Computer Science Instruction using Drones

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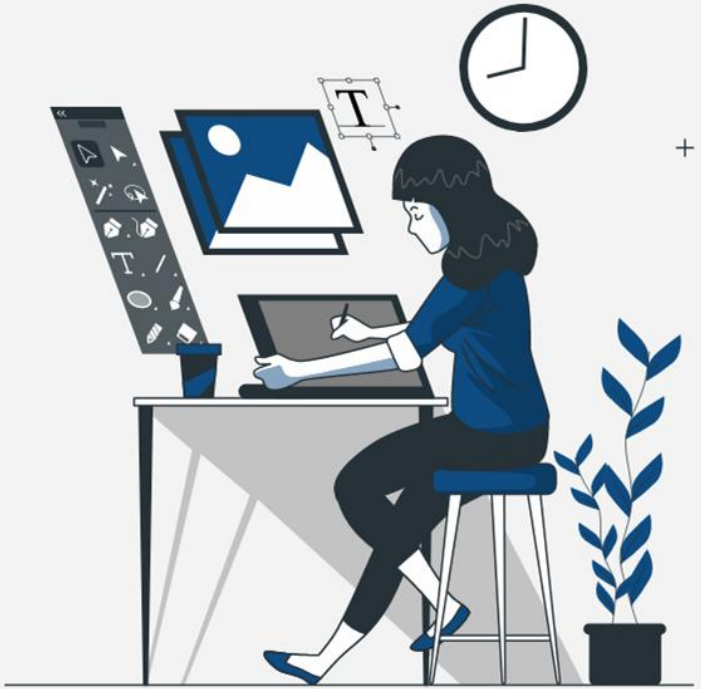

Introduction

Programable drones appropriate for education

Tello Drones

From Drag and drop to Python

Computer Networks

Internet of Things

Computer Vision

Image processing

Neural Networks

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Introduction

- STEM (science, technology, engineering and mathematics) education allows the pupils to become familiar with the new technologies and drone programing is one appealing strategy.

- We will explore in this paper how drone programming can be used in higher education.

- We are students in Computer Science at the Faculty of Engineering in Foreign Languages from University POLITEHNICA of Bucharest and all the coding was used either for real projects and laboratory work or to be shown to the audience at the University fairs.

Programable drones appropriate for education

	Tello	Tello EDU/ Talent	CoDrone	Parrot Mambo	Airblock	LiteBee Wing	Drone:bit
Dimensions	98×92.5×41 mm	98×92.5×41 mm	3.7 x 2.6 x 2.8 in.	6 x 3 x 0.4 in.	230 x 222 x 53 mm	210 x 180 x 50 mm	410 x 410 x 51 mm
Weight	80 g	80 g	36 g	63 g	141 g	128g	509 g
Battery life	13min	13min	6 min	9 minutes	6-8 minutes	10 min	8 min
Camera	HD	HD	no	4K	no	HD	no
Microcontroller	-	ESP32 Controller	-	-	DIY Kit For ESP32	-	-
Prog. Languages	block based language, JavaScript, Python	Scratch, Python, Swift	Python, Blockly, Arduino	Swift Playground Tynker. Workbench Simulink. Python. Javascript.	block based language	block based language	block based language, JavaScript, MicroPython
Extensions	yes	yes	no	yes	no	yes	yes
Price	113€	133€	93 €	103 €	179 €	190 €	177 €

Tello Drones

While the Tello drone is often associated with names like "DJI Drone" or "Ryze Tello", it is a product made in collaboration with Ryze Technology, not just a DJI creation.

The Tello combines a DJI flight control system with an Intel processor, making it an easy-to-use drone that's easy to transport thanks to its compact size.

Tello comes in three different types :

- Tello Quadcopter (2018)
- Tello Edu (2018)
- Tello Talent (2021)

Tello Drones

1.	Motor 1/Counter-clockwise	10.	Aircraft Status Indicator
2.	Motor 2/Clockwise	11.	Vision System
3.	Motor 3/Counter-clockwise	12.	IMU + Barometer
4.	Motor 4/Clockwise	13.	Micro USB Port
5.	Propeller Protection	14.	Collision Detection
6.	Propeller Guards	15.	Intel 14-Core Processor
7.	Propeller	16.	Antennas
8.	Detachable Battery	17.	Power Button
9.	Camera		

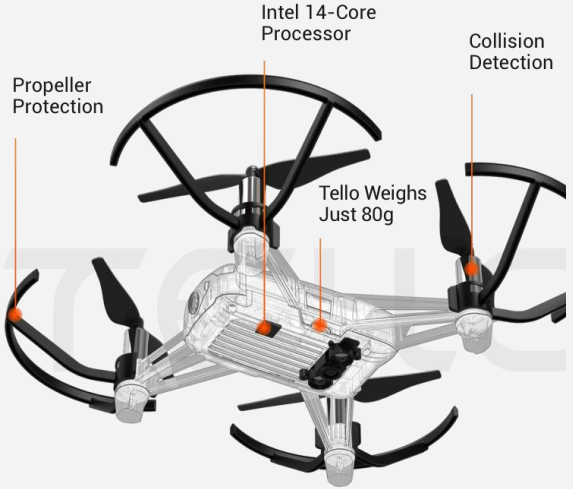
Tello Quadcopter

- Manual Flight Control: Fly around manually
- Supports Block Coding: Can drag and drop in order to make the drones fly
- Supports Script Languages: Python and Javascript
- It has Front Facing Camera
- DroneBlocks App supports: PC, MAC, IOS, Android, Chrome Books
- No storage: Can not take pictures or film videos

Tello Drones

The Tello EDU drone is a versatile educational tool for learning about programming and robotics.

It's small size, and lightweight design makes it easy to use indoors, while its sensors and high-resolution camera provide various options for experimentation.



Everything Tello Does:

- Supports Swarm mode: Connect multiple drones in order to do a designated task
- Supports the Advanced System Development Kit (SDK) 2.0
- Supports Mission Pads : The drone flies over them, it can trigger certain actions
- Support Expansion Kits

Tello Drones

The Tello EDU quadrotor drone's advanced programming capabilities make it an excellent choice for students learning Scratch, Python, and Swift programming languages, as well as for those seeking to integrate artificial intelligence (AI) functionality.

