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学 位 論 文 要 旨
Dissertation Summary

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論　文　名: (Dissertation Title) Multi-Rotor Drone to Fly Autonomously along a River and 3D Map Modeling of an Environment around a River

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In many developing countries, most people living in remote locations such as mountainous areas cannot take advantages of the electricity due to the limited access to the available system. Then, a small hydro electric power plant that utilizes the potential energy of water in a river has been developing in order to solve this problem. Nowadays, photo images and 3D coordinate data along a river are obtained by humans walking along the river by using a camera and a GPS. However, this method is very risky for the humans due to a swift water flow of the river and sharp stones on the bottom of the river. In addition, this method takes much time, cost and energy, to complete the work. In order to avoid the risk for the humans and to reduce the working time, cost and energy, a method to use a multi-rotor drone with a camera flying autonomously along a river is proposed to perform the work in this research. The first structure of the small hydro electric power plant comprises a simple weir located at the upstream of the river. Nowadays, photo images of an environment around the location of a weir are captured using a camera operated by a human. However, it is difficult for the human to capture the photo images due to that it is hard to reach the location of the weir. In addition, the photo images captured by the human are only two-dimensional images. In order to provide detailed views of the environment, a method to create a 3D textured map and a 3D map model of an environment around a river is also proposed in this research.

This research is composed of two works, namely a study on a multi-rotor drone to fly autonomously along a river and a study on 3D map modeling of an environment around a river. The purposes of the first study are to develop an algorithm of image processing to determine flying directions of a multi-rotor drone using photo images of river scenes and to make a multi-rotor drone perform autonomous flights along a river using a single-lens camera and the image processing. The purposes of the second study are to create a 3D textured map by using image processing of static photo images and video images of an environment around a river and a 3D map model of the environment by using a 3D printer.

In the first study, an algorithm of image processing was firstly developed. In the algorithm, a photo image of a river scene captured by a camera is converted to an HSV image. Then, the HSV image is converted to a binary image. Then, the lower part of the binary image is used to determine the river area. Then, the top side of the river area is used to determine the flying direction. After that, the developed algorithm was installed into a personal computer to perform the image processing. Furthermore, flying experiments where a multi-rotor drone (AR. Drone 2.0) performed manual flights along a river were carried out. The experiments were carried out under off-line and with real-time image processing. Finally, flying experiments where the multi-rotor drone performed autonomous flights along a river were carried out. The experimental result where the multi-rotor drone could autonomously fly along the river using the single-lens camera and the image processing for the distance of 83 [m] was obtained.

In the second study, a flying experiment where a multi-rotor drone captured images of an environment around a river was firstly carried out. In the experiment, a fisheye-lens camera mounted on the multi-rotor drone was used to capture overlapping static photo images and video images of the environment. Then, the image processing consisting of five consecutive steps, namely ① the loading and ② the aligning images, ③ the building the dense point clouds, ④ the polygonal meshes, and ⑤ the 3D textured maps were performed by using the Agisoft PhotoScan Professional (Ver. 1.1). After that, a thickened 3D map was built by using a selected area in the 3D textured map of the static photo images. Finally, a 3D map model of the environment around the river was created by using the thickened 3D map and the IRIS 3D printer.