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Algorithmic Approaches for Object Tracking and Facial Detection Using Drones

Kareem Shahatta

Peter Savarese

Gina Egitto

Jongwook Kim

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Kareem Shahatta, Peter Savarese, and Gina Egitto
Advisor: Dr. Jongwook Kim
Department of Computer Science, West Chester University

Introduction

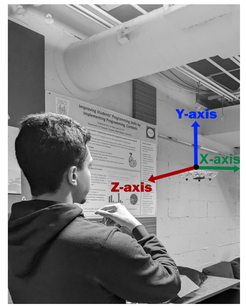
Drones are unmanned aerial vehicles, now with a low barrier of entry. Hence, we were inspired to use drones for research purposes. For our research we utilized a low-cost drone and implemented face detection, along with our own custom expandable algorithms, to have a drone follow a target by detecting the displacement of their faces and following them accordingly.

Tello Drone

A lightweight and programmable drone, manufactured by Ryze Technology, only costs $100. It can fly for 13 minutes covering a total distance of 100m. However, it has very limited sensory input including only a camera at 720p and a gyroscope sensor.
Tello's software development kit (SDK) supports popular programming languages like Java and Python. Altogether, Tello is a basic entry-level drone that is financially accessible, expandable and, suitable for research.

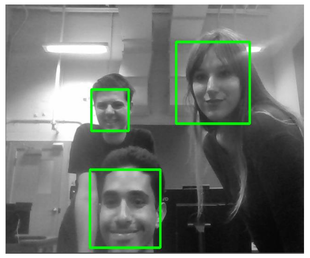
Priority Movement Algorithm

The first algorithm we developed was to overcome Tello's obstacle of rook-like movement. by determining which axis, it should move along first.



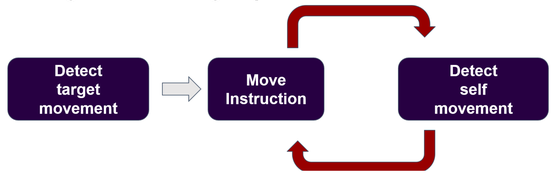
The axes are prioritized as follows:
1) Z-axis (forward and backward)
2) X-axis (left and right)
3) Y-axis (up and down)

The algorithm uses Tello's live stream video to locate the target using digital image processing. OpenCV's facial detection allows us to search for human faces, and once a face is detected we pin its location. Then the algorithm tracks how the face is moving around and instructs Tello to move along with the target. This is done by drawing a green square around the face to track its movement along the three axes over time.

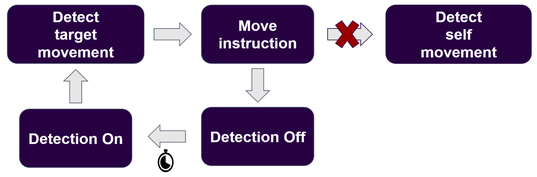


Artificial Velocity Algorithm

The second algorithm supports the Priority Movement Algorithm. With the first algorithm we can move on the Z-axis but struggle to move accordingly on the X-axis and Y-axis. This is due to Tello's inability to differentiate its own movement from the target's movement, causing Tello to fly away when the target move slightly.



The motivation behind this algorithm was to predict when Tello is moving. The algorithm calculates how much time Tello needs to reach the target from when it is instructed to move, by relying on Tello's current speed and calculated displacement to estimate when Tello will reach the target. Hence, this way we can control when Tello should and shouldn't be detecting for movement, eliminating the self movement detection issue.



Future Developments

Future developments could incorporate multi-facial recognition that enables users to label and select faces for tracking. Additionally, integrating yaw rotation could expand range and reduce collision rates in confined spaces. Another possible development may include adjusting our program to constantly center a face in the X and Y axis rather than follow displacement.

Conclusion

The culmination of classes offered by West Chester University's Computer Science Department inspired us to work with Tello. By utilizing Tello's software development kit, OpenCV face detection, and Python with our Priority and Artificial Algorithms, we successfully had Tello detect a target's face and follow them. With our research, we hope that the future developments we mentioned can be integrated, further advancing its functionality and applications in various fields.