Autonomous UAV Capstone

Status Presentation IV

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Mission Needs Statement

- To design a low cost, open architecture, and cooperative autonomous quadcopter.
  - USCG Missions
  - Supplement success of ScanEagle
- Key Performance Parameters:
  - Stable, autonomous flight
  - Transporting small payloads
  - Coordinate objectives with the ASV
  - Takeoff and landing from the ASV

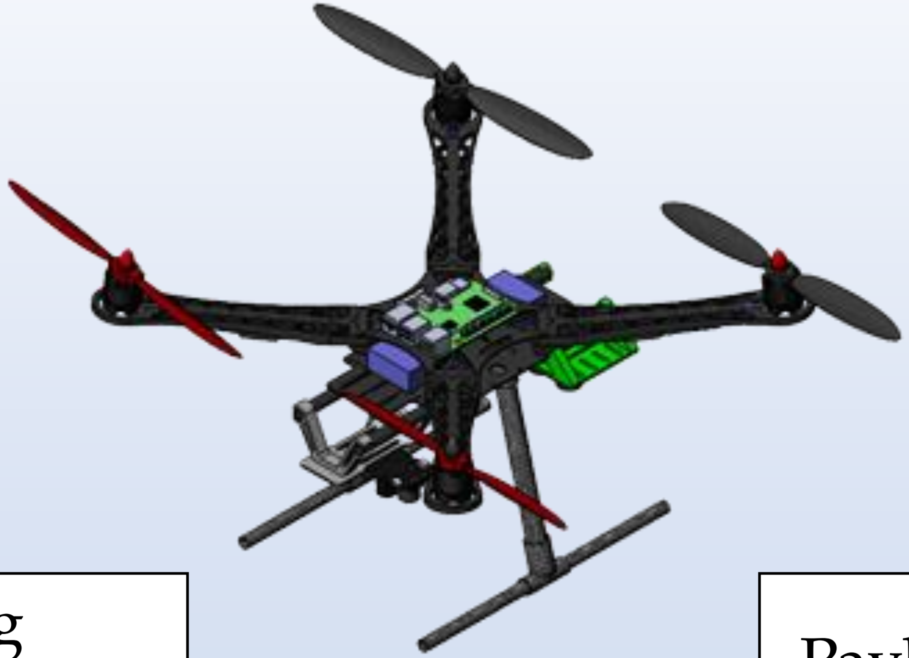
Major Developmental Systems

Communications

Computer Vision

Drone Control

GNSS w/ RTK

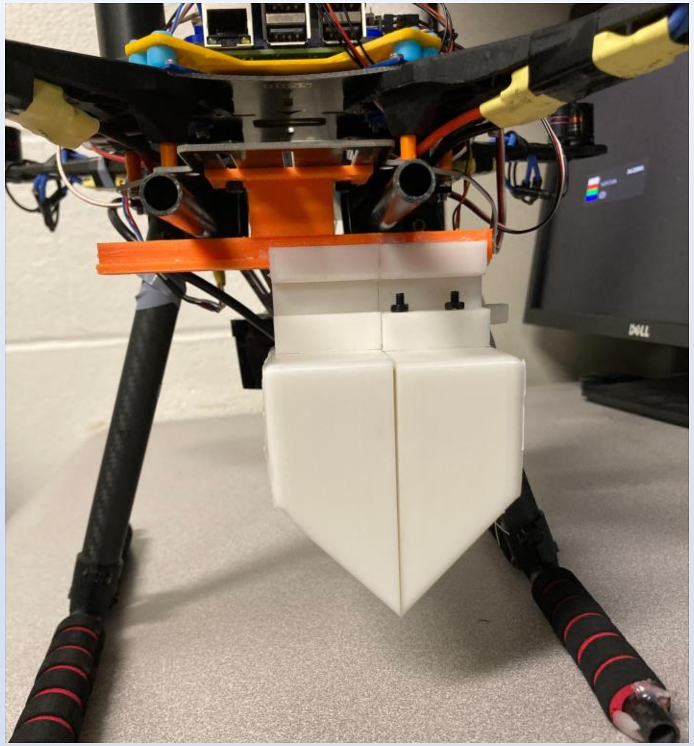


Landing Assembly

Payload Delivery

Platform Requirements

Requirement	Solution
Weigh less than 10 pounds (T), ideally 5 pounds (O).	Small Platform: 3.4 pounds.
Be capable of precision navigation, ideally 10cm (O).	Equipped with GPS-RTK, Lidar, and a camera.
Capable of transporting small objects.	Servo Actuated close/release scoop mechanism.