Everything Tello Edu Does:

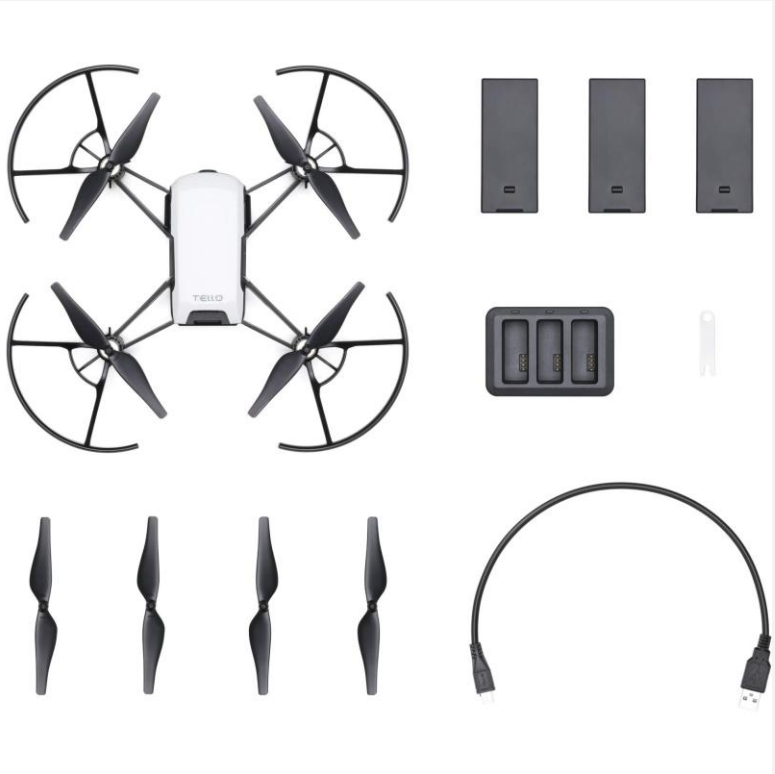
- Add-On : RGB LED
- Add-On : 8x8 Red/Blue Display Matrix - can draw pictures or scroll text
- Built-in Open Source ESP32 Controller - improved Wi-Fi and the embedded esp32 module which allows you to connect an extension board to this drone and lets you plug in things like a temperature sensor
- Arduino Compatible

Tello Drones

All three have the universal gear in common:

- Batteries
- Propellers
- Propellers Guards
- USB Cable

Despite the good general feedback these programmable drones for education has brought to the STEM education and for overall users, the tello drones series are now discontinued.

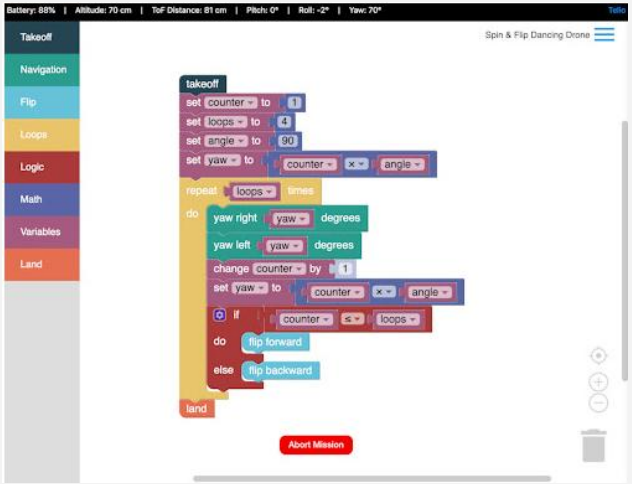


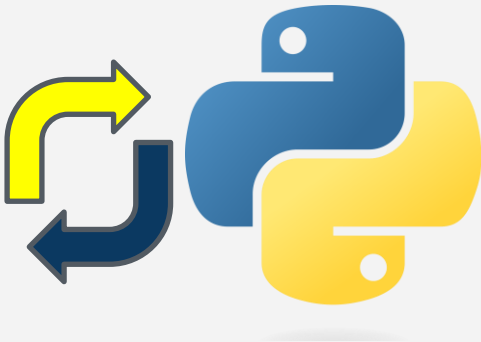
Programming instruction- from Drag and drop to Python

We chose python as our language of development due to its versatility and library support. (OpenCV, DJITelloPy, Thread, Torch, Pygames)

For our IDE we chose PyCharm because it is very friendly and incorporates all the necessary libraries with ease.

For educational purposes the Tello Drones also support drag and drop style of “coding” via the mobile app.

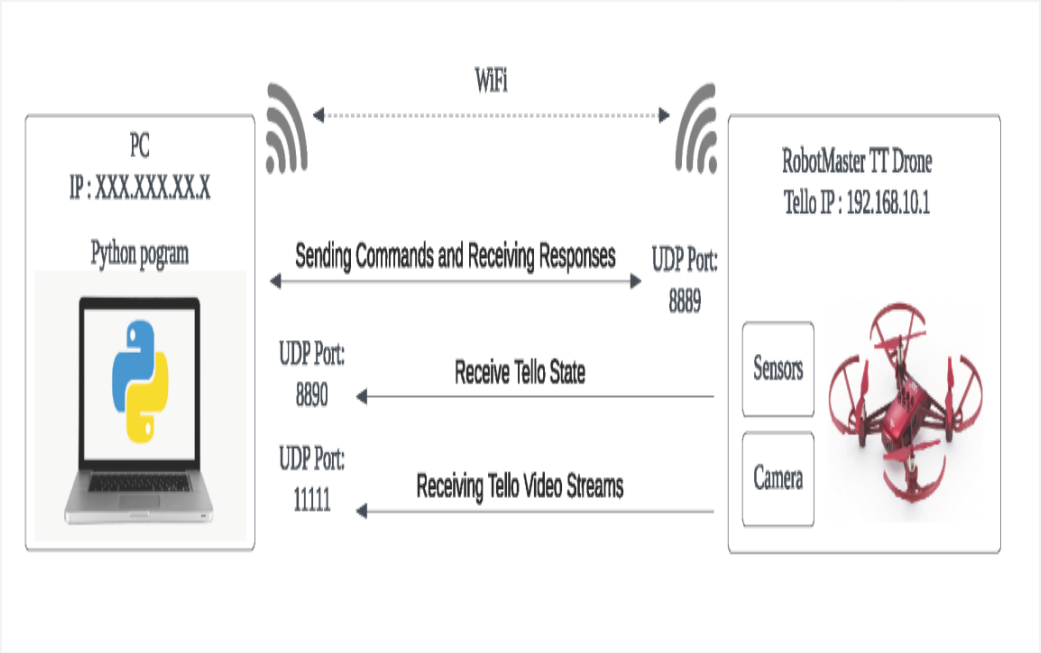




Computer Networks Instruction

Connecting a Tello drone to a PC requires configuring several UDP ports for different functionalities.

