

Integrating Multi-Modal Interfaces to Command UAVs

[Video Abstract]

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ABSTRACT

We present an integrated human-robot interaction system that enables a user to select and command a team of two Unmanned Aerial Vehicles (UAV) using voice, touch, face engagement and hand gestures. This system integrates multiple human [multi]-robot interaction interfaces as well as a navigation and mapping algorithm in a coherent semi-realistic scenario. The task of the UAVs is to explore and map a simulated Mars environment.

To initiate a mission, the user needs to select a robot. To do this, We used the “Touch-To-Name” selection and naming interface [3]. In this method, the user first announces the desired number of robot(s) (e.g. “You” or “You Two”), then gently moves intended robot(s) iteratively. Robots compare their accelerometer readings over Wi-Fi to agree on which one is selected.

Once selected, the user names the selected robot using verbal commands (e.g. “You are Green”). These names are then used to command the robots (e.g. “Green Takeoff”) [4]. Here, we use this interface with maximum group size set to one.

After taking off and while hovering, robot looks for human faces in its camera feed. When user’s face is detected, the robot continuously controls its altitude and heading direction to face the user. A hand wave gesture (left or right) assigns an exploration task to the robot in the indicated direction. We used the method described in [2] for face tracking and gesture recognition.

While exploring, each robot performs vision-based Simultaneous Localization and Mapping (SLAM) using their on-board monocular camera [1]. We used the “Feature-rich path planning algorithm” introduced in [5] to robustly navigate a UAV while exploring an unknown environment. To terminate the mission, the user commands each robot to *come back* home (e.g. “Green come back”). To come back, robots use the same algorithm to plan a *feature-rich* path to their takeoff position. Finally, The user asks robots to *land*. (e.g. “Green land”).

The system provides two types of feedback to the user during interaction sessions and mission execution. Robots change the color and blinking pattern of their LED lights to inform the user about their state (e.g. “tracking user’s face”, “exploring” or “being idle”). In addition, a text-to-speech (TTS) engine provides verbal feedback to the user whenever a robot’s state changes. As an example, when the *Green* robot is asked by the user to comeback, it acknowledges by saying “*Green is coming back*”. The TTS is embedded within a general purpose web-based robot monitoring dashboard.

We used Parrot AR-Drone 2.0 quadcopter as UAV platform in our system. All described software components run off-board on two commodity *Intel Core i7* notebooks (one dedicated to each robot). The computers are connected to UAVs via Wi-Fi connection.

The video shows a complete run-through of a two robot exploration mission in which the HRI worked perfectly.

Categories and Subject Descriptors

H.5.2 [User Interfaces and Presentation]: Robotics, Human Multi-Robot Interfaces, Interaction styles

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