put run blocks here repeat While do Put loop blocks o set Power left drive call Telemetry call Telemetry	notors Sirection to Direction REVERSE - tForStart tive opModelsActive and My Tank Drive opModelsActive there: to gamepad1 LeftStickY gamepad1 RightStickY addData key Left Pow number loft_drive Power - addData key Right Pow number right_drive Power -	<pre>package org.firstinspires.fi import com.qualcomm.robotcom import com.qualcomm.robotcom import com.qualcomm.robotcom import com.qualcomm.robotcom @TeleOp(name = "MyTankDrive public class MyTankDrive ext private DcMotor right_drive private DcMotor left_drive /** * This function is execut */ @Override public void runOpMode() { right_drive = hardwareMap left_drive = hardwareMap // Reverse one of the du // You will have to dete</pre>	tc.teamcode; re.eventloop.opmode.Linear re.eventloop.opmode.TeleOp re.hardware.DcMotor; re.hardware.DcMotorSimple; (Blocks to Java)", group tends LinearOpMode { ve; e; ted when this Op Mode is s ap.dcMotor.get("right_drive" rive motors. ermine which motor to reve

The OnBot Java Programming Tool

FIRST robot controller Blocks OnBolUava	Manage Help
Project Files	<pre>1 package org.firstinspires.ftc.teamcode; 2 import com.qualcomm.robotcore.eventloop.opmode.LinearOpMode; 4 import com.qualcomm.robotcore.eventloop.opmode.TeleOp; 5 import com.qualcomm.robotcore.hardware.DcMotor; 6 import com.qualcomm.robotcore.hardware.DcMotorSimple; 7 @TeleOp(name = "MyTankDrive (Blocks to Java)", group = "") 9 public class MyTankDrive extends LinearOpMode { 10 private DcMotor right_drive; 12 private DcMotor left_drive; 13 /** 14 /** 15 * This function is executed when this Op Mode is selected fr 16 */ 17 @Override 18 @Override 18 withis used sumGeNede() f 18 withis used sumGeNede() f 19 Build started at Mon Jun 17 2019 15:45:25 GMT-0400 (Eastern Daylight Time) Build finished in 2.9 seconds Build succeeded!</pre>

