DJI 매빅에이어를 위한 드론 손 제스처 제어 시스템

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Drone Hand Gesture Control System for DJI Mavic Air

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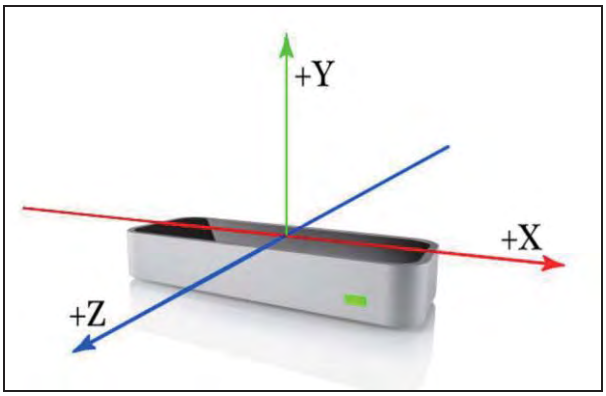
Abstract

This is a study on controlling a drone (DJI Mavic Air) with simple hand gesture using Leap Motion controller. Four component involve are MacBook, Leap Motion controller, Android device, and DJI Mavic Air. All of this component are connected through USB, Bluetooth, and Wi-Fi technology. The studies main purpose are to show that by controlling a drone through Leap Motion, drone amateur user can easily learn how to control a drone, and because of longer drone control range can be archived things such as search and rescue mission will be possible.

1. Introduction

Gesture are always a big part in human lifestyle. We do gesture every day such as thumbs up, a no sign, head nodding or even cursing at each other. All of the gesture have their own definition. Furthermore, we can agree that a handicap person benefit more from the use of gesture in everyday life because of their inability compare to normal person, but not to forget for the case if a person is far from each other yet still visible by eyesight, we also can use gesture to wave 'hello!' or 'goodbye'. Not only the gesture matter, the reaction that needs to follow afterwards also must be taken into action.

This project uses Leap Motion controller, a hand gesture recognition device which implement a 3D virtual coordinate system as Figure 1 stated.



(Figure 1) Leap Motion right-handed coordinate system

By using this coordinate system we can implement any algorithm to recognize certain gesture, and do something afterwards.

Relative to our study, we created a system that contains algorithm so that some gesture will be related to certain definition, therefore will be interpreted into certain action. Gesture defined are hand movement that relate to basic drone movement such as pitch, roll and yaw while the action will be the drone movement itself.

DJI Mavic Air already has a functionality for gesture control but there are certain disadvantages which can be found. The main disadvantages that is crucial is in order to control the drone ones must stand in front of the drone's front camera. This limits the range of controlling drone by gesture, which is not good for some cases such as search and rescue mission. Let us point to recent case at Korean peninsula. The world knows that they had fought tremendously, and certainly if both of them agreed on a peace deals, they might want to demolish all the landmine surrounding the border of both country. This can safely be done using drone which has the capability to be controlled on a wider range. Take DJI Mavic Air remote controller for example, it can only cover up to 4000m of range [1], thus decreasing the reliability of the control system. So, a better system is needed to ensure drone control are simple, reliable, safe and secure.

The development was done by using Leap Motion SDK and DJI Mobile SDK.

2. Related work

2.1 Motion recognition for drone control system [2]

The control of the drone is made up of pitch, roll, yaw and throttle, and is divided into methods of controlling the direction and movement of the drones. When a command "move_forward" is sent to a drone, it moves based on the point of the drone rather than the point of the user. This may cause a sense of divergence due to the difference in gaze and may cause inconvenience to the user. Therefore, in this paper, to solve this problem, it is necessary to match the direction of the drone with simpler system design such as hand gesture movements.