Positively buoyancy in water for 120 seconds (T), or indefinitely (O).	Foam outriggers underneath propellers. 5.1 lbs of buoyant force.
Safety guidelines: remote kill switch, not exceed 60 V DC.	Remote kill switch configured on RC transmitter. Utilizes an 11.1 V LiPo battery.
Total cost to reproduce less than $1,000 (O).	Current sum of components is approximately $900.



Pixhawk & PX4

- Connects the 6 major systems
- Pixhawk Flight Controller
  - Hardware
- PX4 Autopilot
  - Software
- Flight Modes
- Testing

Communications

- Digi DigiMesh®
  - Mesh Networking
    - Communication with ASV
    - RTCM Corrections

- Digi XBee 3 DigiMesh 2.4 RF Modules

Camera Selection

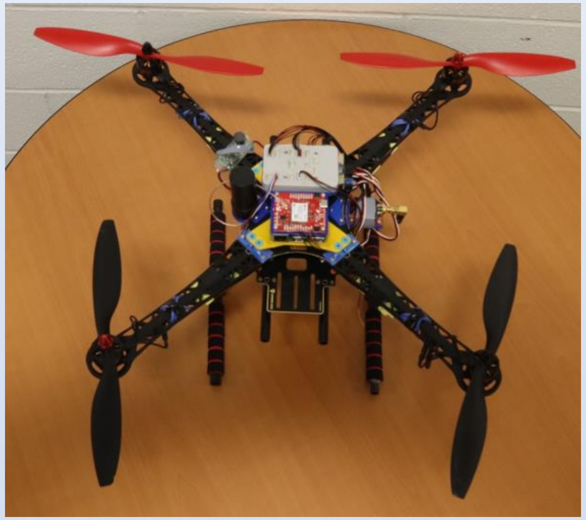
Raspberry Pi + PiCam	Oak 1 AI Camera + Raspberry Pi
Near 100% CPU utilization	0% RPi CPU Utilization
Bottlenecks processing	Integrated processing
Inefficient	Built for AI processing
Tested 480p @ 15 FPS	Capable of 4k @ 60 FPS

