Marker Follower

A Python-based system for detecting ArUco markers in images or video, and computing robot motion commands to follow a specific marker. This repository includes:

- A reusable marker detection class
- A standalone video processing script
- A ROS node for real-time robot control

Contents

marker_detector.py

- MarkerDetector class.
- Member methods:
 - detect(): Detect ArUco markers in the image frame:
 - Uses OpenCV's ArUco module to:
 - Detect markers in images.
 - Estimate each marker's 3D pose (rvec, tvec) relative to the camera.
 - compute_velocity(): Compute linear and angular velocities based on:
 - Marker distance from the camera.
 - Pixel offset of the marker's center from the image center.
- Parameters:
 - Camera intrinsic parameters: camera_matrix, dist_coeffs

run.py

- A python script to:
 - Load a video file.
 - Detect markers frame-by-frame.
 - Compute desired robot velocities for following marker ID 1.
 - Overlay:
 - Marker bounding boxes.
 - Marker ID text.
 - Velocity vectors and debug info directly on the video frames.
- Draws arrows or curves representing motion commands:
 - Straight arrows for pure linear movement.
 - Curved paths for simultaneous rotation and translation.
- · Inputs:
 - o video_path: (e.g.,"../examples/2025-06-30-08-20-43.mp4")

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▶ View the example input video

- · Parameters:
 - Controller parameters:
 - desired distance
 - k_linear
 - k_angular
 - max_linear_speed
 - max_angular_speed

How to run:

python3 run.py

▶ View the visualization of the result

```
marker_follower_ros.py
```

A ROS wrapper of marker_detector.py

- Subscribed rostopic:
 - Camera images from /usb_cam/image_raw.
 - How to rosrun usb_cam in Clearpath Jackal:

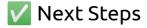
rosrun image_view image_view image:=/usb_cam/image_raw

- Published rostopic:
 - Publish robot velocity commands on /cmd_vel.
 - Publish annotated images for debugging on /marker_follower/annotated_image.
- Parameters:
 - Controller parameters:
 - desired distance
 - k_linear
 - k_angular
 - max_linear_speed
 - max_angular_speed

How to run:

rosrun marker_follower marker_follower_ros.py

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- 1. Check out TODO in each script.
- 2. Here are suggested next tasks for this marker follower project:

1. Try the Example Video

• Run run.py with the provided example video:

```
python3 run.py
```

2. Test with Your Own Videos

- Record your own ArUco marker footage.
- Record multiple videos at ACRE to see if the detection performance degrades in the field or not.
- Save the video in the examples/ folder or Modify the video path.
- Update the video_path in run.py:

```
video_path = "examples/your_new_video.mp4"
```

3. Tune Control Parameters, Find the optimal camera/marker positions

• Optimize the following parameters in both scripts:

```
desired_distance
```

- k_linear
- k_angular
- max_linear_speed
- max_angular_speed
- Observe how these affect:
 - · Robot's following distance
 - Smoothness of motions
- Find the best camera mounting position on the robot.
- Find the best marker height/orientation in the field.

4. Improve Camera Calibration

Replace default camera_matrix and dist_coeffs with real calibration data.

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5. Extend to Multiple Marker IDs

- Currently, the code tracks **only marker ID 1**.
- Enhance it to:
 - Track multiple IDs simultaneously.
 - Use different control strategies per ID.

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• Stop or switch targets if the desired marker disappears.