Smart Control of 2-DOF Helicopter

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1 Project Description

Helicopters are of a paramount importance as they are used in many civilian and military applications due to their ability for vertical take-off and landing. To enable their use in such applications, intensive research has been conducted in the literature to date since helicopters involve complex nonlinear dynamics. Most of the work on helicopter-based research requires dedicated computers for controlling their motion to specific configurations and resistant to turbulent conditions. Such methods are expensive and time-consuming to develop. Implementation of motion control techniques using cost-effective hardware is still a challenge.

In this project, we are proposing an algorithm for smart control of a team of two degree-of-freedom (2-DOF) helicopters using conventional motion control in cooperation with machine learning techniques where a user will be able to configure helicopters from any initial position. Even though conventional techniques have been tested with simple platforms in the literature, the current project employs conventional motion control strategies in cooperation with machine learning technique (reinforcement learning, for instance) for a team of helicopters as well as introducing user control via mobile devices. This project is expected to encourage research in this area as well as serve as an educational tool in teaching environments.

2 System Architecture

Figure 1 shows the high-level system architecture of the proposed project for control of a team of helicopters. As shown, mobile devices will serve as terminals for users to communicate with the helicopters. Mobile devices can be used in a wider variety of locations over stationary and is desired by more people. Information sent by the users will be transmitted through a wireless TCP/IP network. Their inputs will interface with our proposed smart control algorithm and change the configuration of the helicopters. In particular, we will be applying Linear Quadratic Regression (LQR), Linear Quadratic Gaussian (LQG), and a machine learning based algorithm for the control of these helicopters, Approximate Dynamic Programming (ADP).

Each of the helicopters used will have fixed bases as shown in Figure 2 (courtesy of Quanser Inc.).

The tail of the helicopter has a motor that controls its yaw motion. Similarly, the main rotor changes the pitch of the helicopter. The directions in which the motors spin will be

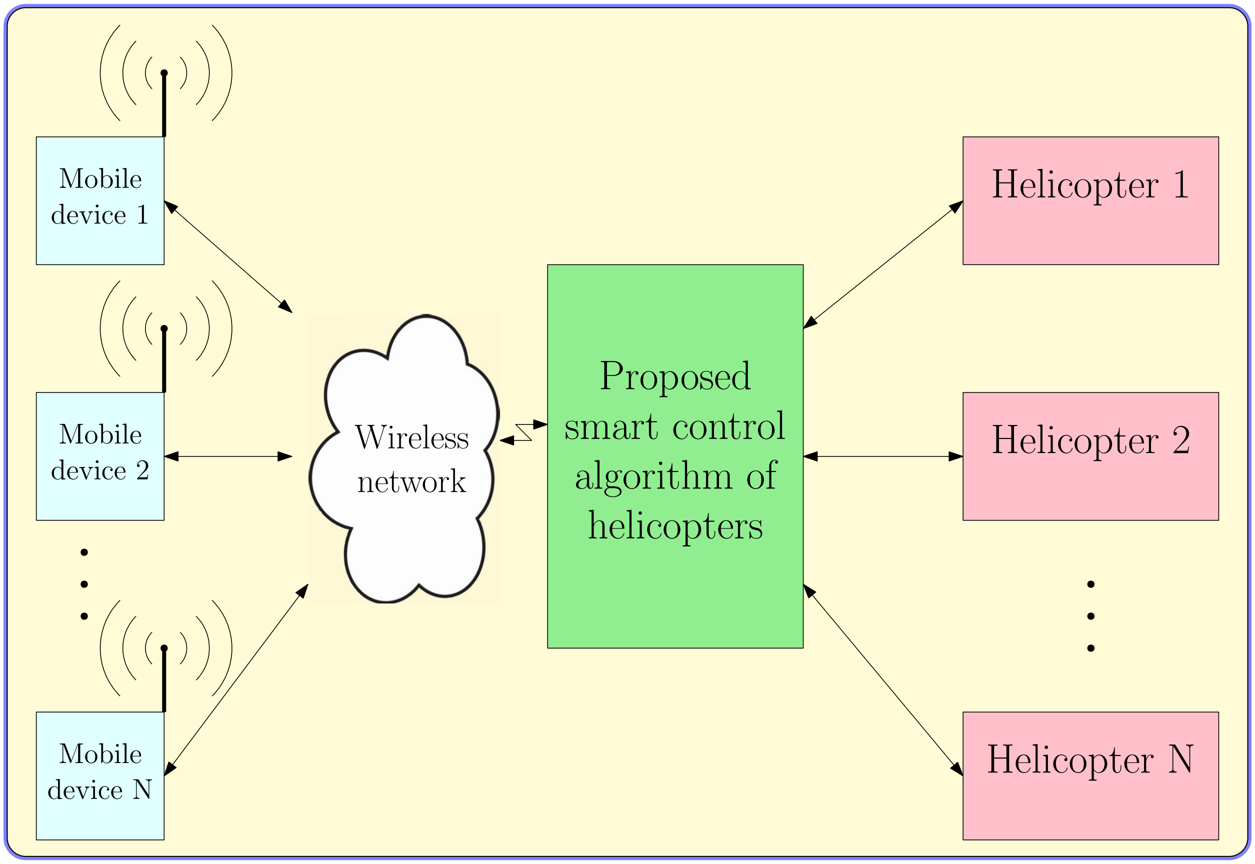

Figure 1: General High-Level System Architecture

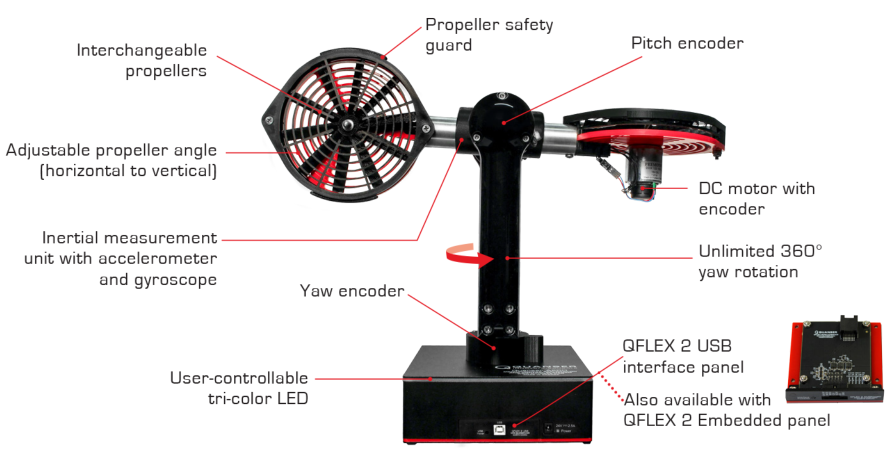

Figure 2: Quanser Aero 2-DOF Helicopter
(`https://www.quanser.com/products/quanser-aero/`)

determined by the polarity of the applied voltages. This will be regulated by our smart control algorithm.

3 Modes of Operations

We plan on allowing the user to control the helicopter using three modes of operation. A short description of each mode is given below.

Mode #1: Allows the user to control the helicopters to a given configuration. For example, setting the pitch to 45 degrees and the yaw to 90 degrees will move the helicopter that much from the initial configuration.

Mode #2: Allows the user to choose a time varying input signal, so the helicopter will have a wave-like motion shifting from one configuration to another. Examples include sine and square waves.

Mode #3: Allows the user to control the algorithm that the user wishes to apply. They will be able to choose from LQR, LQG, or ADP.