Satellite Navigation with RTK

- Improved accuracy for ASV
  - Control finely tuned

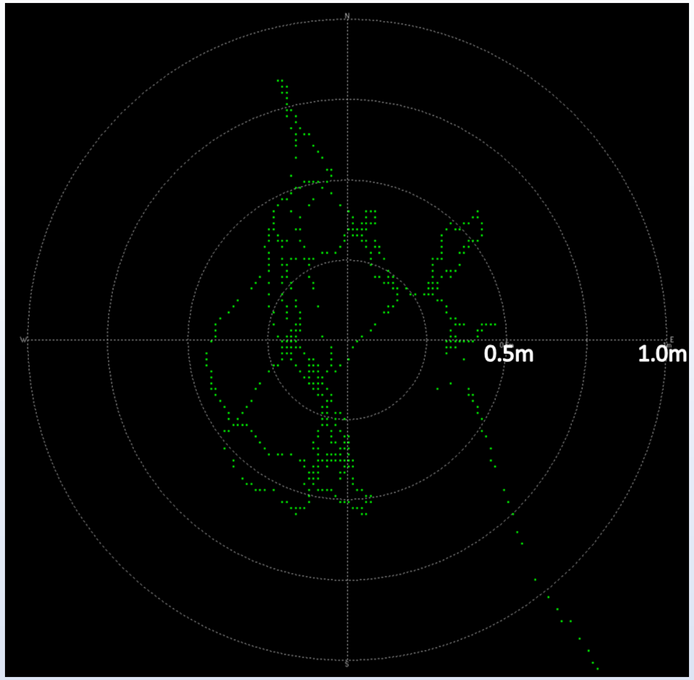
    movements
  - Not location,

    but accuracy on ASV

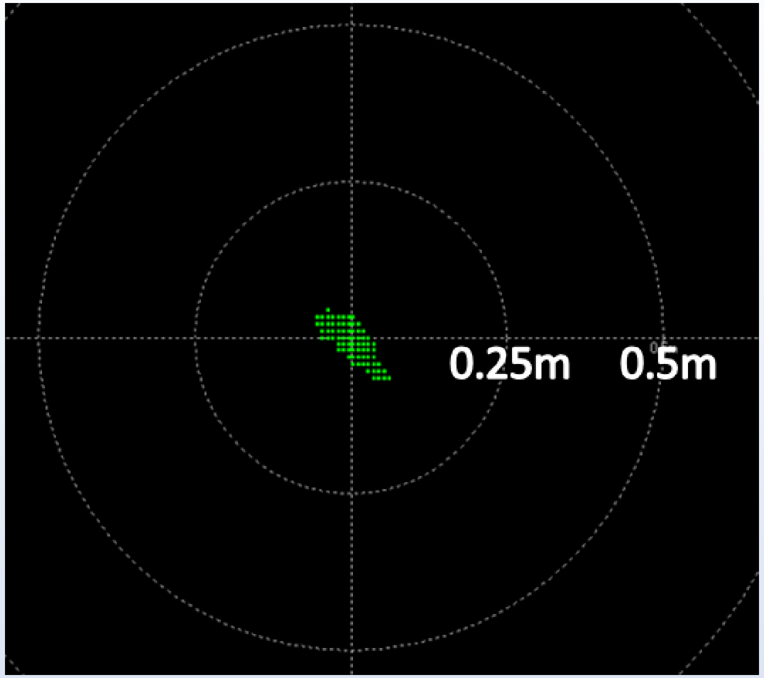


RTK Testing Development

- Test processes and risks
  - GPS: +/- 60 cm
  - RTK: +/- 6 cm
- Utilizing
  - QGroundControl
- Increasing reliability



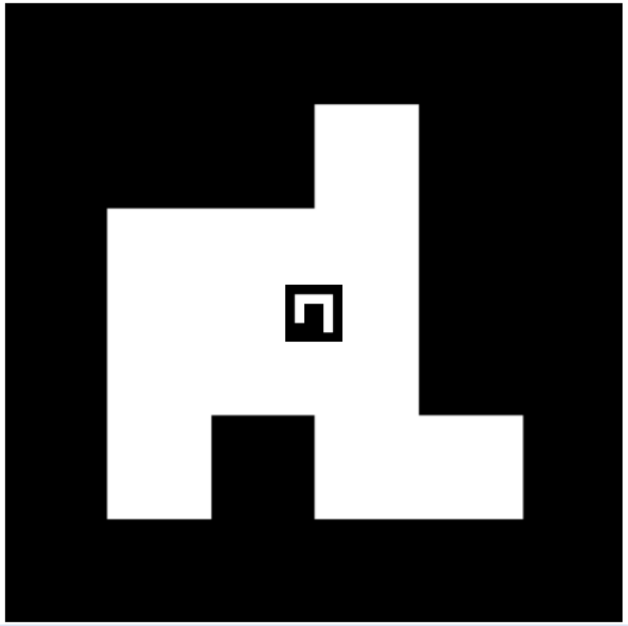
GPS: +/- 60 cm



RTK: +/- 6 cm

Dual AruCo Marker Landing Solution

- 30″ x 30″ plywood
- 2′ x 2′ Velcro AruCo Marker
  - Smaller 4″ x 4″ marker in center
- Common Base, Allowing for innovation in future
- Successful small-scale test
- 2′x2′ detectable at up to 150′
- 4″x4″ detectable at up to 13′
  - With pi cam - improvements expected with OAK



