Remote Tandem Robots (RETRO)

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Research Experiences for Undergraduates
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REU Site: Smart and Autonomous Systems

Motivation and Project Goal

- Mitigate human risk in operations involving human danger such as search and rescue procedures during disasters
- Reconnaissance and real time data collection
- In Cloud Robotics, communication challenges can obstruct the coordination between remote robots. This is detrimental for applications reliant on real time critical data
- **RETRO is a proof of concept for a reliable cloud robotic system that blends individual robotic capabilities and coordination via communication for a shared cause**

Fig 1a. (Left) The aftermath of a Nepalese earthquake in 2015

Fig 1b. (Right) Firefighting Robot taking on a building fire

Overview

- The RETRO project implementation has three verticals:

Cloud Communication	Sensory Data Management	Mission Coordination
○ Manage connections and data from each robot ○ Control mission state ○ Deploy UI	○ Configure the sensory equipment for data collection and processing ○ Algorithm for navigation	○ Task design and coordination with navigation ○ Actuation with motor control

Fig 2. The responsibilities of each project component

Devices And Components

- NVIDIA Waveshare JetBot AI kit comprising of a Jetson Nano 2GB (with an Ubuntu distribution), 2 DC motors, a camera module and a PiOLED display
- A central cloud server running Linux to handle decision making and instructions

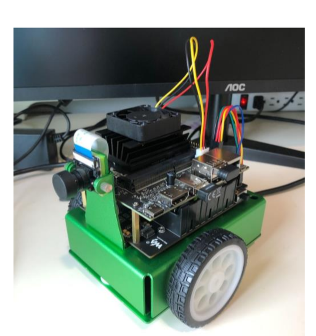

Fig 3. The assembled Waveshare JetBot

Object Detection

- The JetBot is connected to 8MP image sensor with a resolution of 1280x720 pixels and 160° FOV
  - Each JetBot uses the SSD mobilenet-v2 model for object detection and identification of targets. Aruco markers used to identify grid perimeter.

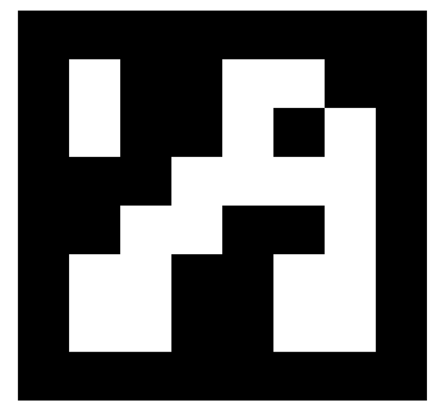

Fig 4. The CV2 Aruco Markers used to create the boundaries for each 6ft x 6ft mission grid

Fig 5. The object recognition model identifying a person and CV2 identifying an Aruco marker during the mission

