Applying Image Based Pose Detection Algorithms to Tello Drone

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Introduction

Fig. 1: Tello drone, developed by Ryze Tech and powered by DJI

Applying image based pose detection algorithms to the Tello drone provides an affordable, compact, and easily programmable research platform compared to other commonly used drones such as the Bebop drone.

This research aims to evaluate whether or not the Tello can perform at the same level as the Bebop drone, determining its suitability for using pose detection algorithms in future lab applications.

Pose detection is a crucial first step in developing tracking technology that could be applied to autonomous vehicle navigation software. By evaluating the Tello, we can determine whether it can support such technology.

Key Terms

- **Pose Detection**
  - Process of detecting keypoints on an object to determine its position in space.
- **Pose Detection System in Lab**

1. Image of drone is captured.
2. Keypoints are detected on drone.
3. Program uses identified key points to determine the drones position in space.

- **Vicon Motion Capture**
  - System that tracks an object's movement using motion capture cameras and reflective markers.
- **ROS2**
  - Robotic Operating System 2 (ROS2)
  - Framework used for developing robotic applications.
- **Python**
  - High-level computer programming language.
  - Used to write coding commands.

Methodology

- **Establishing Communication with Tello**
  - Developed code using python to enable communication with the Tello drone.
  - Including keyboard controls, live stream, and publishing data.

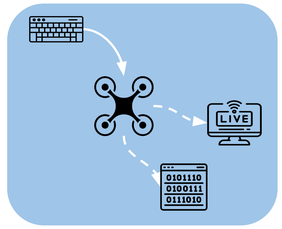

Fig. 2: Diagram illustrating communication with Tello (Freepik)

- **Vicon Object Creation**
  - Reflective markers were attached to the Tello, enabling vicon system to accurately capture the drones position..
  - This establishes the Tello's correct position in space as the ground truth, and will be what the program will aim to replicated.

Fig. 3: Tello drone with reflective Vicon markers attached

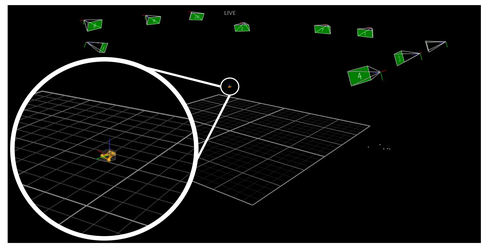

Fig. 4: Tello drone in Vicon system

- **Camera Calibration**
  - Properly calibrating the camera was necessary to ensure the images were accurately captured.
  - Parameters are applied to the camera matrix to convert 2D image coordinates into 3D coordinates in space.

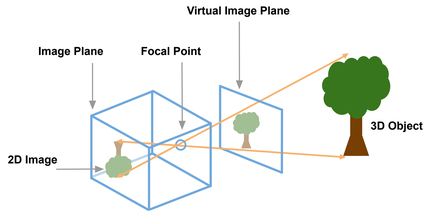

Fig. 5: Diagram depicting pinhole camera model (Mathworks)

- **Using ROS2 Pose Detection System with Tello**

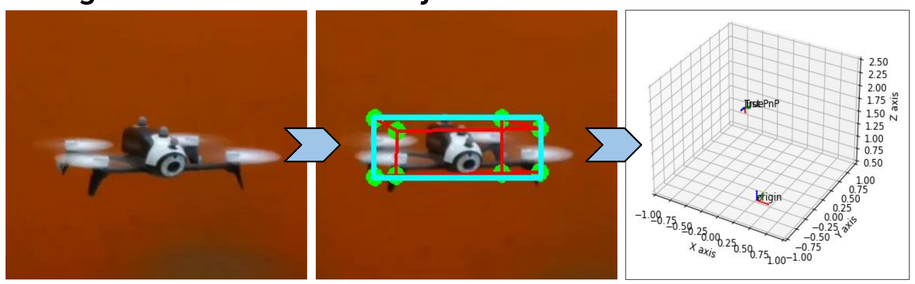

Fig. 6: Image capture → Identified key points → 3D plot of Tello in space along x, y, and z coordinates

Results and Conclusion

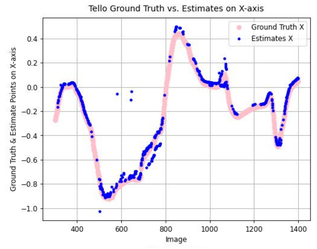

Fig. 8: Plot depicting ground truth vs.estimates

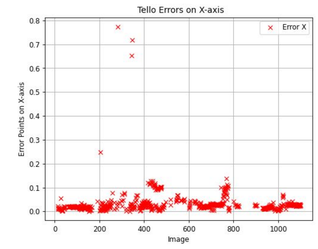

Fig. 9: Plot depicting errors made

		Tello Drone	Bebop Drone
Camera Latency		0.52 seconds	0.27 seconds
Estimates Made		56.8%	57.3%
Average Error	**X**	0.034 m	0.036 m
	Y	0.022 m	0.015 m
	Z	0.145 m	0.089 m

Fig. 10: Table contrasting the performance of Tello to Original drone

- **Conclusion**
  - Tello performs similarly to Bebop drone.
  - Drawbacks of the Tello include significant camera delay due to latency.
  - Data above supports that the Tello hardware can support and operate effectively within the pose detection system.
  - Future work may include developing tracking software and using the Tello to autonomously pursue another drone.

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Citations

- Damiafuentes. (2023). GitHub - damiafuentes/DJITelloPy: DJI Tello drone python interface using the official Tello SDK. Feel free to contribute! GitHub. https://github.com/damiafuentes/DJITelloPy
- Zhang, Z. (2000c). A flexible new technique for camera calibration. IEEE Transactions on Pattern Analysis and Machine Intelligence, 22(11), 1330–1334. https://doi.org/10.1109/34.888718
- [Fig: 5] What is camera calibration? - MATLAB & Simulink. (n.d.). https://www.mathworks.com/help/vision/ug/camera-calibration.html
- Screen Detailed Rounded Lineal color icon. (2017, October 6). Freepik. https://www.freepik.com/icon/screen_588239
- Drone Meticulous Yellow shadow icon. (2020, February 21). Freepik. https://www.freepik.com/icon/drone_2631480
- Box Generic outline icon. (2024, January 30). Freepik. https://www.freepik.com/icon/box_14454566#fromView=search&page=1&position=85&uuid=1c293072-65d8-40ce-a130-fe65d1b2fc57
- [Fig: 2] Drone Kosonicon Solid icon. (2020, February 3). Freepik. https://www.freepik.com/icon/drone_2541514#fromView=search&page=1&position=14&uuid=af8f20cb-37d5-4802-9e7f-9de7fd6a1713
- [Fig: 2] Keyboard Generic black outline icon. (2023, August 16). Freepik. https://www.freepik.com/icon/keyboard_11869518#fromView=search&page=1&position=2&uuid=e9a37259-a6d8-45a2-9386-119d9d5b7836
- [Fig: 2] Website codes Juicy Fish Outline icon. (2019, November 29). Freepik. https://www.freepik.com/icon/website-codes_2352268#fromView=search&page=4&position=56&uuid=650636e5-6ddd-480b-9c73-a3f785e8796b
- [Fig: 2] Monitor Generic Others icon. (2024, January 29). Freepik. https://www.freepik.com/icon/monitor_14438573#fromView=search&page=1&position=6&uuid=c337d74a-fae8-4a90-9ff7-872cb3e1a585