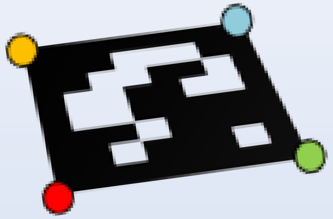
Computer Vision Based Landing

Searching

Marker Identified

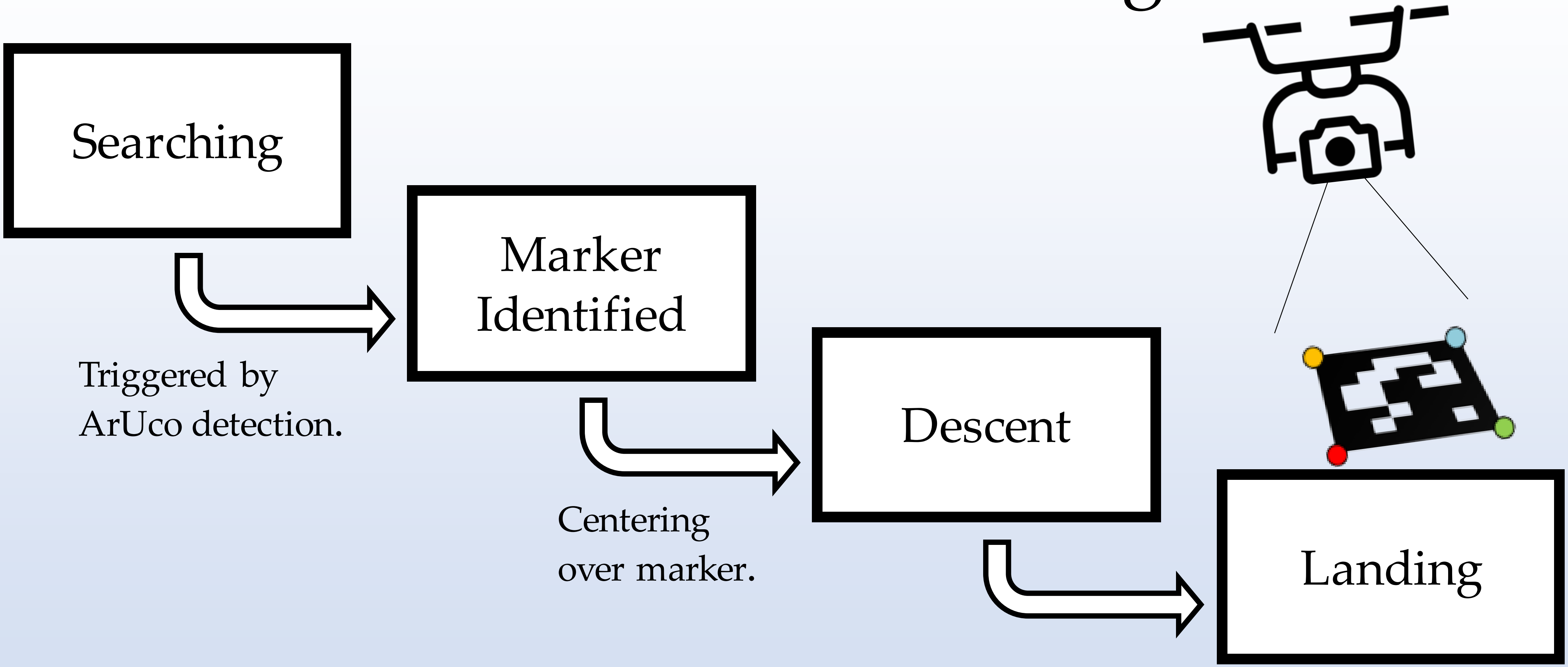
Triggered by ArUco detection.