Mission Plan

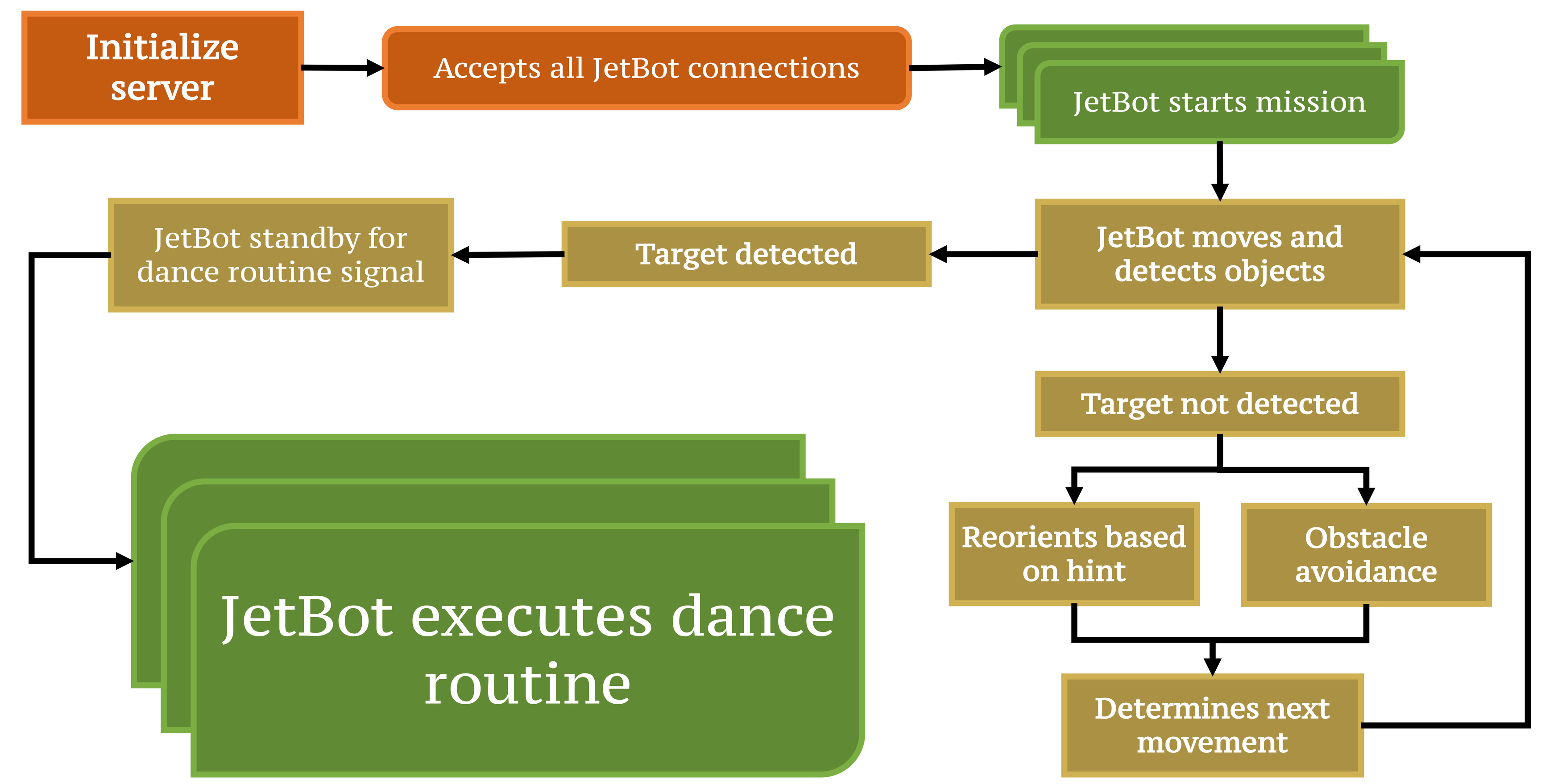

Fig 6. Synchronized mission plan

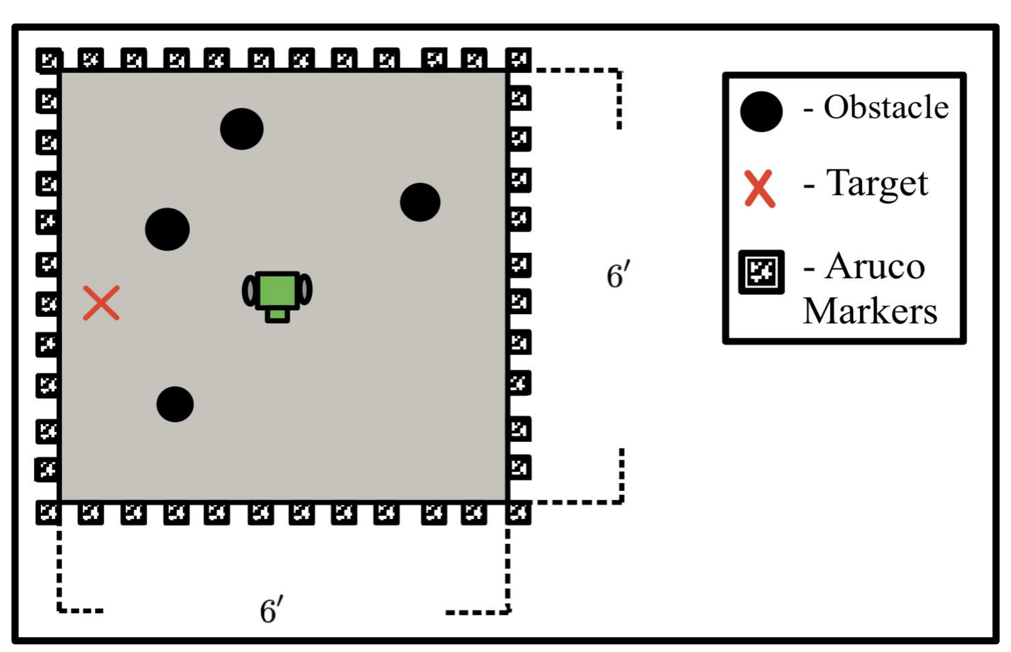

Fig 7. Mission layout

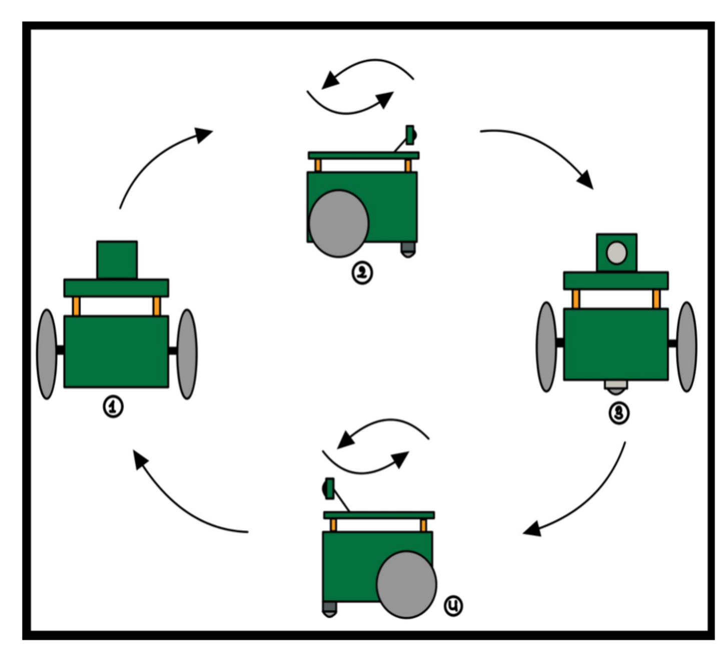

Fig 8. Dance routine

System Architecture

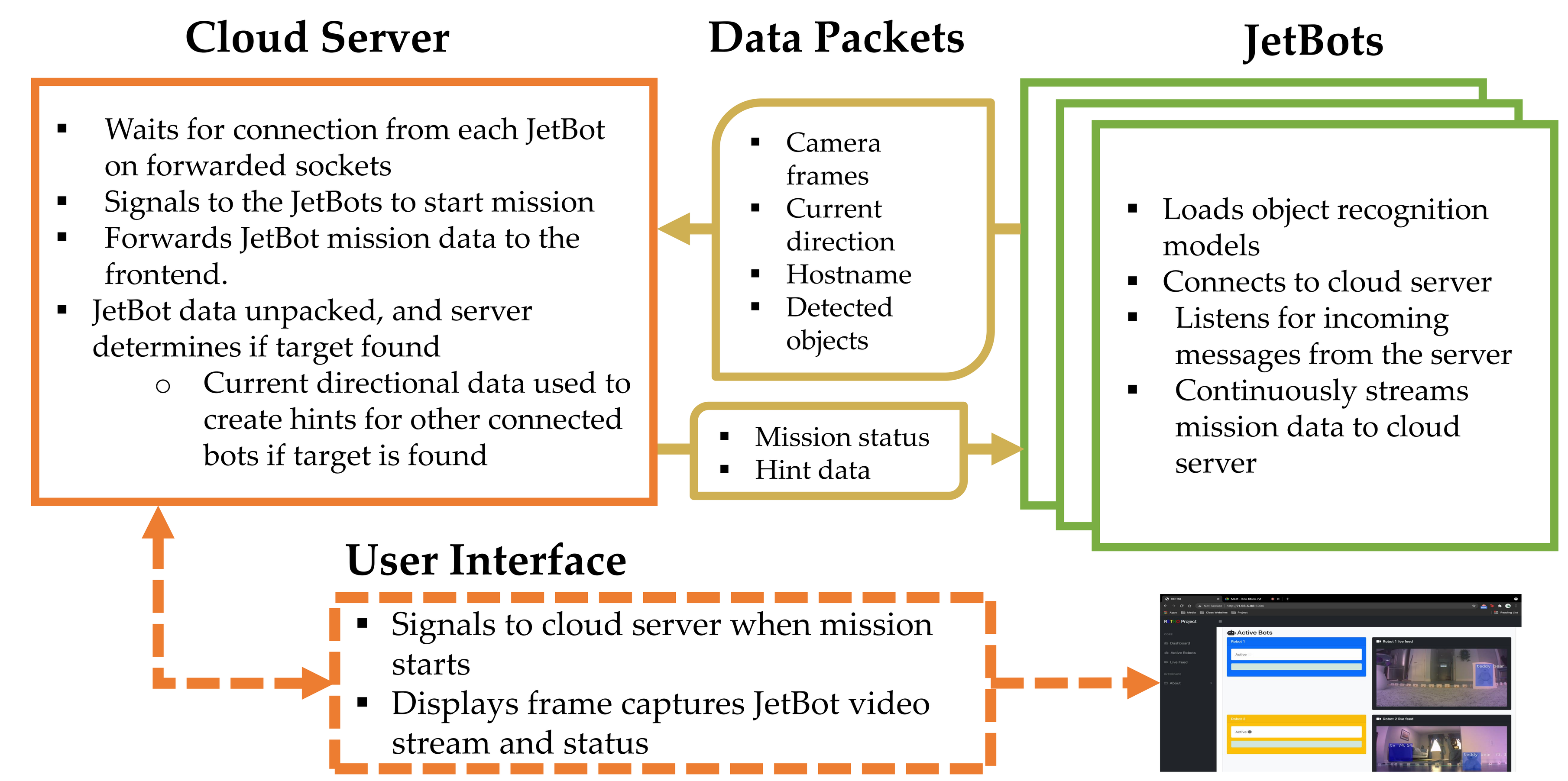

Fig 9. The full layout of the JetBot and cloud server data exchange during the mission including the deployment of the user interface

Results And Future Scope

