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Ground Station Framework Design for Multiple UAVs with Embedded Devices

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Abstract. To archive diverse kinds of goal, multiple unmanned aerial vehicles (UAVs) need to cooperate each other. Therefore, the importance of a ground station becomes more important. This paper proposes a framework of the ground station that controls multiple and hetero UAVs. The framework contains multiple UAV control modules and UI interfaces and has the flexibility for adding diverse kinds of UAVs and embedded devices such as commercial UAVs, Arduino-based UAVs, cameras and storage devices.

Keywords: UAV, Ground station, UAV Controller, Drone

1 Introduction

As the importance of ground stations for controlling unmanned aerial vehicles (UAVs) has recently been highlighted, studies aimed at proposing various ground station structures to archive multiple goals are being conducted [1-4]. In particular, a structure of the ground station for simultaneously controlling multiple and hetero types of UAVs has been conducted [5].

To enable the widespread use of ground stations, the following functions are required. First, a system capable of controlling various embedded devices on a UAV is necessary. In order to enhance the usability of a UAV, a system capable of controlling not only the UAV itself but also the devices embedded in the UAV, such as the camera, gimbal, and infrared sensor, is necessary. Second, a system that can simultaneously control a number of UAVs and embedded devices by integrating them is necessary. Generally, in the existing ground stations, only a single UAV is usually controlled or an embedded device installed on the UAV is individually controlled. However, it is necessary to control various types of UAVs or embedded devices installed on different UAVs simultaneously. For example, a function of controlling the cameras installed on a number of UAVs is required to record simultaneously. Third, a ground station structure that can easily incorporate and control the embedded devices included in a UAV is necessary. Given that the embedded devices included in a UAV are diverse and vary according to the UAV, a flexible system structure is

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desired. Fourth, a system through which a UAV can use the ground station is necessary. The focus of the existing ground station is on the function of controlling the UAV. However, in order for the UAV to achieve various goals, it is necessary to use the embedded and attached devices installed on the ground station. Furthermore, in order to reduce the system load of the UAV, functions such as remotely processing the data instead of the UAV in the ground station and receiving the result are necessary.

In this paper, the framework of a ground station that can integrate and simultaneously control various types of UAVs and various embedded devices installed on the UAV. The framework exists in a flexible system structure, and diverse embedded devices can be incorporated and controlled in the future.

2 An Integrated Control System for Multiple UAVs and Devices

An integrated control technique is required to control various types of UAVs and embedded devices simultaneously. In the proposed system, a *Channel* is a unit for integrated control and a *Scene* is a unit for connecting the software modules and embedded devices that are to be executed. Only one Channel can be selected and operated at a time, and after a single Channel is operated, the software modules and embedded devices of the Scene registered in the relevant Channel are executed.

The proposed ground station is operated as shown in Fig. 1. Given that all instances of the classes in Fig. 1 are created and the user interface (UI) to start *GSChannels*, a Channel class, is provided by the *ChannelController*, users selects the GSChannel to be controlled. In the *GSChannelManager*, in which GSChannels are managed, the selected GSChannel is retrieved, and the registered Scenes in the selected Channel are operated. Given that one *GSDirectoryScene* and one *GSCameraScene* are registered, an relevant camera is controlled through the *GSEventManager* by the GSDirectoryScene and GSCameraScene.

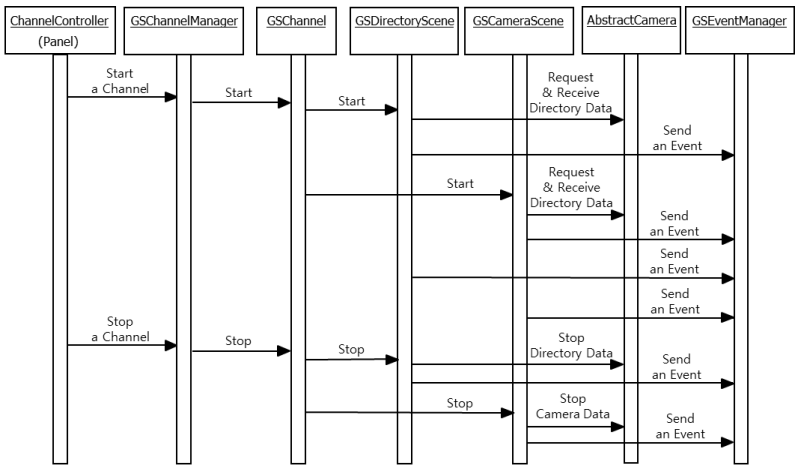

Fig. 1. Integrated control sequence diagram

The proposed ground station manages related UIs by binding them and defining as *Panel* and also provides the *GSIFrame*, *GSFrameManager*, and *GSSystemFrame* in order to manage various panels hierarchically. Based on these classes, the GSEventManager operates as shown in Fig. 2. The GSEventManager sends the event to each GSSystemFrame through all registered GSIFrames. In case the sent event should be processed by the received GSSystemFrame, the GSSystemFrame sends the received event to the GSPage included in it. Eventually, the GSPage delivers the event to the SceneView, which outputs the delivered event data.

