1.1 Platforms

For task 3, we applied two kinds of UAVs to challenge the task. The general UAV called "hawk" as shown in Fig.**??**, which is similar to the one used in task 1, and the transformable aerial robot with multilink which is called "Hydrus"(Fig.**??**). As described in Fig.**??**,tThe hardware platform of "Hydrus" envolves the controller for joints which enables the stable aerial transformation.

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Figure 1: Image of task3 Hawk

[clip, bb=0 105 720 535, width=]sections/task3/images/task3-hydrus.pdf

Figure 2: Image of Hydrus

[clip, bb=0 0 720 540, width=]sections/task3/images/hydrus-platform.pdf

Figure 3: Hardware platform of task3 Hawk

Although the flight control algorithms between "Hawk" and "Hydrus" are fundamentally different, we use the smae flight controller board which is build by ourselves. We additionally designed another PCB board for controlling the eletromagnet module which can generate the suction force up to 20[N]. We equipped 5 eletromagnet in the UAV and build the attachment with tactile sensors as shwon in Fig.**??**(c). The electro-magnet moudle control board is connected to the flight controller board unit through CAN bus.

For the transformable UAV, we introduce the prototype which contains four links and three servo joints. The modularization of the whole platform is achieved by distributing the power and control system to each link with excpect of flight controller and sensors. Therefore, it becomes easier to the change the amount of rotors, according to the application of the flight.

1.2 Aerial Manipulation Strategy

For each type of UAV, we develop different piccking method. For "hawk" type UAV, we appy the magnetic force to absorb the ferrous object as shown in Fig.**??**. When the contact between the bottom of landing gear and object occurs, the tactile sensor provides certain signal, leading the actication of the eletromagnet module. We have achieve to the pick and carry the object inder indoor enviroment using motion capture system, which confirm the validty of the eletro-magnet based manipulation strategy. The cylinder type object is created according to the regulation description.

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Figure 4: Aerial manipulation method of Hawk

On the other hand, the object transporation based on the whole-body-manipulation strategy using "Hydrus" is also acheived as shown in Fig.**??**. The grasping control is developped based on the torque feedback from each joint.

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Figure 5: Aerial manipulation method of Hydrus

1.3 Software

Just like other tasks the softwares are build on ROS environment and some functionalities are shared from task 1. Point Cloud and OpenCV libraries are used for visual perception.

1.3.1 General Approach

Basically for task 3, we divide the task into three states: Search, Pick and Place. The UAVs are always within these three states and the states automatically transferred to the next one if the certain condition is satisfied as illustrated in Fig. 1A. In "Search" state, the drone will traverse to the center of the arena and randomly generate a search end-point, the treasure detector will work when the drone is searching, once the object is detected and locked, a pick motion will be generated in the "Pick" state, the UAV will open the Elec-Magnet and moving approach to the treasure. The transfer state signal depends on the trigger of

1 task3