2.2 Web-based interactive drone control using hand gesture [3]

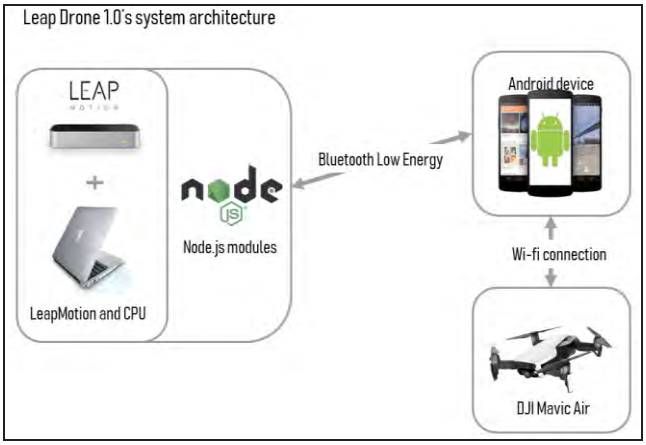
To learn on how to operate a conventional controller, you first need to know which buttons are present, what

roles these buttons play, and use them to control the drone. This will be very difficult for beginners, and those who want to get a drone license will also have to spend a lot of effort and time. Therefore, in this paper, they propose a method to control the drone by using gestures. The implemented method is the development of a web based NUI (Natural User Interface) system. The user can communicate with the drone through the NUI. This communication is implemented using Wi-Fi technology. Also, Leap Motion recognizes a gesture taken by a person, uploads it to a server, and the server sends a command to the drones respective to user's gesture. Direction and speed of drone are determined by the direction and speed of hand gesture going through the Leap Motion controller. Therefore, the user can perform the operation of the drone with much simpler hand gestures.

3. Proposed system

3.1 System configuration

Basically, there are four component for the system architecture which are the computer (MacBook pro), Leap Motion controller, Android device, and the drone (DJI Mavic Air) as stated on Figure 2.



(Figure 2) System Architecture

The environment involved for development are android studio, visual studio code, node.js, and also mac OS. Because of Leap Motion do not provide android SDK, we used node.js BLE (Bluetooth Low Energy) module to send stream of data to android device. On the other hand, because DJI Mavic Air yet to provide window/mac OS SDK, we used Android BLE API to read data from MacBook through BLE.

CPU and Leap Motion interfaced using USB while the CPU interface with Android device using BLE, and finally the android device interface with the drone using Wi-Fi connection or maybe 4G connection in future development.

3.2 System implementation

The implementation of the system varies between each component. The scenario will be started from a user's hand gesture. Hand gesture of a user will be the input of Leap Motion controller using its state of the art optical sensor. Then the Leap Motion will interface with the computer (MacBook Pro) by sending the raw data via USB. This will happen each frame depends on user configuration of the Leap Motion device. The computer then run module provided by Leap Motion SDK (with respective to current environment) changes all the raw data into a virtual coordinate system consisting of x, y, and z-axis. This virtual coordinate system will be implemented to match with drone control movements resulting in implementation of certain functions. Function can varies between controlling the drone direction, speed, and also some utilities (battery status, GPS, camera and gimbal position, etc.).

All of this will be integrated to become one component, and will be interface with Android device using both node.js and android API BLE module. While data (string of command such as "move_foward") are being stream from peripheral side (Leap Motion and CPU) using BLE, the central side which is the Android device will get the command string and interpret it before determining which function to call in order to control the drone.

Finally, the interface of drone and Android device are implemented through Wi-Fi connection. Because one the purpose of this study is to widen the range of drone connectivity, a 4G connection will be implemented for further development.

4. Conclusion and future work

As the study purpose are creating a system that use simple hand gesture and making complicated drone control easier, further implementation will be to increase the flexibility by letting user configure the hand gesture suiting to their personal taste. This makes it easier for amateur drone lover to avoid complexity of typical remote controller stick operations. In addition, it will be able to provide a more convenient operation environment for users whom is handicapped person. The system also can be used for un-ordinary drone mission such as search and rescue which needed wider drone control range.

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