Android Studio

If c.app) Proceeding Proceeding <th></th> <th>G PushootheleopPov_LinearJava - rtc_app - [~/Documents/workspace/rtctechim/rtc_app]</th> <th>0.5</th>		G PushootheleopPov_LinearJava - rtc_app - [~/Documents/workspace/rtctechim/rtc_app]	0.5
<pre>Inc.app) PReRobaController I trc I main) #wa) org) firstingpres) fn () robotcontroller) external) samples) @ PushbotTeleopPOV_Linear java ×</pre>		∧ Ca TeamCode → ▶ ↑ 15 16 18 18 20 Cat ▲ ?	Q.
<pre> Advide</pre>	ftc_app) 🛅 FtcRobotController) 🛅 src) 🛅 main 🔪	🗂 java 👌 🛅 org 👌 🛅 firstinspires 👌 🛅 ftc 🤇 🛅 robotcontroller 🤇 🛅 external 🤇 🛅 samples 🔪 😨 PushbotTeleopPOV_Linear 🤇	
<pre>PushbotTolear PushbotTolear PushbotToleapPOV_Linear PushbotToleapPOV PushbotPOV PushbotPoV PushbotPoV PushbotPoV PushbotPoV PushbotPoV PushbotPoV</pre>	🖷 Android 👻 😳 🌞 🎄- 🖿	© PushbotTeleopPOV_Linear.java ×	e
<pre>* CreamCode * minifests * Digwa * Crog_firstinspires.ftc.teamcode * This mode the left sick moves the robot FND and back, the Right stick turns left and right. * This mode the left stick moves the robot FND and back, the Right stick turns left and right. * This mode the left stick moves the robot FND and back, the Right stick turns left and right. * This mode the left stick moves the robot FND and back, the Right stick turns left and right. * Trains and lowers the claw using the Gampad Y and A buttons respectively. * It raises and lowers the claw using the Gampad Y and A buttons respectively. * The stand lowers the claw using the Gampad Y and A buttons respectively. * The also opens and closes the claw slowly using the left and right Bumper buttons. * We Android Studios to Copy this Class, and Paste II into your team's code folder with a new name. * Remove or comment out the @Disabled Line to add this opmode to the Driver Station OpMode List * Use Android Studios to Copy this class, and Paste II into your team's code folder with a new name. * Remove or comment out the @Disabled Line to add this opmode to the Driver Station OpMode List * Use ClawOffset # Declare OpMode members. */ HardwarePushbot: Teleop POV', group="Pushbot'] // Use a Pushbot's hardware # Declare OpMode members. */ HardwarePushbot releopPOV_Liner extends LinearOpMode { /* Declare OpMode members. # Initial double ClawOffset = 0; // Serv raid position # Initial to Left; double est; # Initialize the hardware variables. * The init() method of the hardware class does all the work here */ * Tob. init(hardwareMap); // Send telemetry message to signify robot waiting; telemetry.udpdat(); # Itelemetry.udpdat(); # Initialize the inft: # Could to right for the fortwart is a signify robot waiting; telemetry.udpdat(); # Could to right for the signify robot waiting; # Could teleft; # Could to right for the signify robot waiting; # Could teleft; # Could teleft; # Could teleft; # Could teleft; # Could teleft; # Co</pre>	FtcRobotController	PushbotTeleopPOV Linear	4
<pre>/* Declare OpMode members. */ HardwarePushbot robot = new HardwarePushbot(); // Use a Pushbot's hardware // could also use HardwarePushbotMatrix class. double clawOffset = 0; // Servo mid position final double (LAW_SPEED = 0.02; // sets rate to move servo verride public void runOpMode() { double Infit; double max; // double max; // a initialize the hardware variables. * The init() method of the hardware class does all the work here */ robot.init(hardwareMap); // Send telemetry metsage to signify robot waiting; telemetry.update(); // Send telemetry.update(); </pre>	 ▼ TeamCode ▶ manifests ▼ java ▼ org.firstinspires.ftc.teamcode ⊗ ireadme.md ▶ jiniLibs ▶ ares ◊ Gradle Scripts 	46 * All device access is managed through the HardwarePushbot class. * The code is structured as a LinearOpHode * This particular OpHode executes a POV Game style Teleop for a PushBot * Th this mode the left stick moves the robot FND and back, the Right stick turns left and right. * It raises and lowers the claw using the Gampad Y and A buttons respectively. * It also opens and closes the claw using the Gampad Y and A buttons respectively. * It also opens and closes the claw slowly using the Ieft and right humper buttons. * Use Android Studios to Copy this Class, and Paste it into your team's code folder with a new name. * Remove or comment out the @Disabled Line to add this opmode to the Driver Station OpHode List */ * TeleOp(name="Pushbot: Teleop POV", group="Pushbot") * GeleOp(name="Pushbot: Teleop POV_Linear extends LinearOpHode {	
83 // Wait for the game to start (driver presses PLAY) 84 waitForStart();		<pre>/* Declare OpMode members. */ HardwarePushbot robot = new HardwarePushbot(); // Use a Pushbot's hardwarePushbotMatrix class. double clawOffset = 0; // Serve mid position final double clawOffset = 0; // Serve mid position governde public void runOpMode() { double left; double right; double right; double right; double init() method of the hardware class does all the work here */ robot.init(hardwareMap); // Send telemetry message to signify robot waiting; telemetry.addOta("Say", "Hello Driver"); // telemetry.update(); // Wait for the game to start (driver presses PLAY) waitForStart(); } // Send telemetr(); </pre>	1 H H
0 Marcines Tarring & 6 Android Monitor @ 1000	🔲 O: Morragon 🗮 Terminal 🏯 6: Android Monit		adle Consolo

Programming the Robot

- Allow time to program the robot. All robots need a driver controlled program.
- The robot should be able to do something from all four positions in the autonomous period.
- Detecting the Team Prop and pushing a purple pixel to the indicated spike mark is a simple program all teams should aim to create. That's one program that would work from all starting positions and earns 20 points.
- Navigating to the backdrop is more of a challenge, especially from the front of the
 - field.

Programs

You create programs that are called OpModes (Operational Modes).

There are two styles of OpModes that you can create.

- Autonomous you select one of this type of program to run during the 30 second autonomous period at the start of a match. The program runs without any input from the drive team, but it can use cameras and sensors to navigate and perform actions on the field. You can also provide inputs to the program during the initialization period.
- Teleop after the autonomous period, there is a two minute driver controlled period where the drive team uses the gamepad(s) to issue commands to drive the robot and have it perform actions on the field.

OpMode vs LinearOpMode

LinearOpMode is a class derived from OpMode that was meant to simplify Java programming. Blocks and the sample Java programs operate using LinearOpMode. That can be seen where the program flows from initialization to wait for start to the loop and then finally exits the loop.

OpMode operates in more of a real-time programming style where you need to maintain state about what action you want to do next. There are also separate Initialize, start and stop functions you need to write.

Both Autonomous and TeleOp programs often end up with state machine like logic which can operate better as a non-linear op mode.