- UDP Port 8889: Used for sending commands and receiving responses; initiate by activating Tello's SDK mode.
- UDP Port 8890: Establish a UDP server on the PC to collect drone state information from IP 0.0.0.0.
- UDP Port 11111: Set up another UDP server to receive video streams from the same IP.



Internet of Things Instruction

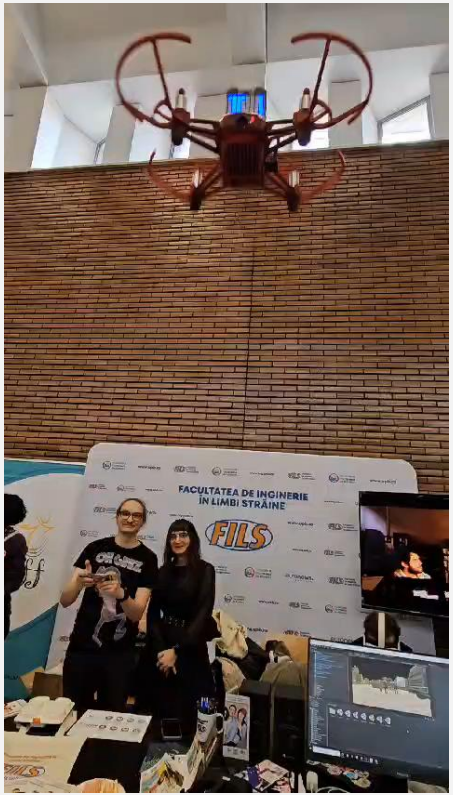
Drones can also be controlled by smart devices like smart phones.

The advantages of controlling a drone over the internet, are the flexibility and speed with which one can control the drone from a distance.

We played with controlling the drone using an external network card to simulate hosting a web-page and managed to control the drone with acceptable latency on commands.

Microcontrollers Instruction

In our project, we utilized the ESP32 microcontroller to display the name of our faculty. We integrated the ESP32 with a matrix display to showcase text messages and engage the audience.



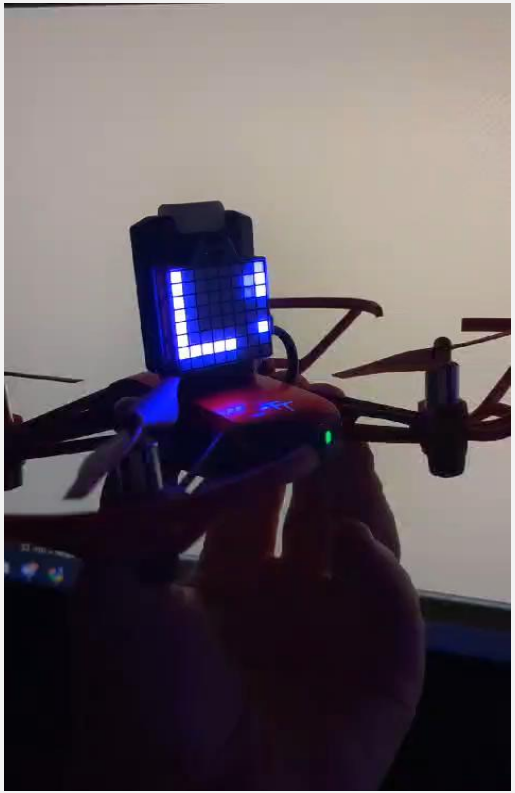


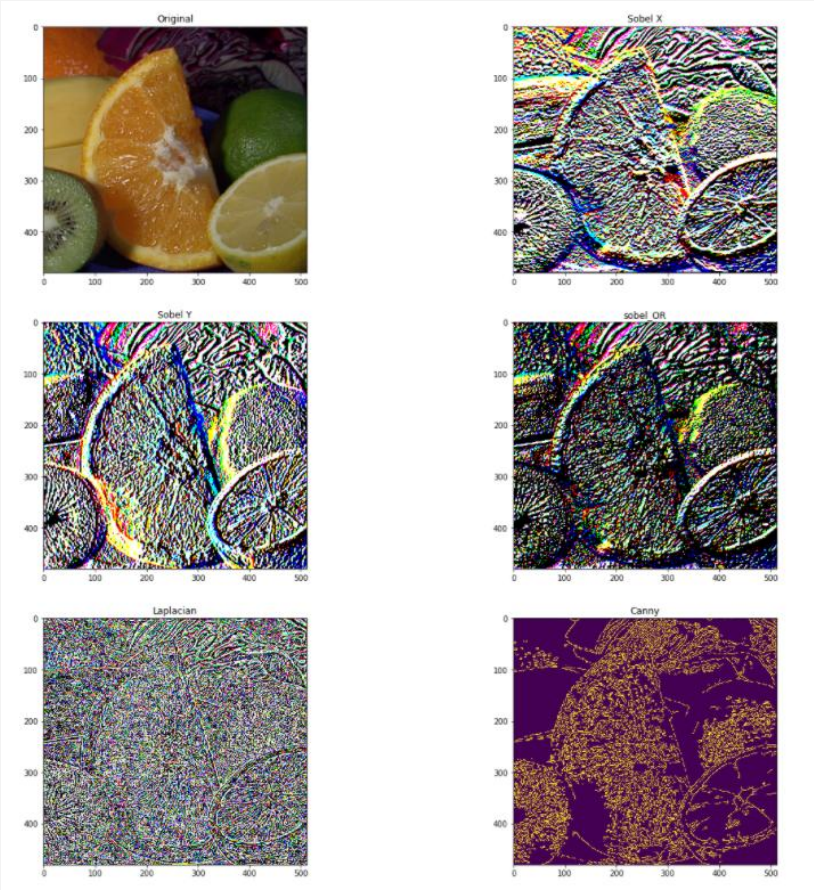
Image Processing Instruction

A core application of computer vision in our project was object tracking by color. This feature is crucial for following set paths, locating specific objects, and maintaining visual contact with targets during autonomous flight.

