Research on object following by an autonomous airship robot

Yousuke Tsukamoto

School of Knowledge Science,
Japan Advanced Institute of Science and Technology
March 2002

Keywords: airship robot, autonomous robot, object following, visual servo

We developed an autonomous airship robot which follows efficiently an object. Our robot is designed to carry out practical task. In the process, the problems peculiar to our autonomous airship robot are clarified.

As for the robot which operates autonomously with the consciousness capability over the external world, researches up to now have been done as a "tool", as a "pet", a "friend", or "a human model" for cognitive science. Since it is the most fundamental and important action about movement of a robot especially, many researches have so far been done. The target for these researches is a ground robot in general, and there is not so much research for the robot, which works underwater or in the air.

Since the autonomous flight robot has the advantage over a ground robot -- it can work in places whose ground robots cannot advance, such as a place on which a height and rubble were scattered, and information over a wide area can be acquired by the viewpoint from a high position -- does not have, the utilization in the spot was expected from before and various researches have been done. However, in the utilization, there is a problem of a payload, which is a problem peculiar to flight robots. Since there are restrictions of a payload, the sensors for acquiring information required for autonomous actions cannot fully be carried in a flight robot. However, since a lightweight and highly efficient small camera can receive now cheaply or GPS system, which can acquire position information with high precision progressed in recent years, autonomous flight robots are expected to be developed rapidly [Michio Sugeno, 2000].

An autonomous flight robot's form is decided according to the kind of aircraft to be used, and the task in which the application is possible is also decided by each characteristic.

Although various forms, such as a fixed wing type, a rotor type, and an insect type [Michael Dickinson, 2001], could be considered, in this research, the airship was adopted as a platform. It is because this could come to hand comparatively cheaply and the simple nature by that a maintenance is easy, being fit for operation indoors, etc. was taken into consideration. As a fault of an airship, it is sensitive to disturbance, the payload is small, and the response is bad under the influence of inertia. If these characteristics are taken into consideration, the observation with camera in indoors is suitable for the practical task, which can apply an autonomous airship robot. Therefore, realization of action of following or acquiring an object is the small task, which is needed in order to realize action of observing was set as the target in this research. The camera is indispensable in order for man to observe through the robot or the robot itself to observe. If a camera can be used also as a sensor for a robot recognizing the external world, it will become unnecessary to carry an excessive sensor and will become saving of a large payload.

In order to evaluate the autonomous airship robot we developed, the experiment of acquiring a stillness object was conducted. The plinth with a height of 70cm was installed in the laboratory, and the dodge ball, which is red and the diameter of 20cm was placed for a target object on it. Used for evaluation the data, which timed the period when the camera carried in the airship had acquired the object, and acquired the orbit of the central point of the object within an input picture for every time as relative move record with an airship robot and an object.

The algorithm of sequence control, which is an intuitive method was used for the experiment. Since this can determine a parameter by trial and error, looking at a state of operation, this algorism is convenient for an airship robot, which is difficult to describe the feature as a system in mathematical principle. Although it is known that the system, which has the output of relay-ON/OFF like the airship used by this research will tend to cause an oscillation, this oscillation can be suppressed by preparing the dead zone where an output does not react to the input near a target value [Giichi Sawaragi, 1977]. Although an oscillation is suppressed so that the range of dead zone is wide, since the fine reaction near a target value becomes impossible, a flattery performance falls. Then, the stable following and acquiring operation were able to be obtained by introducing the method of adjusting the range of dead zone alternatively. Although it examined asking for operation stabilized more and introducing classic PID control, sufficient result was not obtained from it being difficult to obtain a-like proportionally output by hardware-restrictions.