

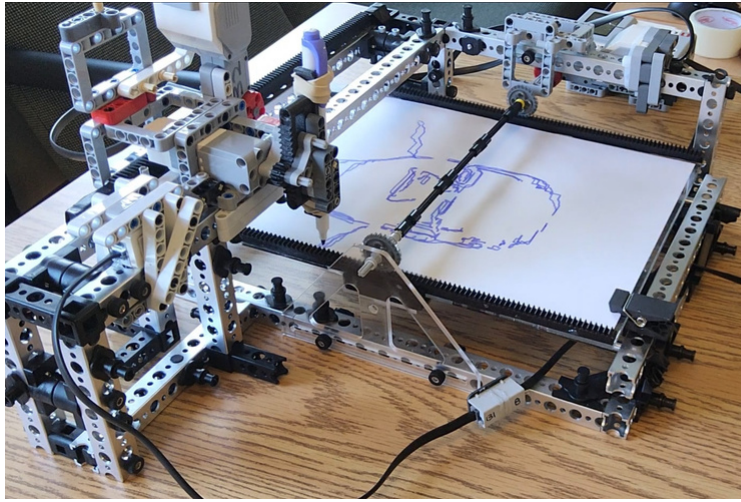
# MARK DO

MECHATRONICS ENGINEERING AT THE UNIVERSITY OF WATERLOO



## ARTICUS MAXIMUS (SKETCHING ROBOT)

April 2023 - July 2023



### Project Description:

- Articus Maximus is a 2-axis-gantry robot that sketches images from a file onto paper as line-art

### Image Processing Algorithm

- Python pipeline starts with pre-processing (Gaussian blur, greyscale, and resizing) input JPG/PNG files
- **Canny edge detection** and **contour detection** applied
- Contour detection output still contained redundant lines: combined **Hu Moments** and position matching algorithm to remove duplicates
- Simplified each contour using a recursive **Douglas-Peucker algorithm** to decrease drawing time



### Robot Control Systems

- Created a PID controller in C for X and Y-axis motors with Heuristic tuning
- Controller uses a **low pass filter**, **anti-windup**, and a 1D **motion profile** to draw lines accurate to within 2 degrees.

[GitHub - Articus Maximus](#)

## AUTONOMY DEVELOPER - WARG

April 2023 - Present

**WARG** is a design team focused on the unmanned aerial vehicle industry, which develops open-source autonomous flight software.

### Clustering Algorithm

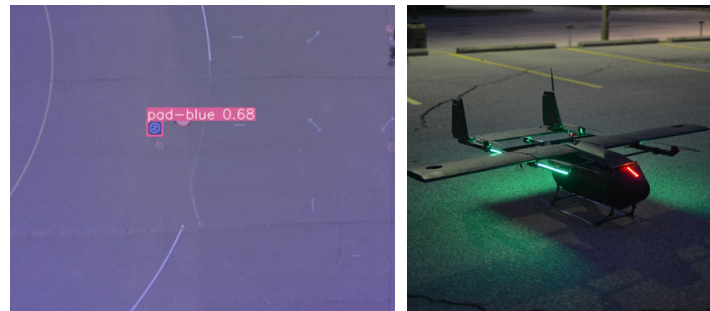
[GitHub - WARG/ClusterEstimation](#)

- Developed a clustering module for the perception-decision-controls system to predict drone landing locations.
- Landing pad detections from camera has positional inaccuracies and false positives.
- Module uses a Variational Gaussian mixture model to group all detections to find probability centers and predict most likely landing pad locations

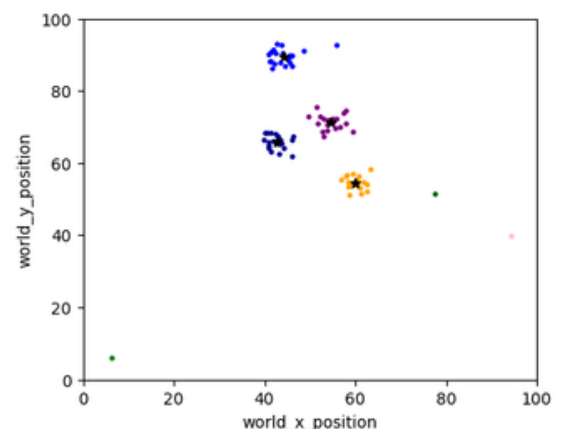
### Documentation Contributions

[Confluence Documentation](#)

- Wrote post-mortem summaries after test flights.
- Created high level documentation for cluster module, programmed according to PEP 8 & internal style guide.



Sample model result for input data with outliers and poor distribution

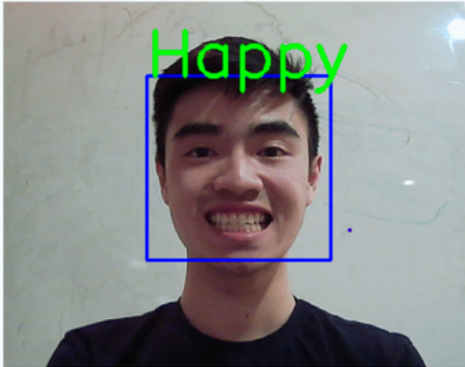


## EMOTIONAL CARDIOGRAPHY (ECG)

January 2023 - March 2023



### Emotional Cardiology

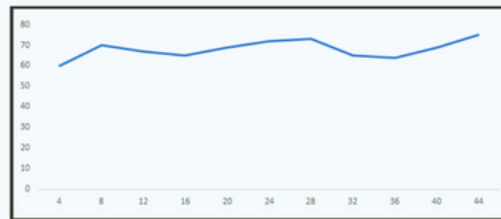


John Doe  
Room 317  
Condition: Healthy

#### Emotion Likelihood

Happiness: 87%  
Sadness: 1%  
Pain: 3%  
Fear: 7%  
Surprise: 2%

#### Heart Rate



#### Neural Network Architecture:

- KER 2013 dataset- 27,000 (48 x 48 x 1 greyscale) images.
- 4.7 million parameters total from **12 convolutional layers** and **2 fully-connected layers** (ELU non-linearity), with 5 units SoftMax output.

#### Project Description:

- ECG is an application that monitors a patient's emotional state and heart rate using OpenCV, Machine Learning & heartrate sensors.

#### Software:

- Emotion recognition CNN model built on Python with **OpenCV** and **TensorFlow Keras**
- Built a **web application** that receives all the data and displays it to a doctor, with an algorithm that predicts the patients state based off sensor data.
- Streamed video feed and model predictions a website.

[GitHub - ECG](#)

## IoT Soil Humidity System

Oct 2023 - Present

My mom claims that she "never forgets to water" her potted plants.

#### Project Description:

- A system that tracks soil humidity data for house plants, sending an email notification if any plant is < set threshold %.
- She buys me bubble tea if any of her potted plants falls < 5% soil humidity

#### System Design

- ESP8266 wireless boards are used to power the capacitive soil humidity sensors
- Data sent to **MQTT topic on AWS IoT core**
- Message payloads re-routed into a **AWS DynamoDB database** for long-term storage
- AWS Lambda** function triggered each time the DynamoDB is updated
- Lambda function **publishes an email** via **AWS SNS** if readings in the last hour < humidity threshold %