One of the primary image processing techniques we employed was object tracking using OpenCV (Open-Source Computer Vision Library)

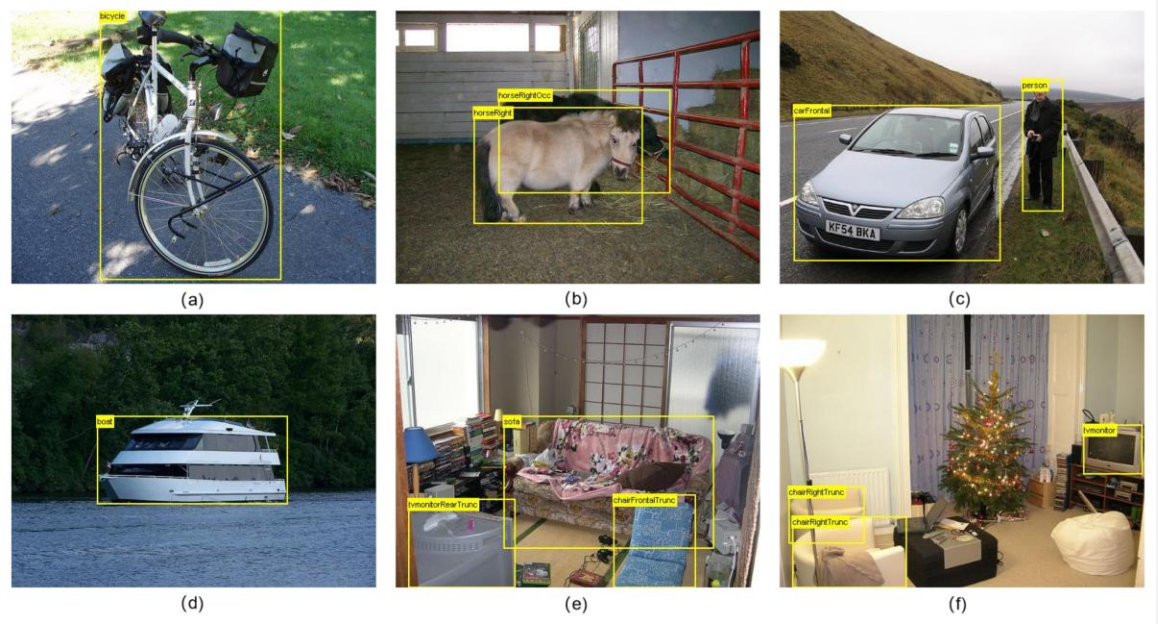
Our object tracking approach with OpenCV included these steps:

- Color Detection
- Object Localization
- Tracking Algorithm



Neural Networks Instruction - Object Detection and Classification

Neural networks are a fundamental component of deep learning and machine learning, enabling machines to learn from data and perform complex tasks such as object detection and classification. In our project we delved into neural networks to empower our drones with the ability to detect and classify objects in their environment.



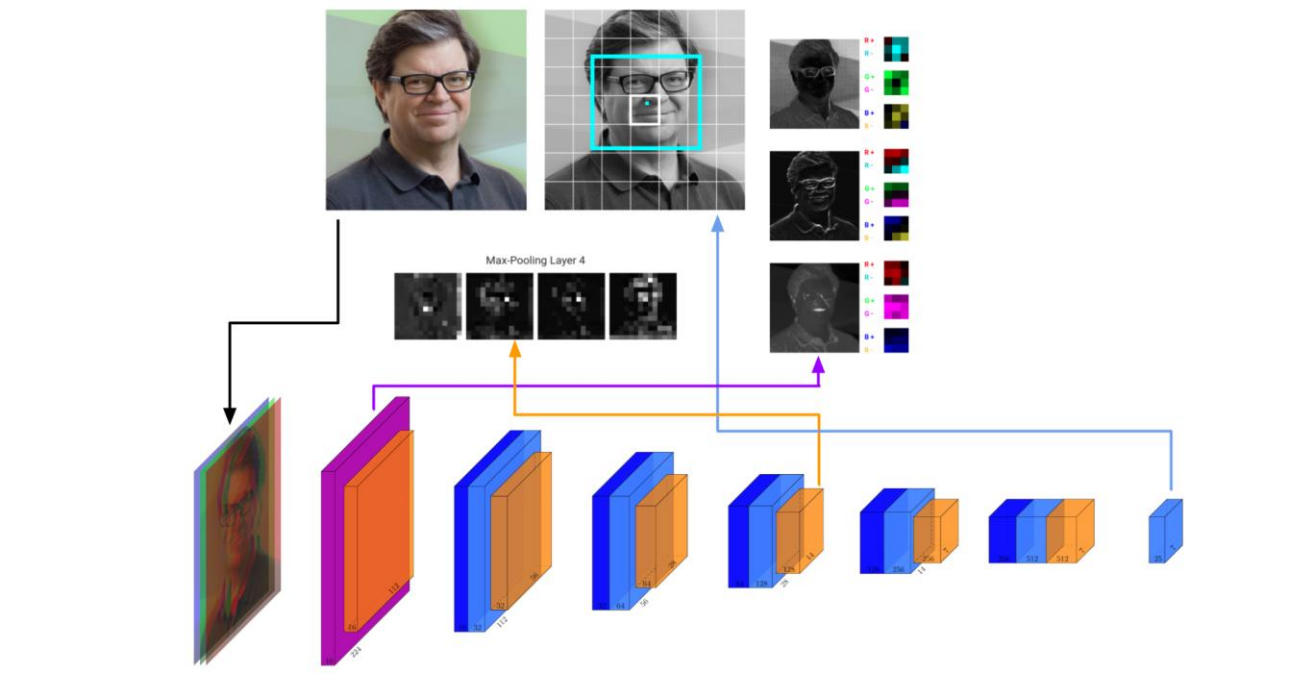
One of the key neural network architectures we employed for object detection was YOLO (You Only Look Once). To integrate YOLO into our drone systems, we followed a multi-step approach:

- Model Training
- Model Deployment
- Live Image Processing
- Low-Latency Processing
- Fail-Safe Mechanisms
- Pre-processing Techniques