Descent



Landing

Autonomous Search to Landing



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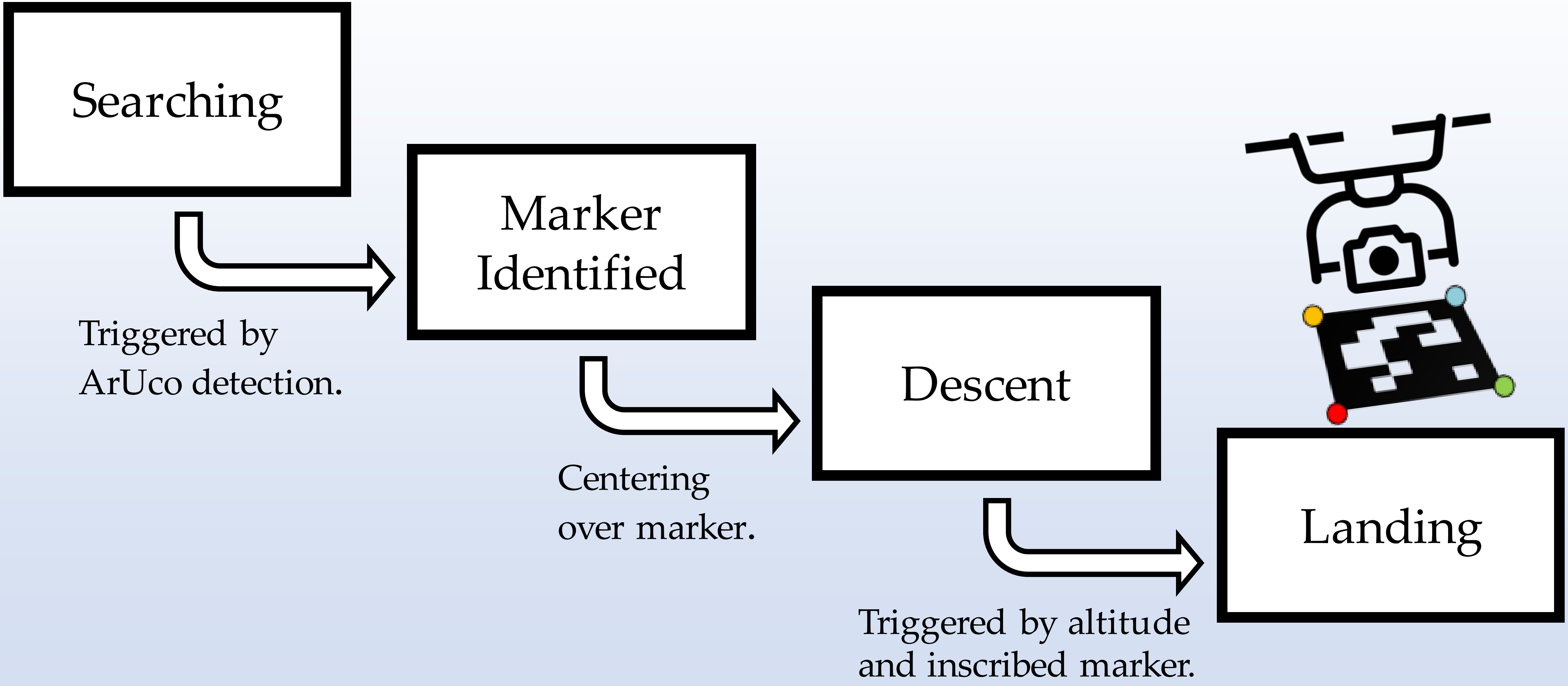
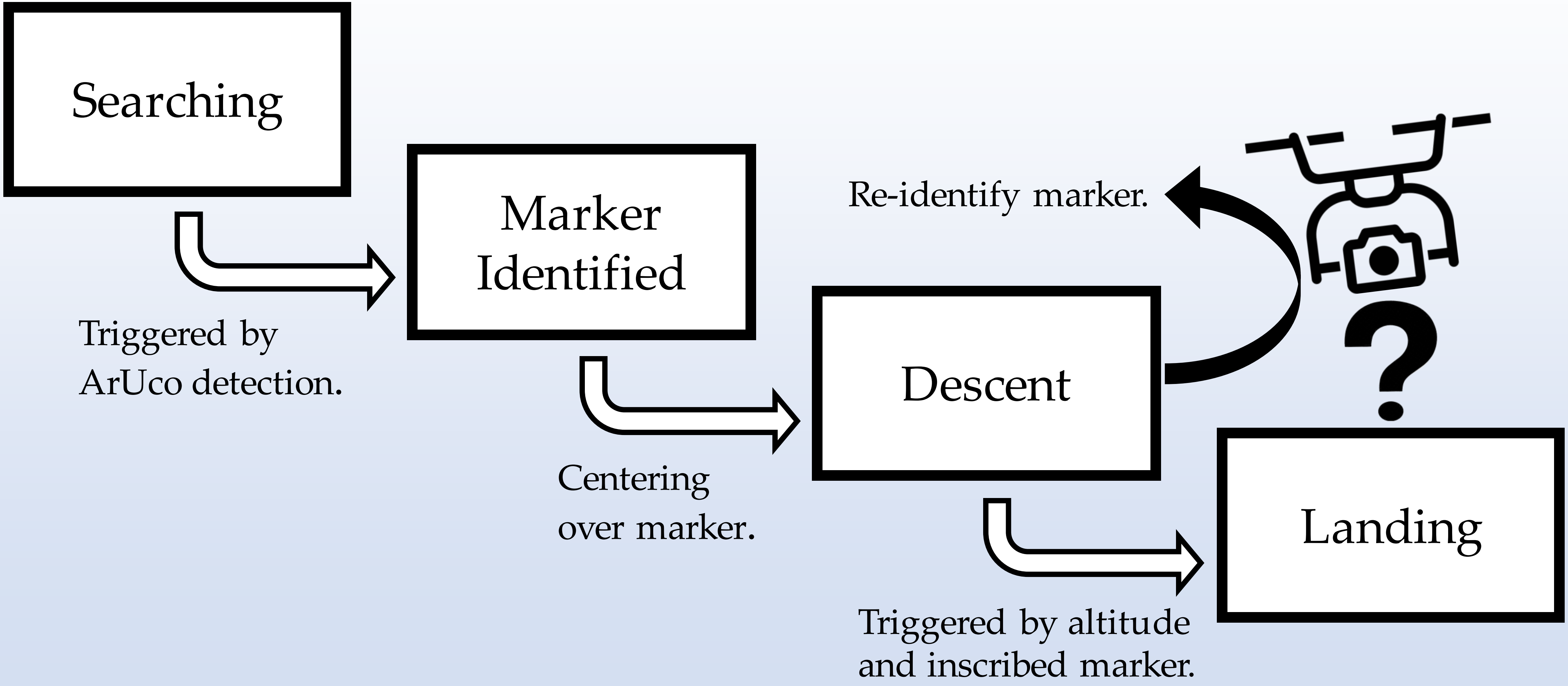