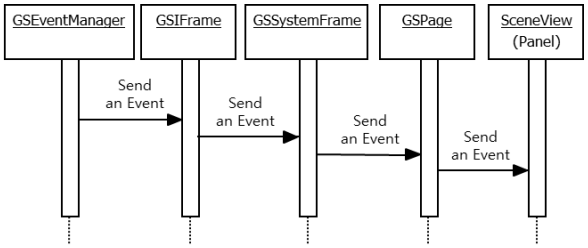

Fig. 2. Event sequence diagram

The proposed ground station is divided into *GroundStation* module and *Extension* module, as shown in Fig. 3. The GroundStation module defines the essential function for controlling the UAVs, ground stations, and etc. First, the *GSCore* includes the function of managing the UAV and its devices as well as the function of processing the events. For example, the *GSEvent* defines the structure of the event used in the ground station. The UAVs and computers are managed through the *GSISystem, which provides GSIUAV and GSIComputer*. The *GSISubSystem* manages the camera devices and storing devices and can incorporate various embedded devices in the future. The *GSComponent* provides a frame for providing a user interface in the ground station. The *GSMedia* includes functions for the integrated control of the UAVs and its devices. The *GSFramework* provides the main framework of a ground station.

The extension module is divided into *Hardware* and *Software*. Hardware includes functions that manage the UAVs and Computer-related information as well as Panels. Software includes UI Panels for controlling the software modules. In particular, the *GSMedia* in Software defines the UI for controlling the functions of GSMedia in the GroundStation module. For example, the ChannelController, one of GSMedia Panels, is a panel that controls a number of Channels. The *StorageController* controls the storage space in use, and the *StorageManager* registers or removes the storage space to be used. The *SceneView* is a panel that shows the selected Scene data.

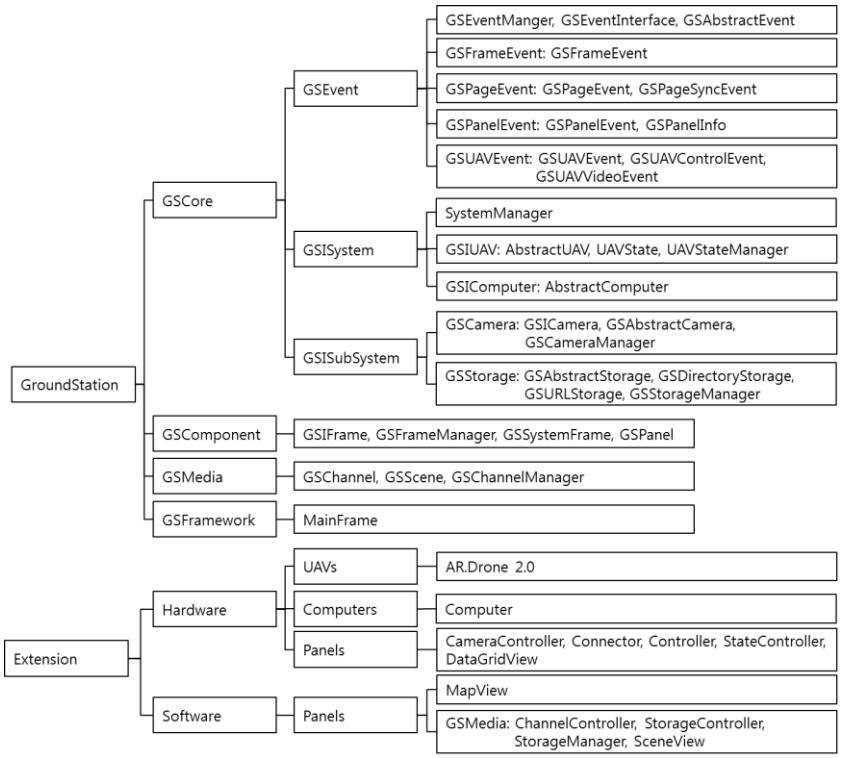

Fig. 3. Structure of the proposed ground station

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