Computer Vision Instruction

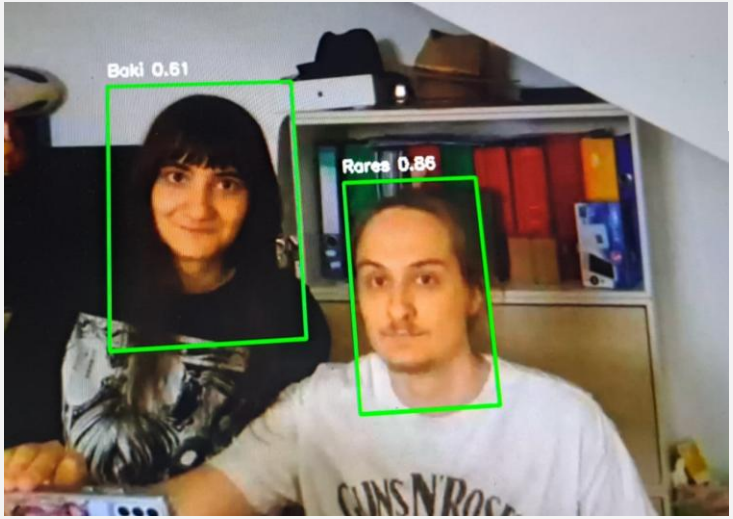
Computer vision is a field of artificial intelligence that enables machines to interpret and understand visual information from the surrounding environment.

In the context of our project, we utilized computer vision techniques to enable our drones to recognize colors and faces, enhancing their capabilities for various applications.



Computer Vision Instruction

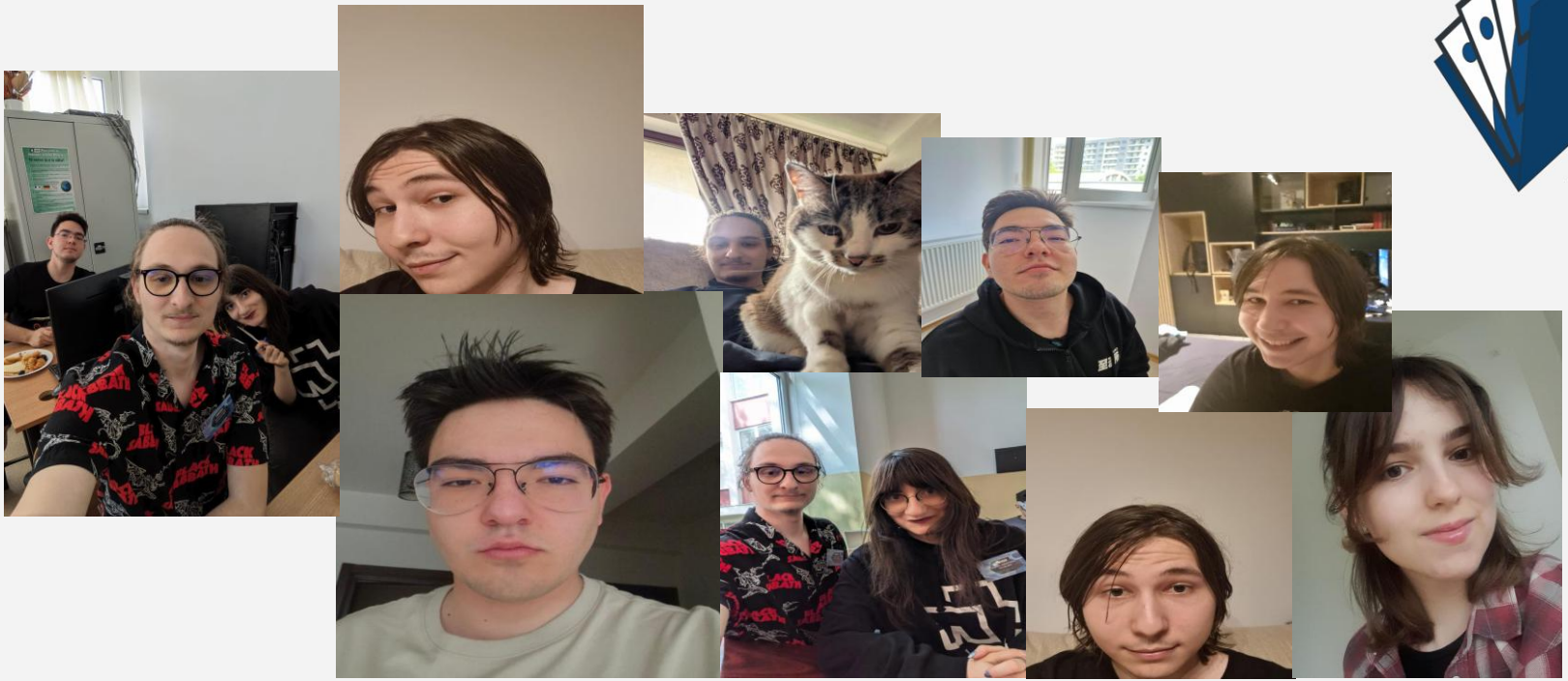
In addition to color-based object tracking, we integrated advanced face recognition capabilities into our drone systems using the YOLOv5 (You Only Look Once) model.



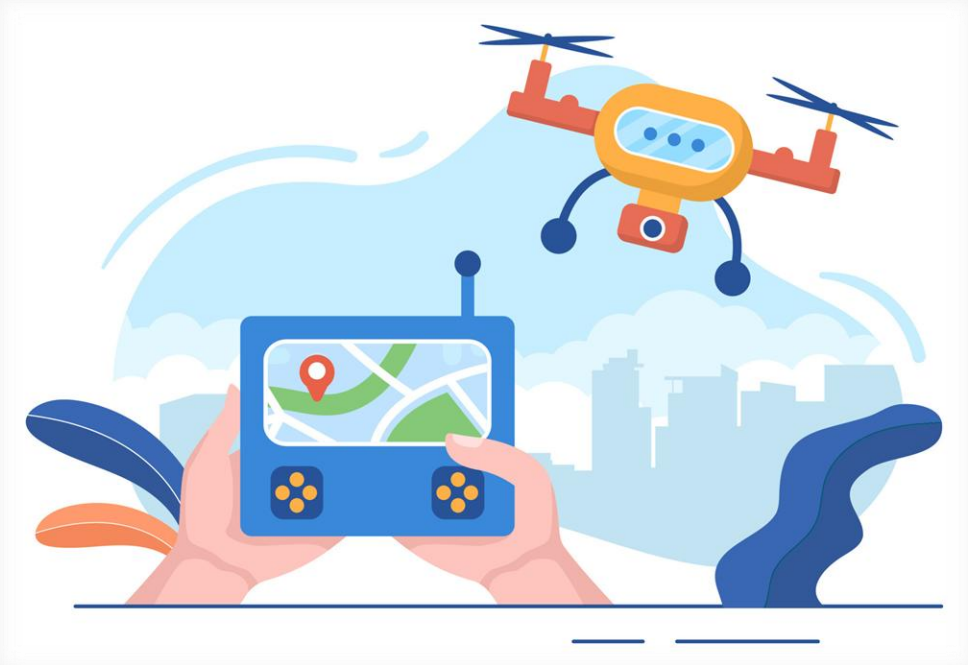
To implement face recognition using YOLO, we trained the model on a dataset of facial images, allowing it to learn distinctive features and patterns associated with human faces.