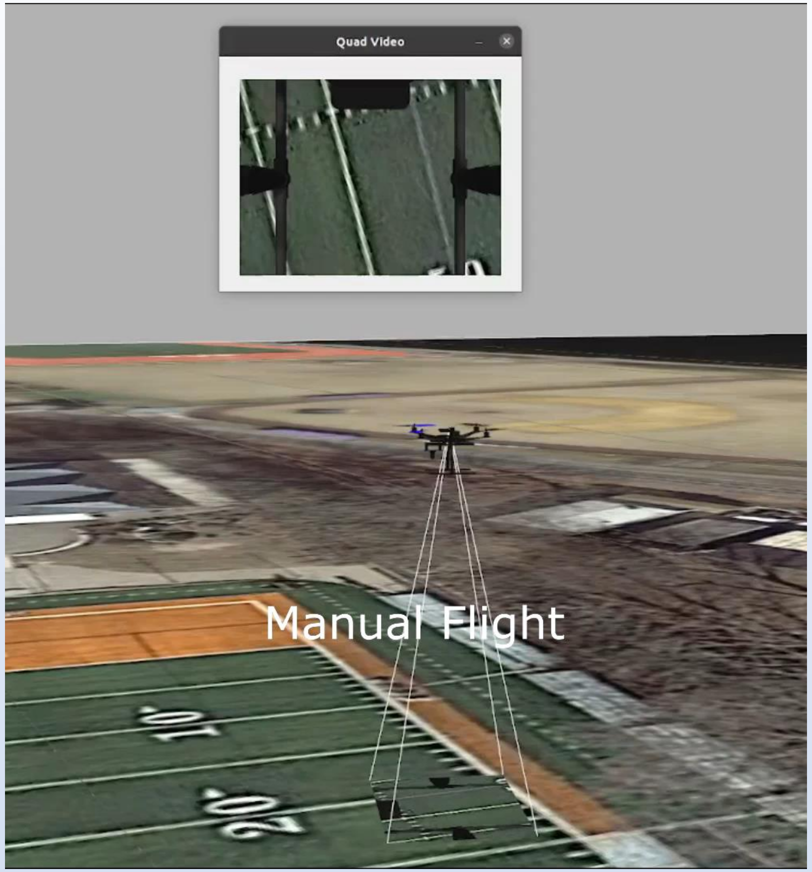
Autonomous Search to Landing



Computer Vision Based Landing

- Software in the Loop
  - Virtual world, virtual drone.
  - Identify states of the landing sequence.
  - Low risk, rapid testing.

- Hardware in the Loop
  - Virtual world, real drone.
  - Identify hardware limitations (RasPi Cam).
  - Low risk, time-consuming testing.



SITL Testing

Primary Risk: Real-World Flight Tests

- Computer vision-controlled flight tests pose the greatest risk to the drone, persons and property.
  - Uncontrolled flight due to false detection.

- Mitigation:
  - Extensive SITL/HITL testing: delayed real-world flights.
  - Additional safety shutdown mechanisms.
  - Incremental testing hierarchy, from static target to moving vessel.

Schedule of Events

- Upcoming Testing
  - Continuous Simulation Testing
  - 16 - 20 Feb: Dual Aruco Marker detection, Autonomous waypoint flight
  - 21 Feb – 04 Mar: Autonomous landing using dual AruCo marker

- Expected Completion Dates
  - February 21st: Demonstration of Autonomous waypoint flight with RTK
  - March 5th: Demonstration of Autonomous landing with dual AruCo marker
  - March 14th: Demonstration of computer vision payload delivery.
  - March 14th: Completion of Landing Platform
  - April 11th: Demonstration of successful search, payload delivery, landing. From start to finish

Questions?

Budget

Major Costs:

- S500 Frame: $59
- Motors: $100
- Raspberry Pi 3B+: $55
- Pixhawk 2.4.8: $75
- RTK: $350
- Oak I Camera: $180

Approximate Drone Cost: $900

Future Costs:

- No anticipated additions to drone
- Maintenance costs

The RoboBoat Competition

- RoboBoat is an international competition where an autonomous surface vessel performs navigating and docking tasks.
- Each ASV is allowed to cooperate with a UAV.
- Our role as the UAV:
  - Takeoff from and land on the ASV.
  - Locate and deliver a payload.
  - Fly desired search patterns.
  - Communicate findings with the ASV.