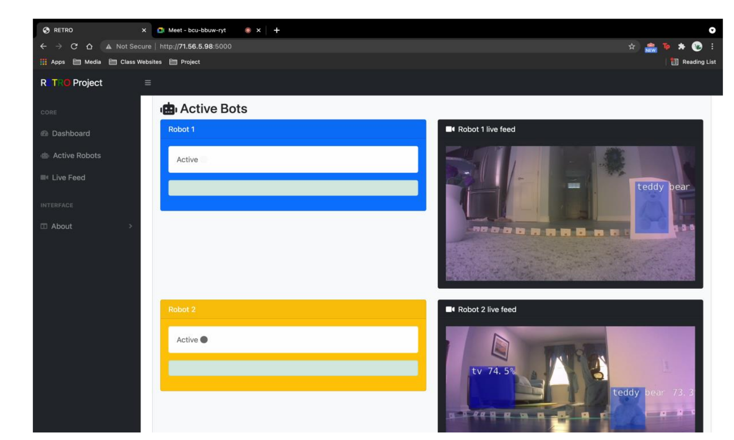

Fig 10. The RETRO Project User Interface with simultaneous JetBot video streams

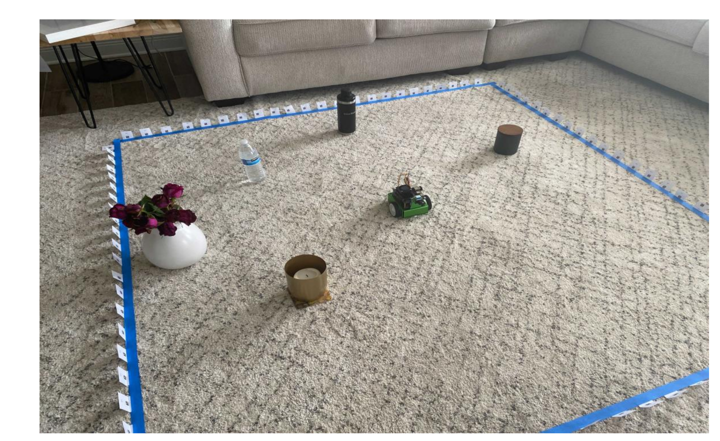

Fig 11. A JetBot carrying out the mission plan in its respective grid

	Trial 1 & 2	Trial 3	Trial 4	Trial 5	Trial 6
Mission Completed	✓	✗	✗	✓	✓
Mission Observations	○ Incorrect hint data ○ Jetbot-2 searched wrong direction	○ JetBot-2 confused by simultaneous reactions to perimeter, object and hint	○ Carpet friction causing inaccurate angle calculation ○ Recalibrated JetBot movement speed for carpet	○ Rearranged mission grid and obstacles to increase difficulty	○ Accurate hint data ○ Mission speed may be due to proximity to target
Mission Time	~3:00-4:00	N/A	N/A	~6:00	~1:30

- **Future scope:**
  - Improvement in the local navigation algorithm using sensors
  - Improve scalability of the server logic to handle multiple robots (intra and inter network)