Computer Vision Instruction

The dataset for our customized dataset consisted on photos of us, a lot of photos ☺

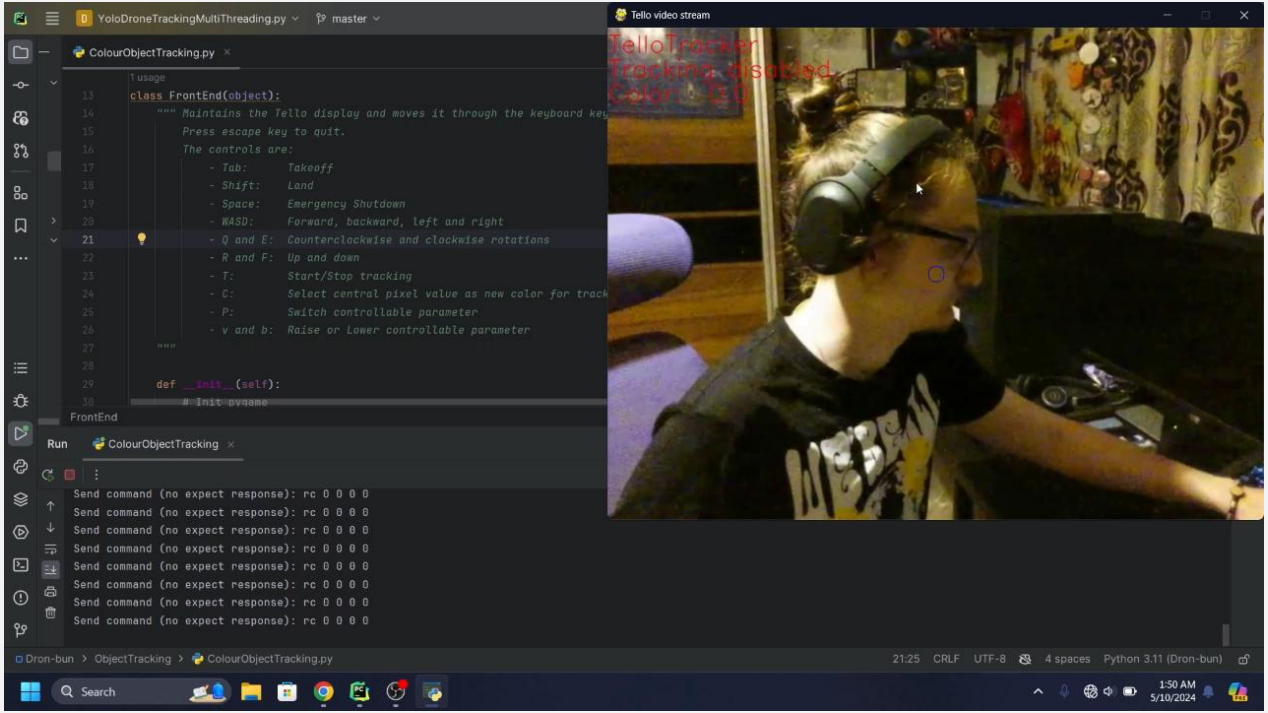


Up Next: The Demo Section

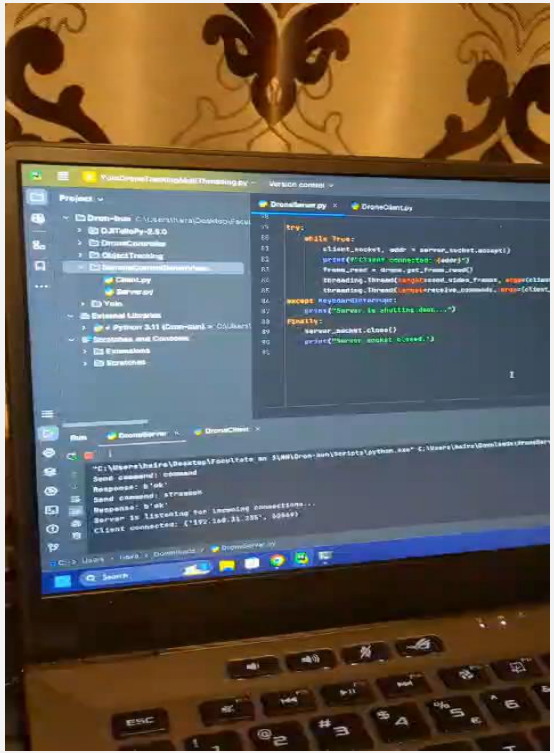


Demo-PyGame Gamepad Control

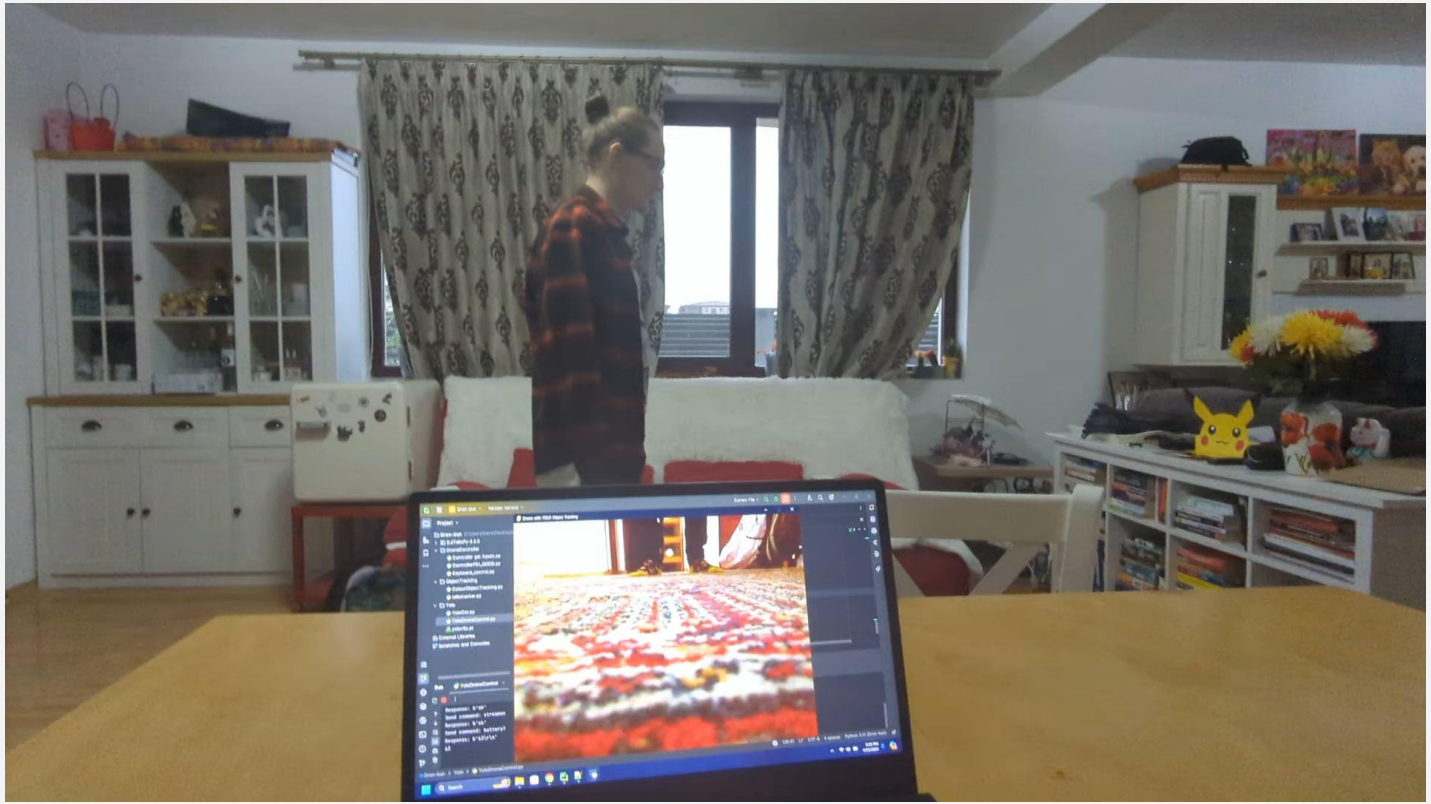
Demo-OpenCV Color Tracking



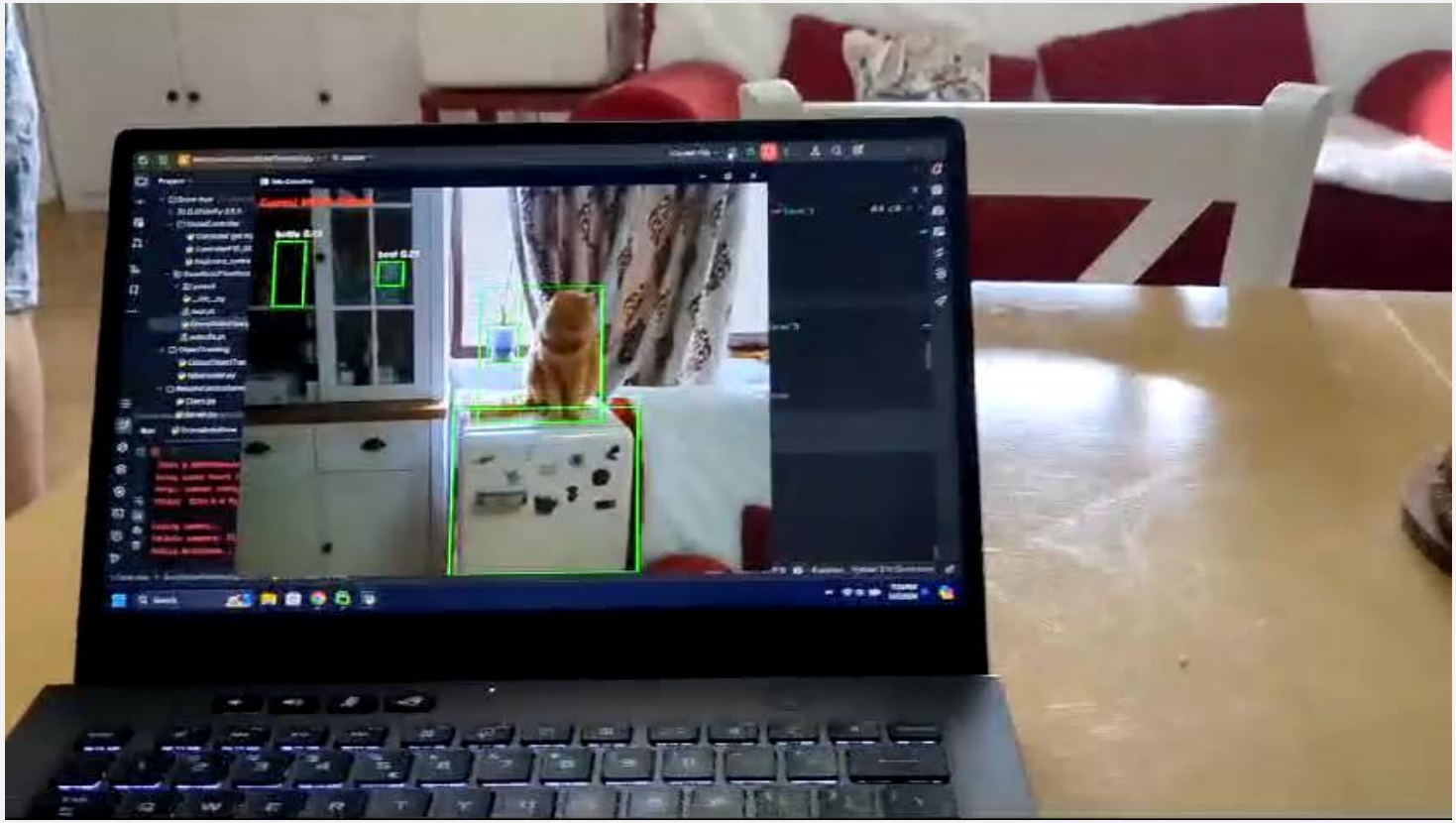
Demo-Internet-Based Drone Control



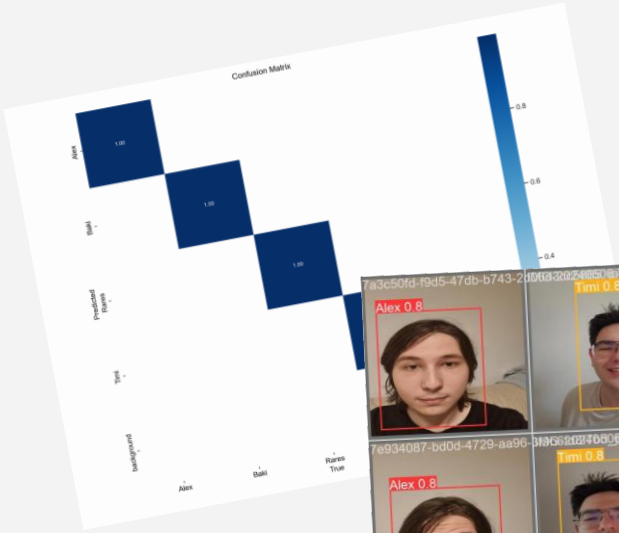
Demo-Yolo Object Tracking

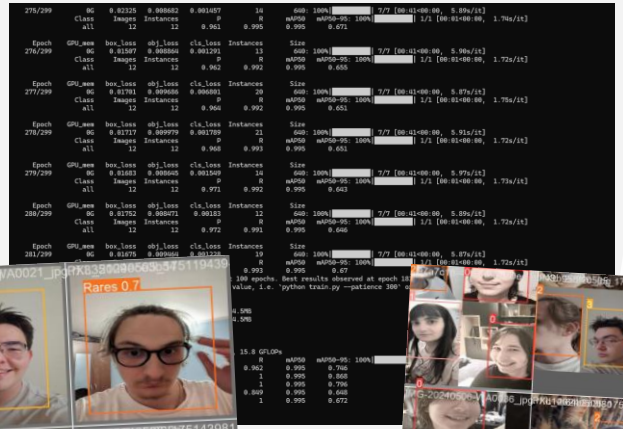


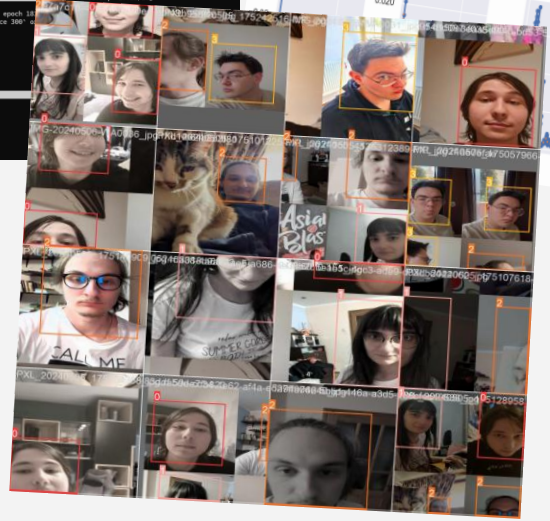
Demo-YOLO Object Detection



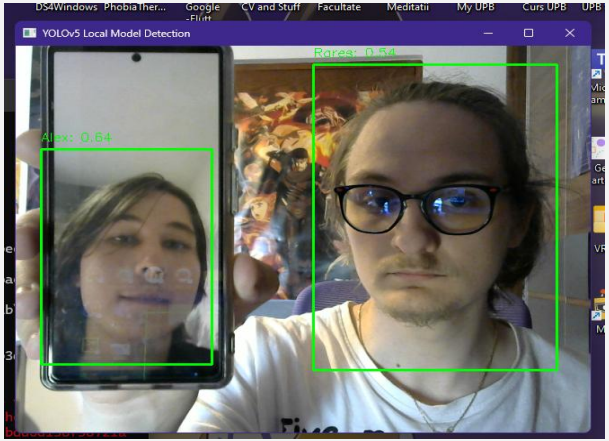
Demo-YOLO Training

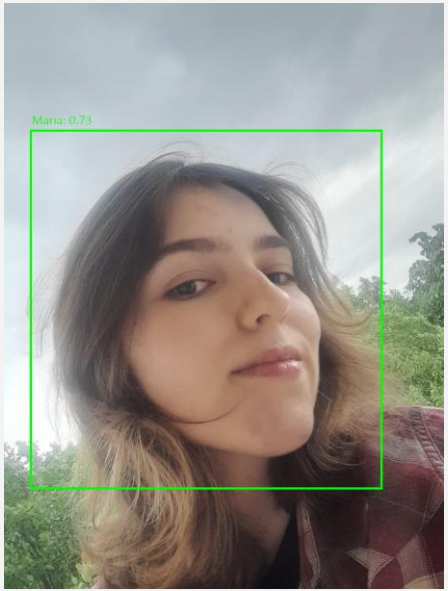


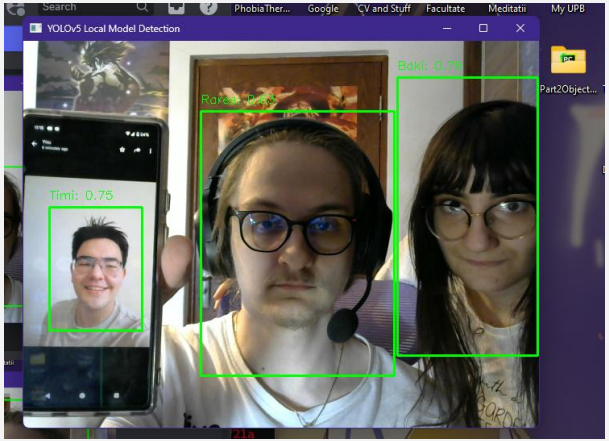




Demo-YOLO Custom Face Detection







Buckle Up: Live Testing in Action!”

Conclusion

90% of the information processed by the brain is visual.

Most people only read 20-28% of the words on the page.

Let’s focus on the important faces

THANK YOU!

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