Annotation-Based Rescue Assistance System for Teleoperated Unmanned Helicopter with Wearable Augmented Reality Environment

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Abstract—
In this paper, we introduce an annotation-based rescue assistance system for a teleoperated unmanned helicopter with an wearable augmented reality(AR) environment. In this system, an operator controls the helicopter remotely while watching an annotated view from the helicopter through a head mounted display(HMD) with a laptop PC in a backpack. Virtual Buildings and textual annotations assist the rescue operation indicating the position to search rapidly and intensively. The position and the attitude of the helicopter is measured by a GPS and a gyroscope, and sent to the operator’s PC via a wireless LAN. Using this system, we conducted experiments to find persons and verified the feasibility.

I. Introduction

Unmanned helicopters are currently used for various purposes, such as crop-dusting and remote sensing. However it is difficult for an operator to control an unmanned helicopter remotely. One reason is that an operator cannot be aware of its attitude when he/she is far away from the helicopter. Another reason is that the coordinate system between the helicopter and the operator changes drastically depending on the attitude of the helicopter. To solve these problems, several studies have been made on autonomous helicopters [1]-[5]. Autonomous helicopters need pre-determined landmarks or flight paths in order to fly, thus they are not suitable for flight tasks where the situation changes every minute such as in disaster relief. Additionally, many on-board sensors and computers for control are needed. Since the payload of a helicopter is sharply small, autonomous helicopters tend to be large, heavy, and expensive.

We proposed an immersive teleoperating system for unmanned helicopters using an omnidirectional camera(Figure 1)[6]. In this system, the operator controls the helicopter remotely by viewing the surroundings of the helicopter through a HMD(Figure 2). The advantage of this system is that it is only necessary to install a camera and a transmitter on the helicopter. Therefore it is possible to use a compact helicopter with a small payload, and make it lightweight and cheap.
Additionally, it becomes easy to control an unmanned helicopter because a coordinate system between a helicopter and an operator doesn’t change even when the attitude of the helicopter changes. Furthermore, an operator can retain control even when a helicopter is out of the operator’s sight as long as the video image can reach the operator and the helicopter can receive the control signal.

However, in this system, it is impossible to control when the image transmission fails or the visual range is poor. In addition, the resolution of a perspective image which is generated from omnidirectional image becomes low and the operator has trouble seeing distant objects.

To solve these problems, we are developing an annotation-based assistance system for an unmanned helicopter.
II. Annotation-Based Assistance System for Unmanned Helicopter

We developed an annotation-based assistance system for an unmanned helicopter. Figure 3 and Table I show the configuration and the specification of our system. On the helicopter, an omnidirectional camera and a gyroscope are mounted at the front, and a PC with a wireless LAN and GPS receiver are hung at the bottom (Figure 4). Position/attitude data and an omnidirectional image are sent to the operator during the flight via a wireless LAN through a data relay station (Figure 5). On the ground, a perspective image is generated from a received image, and displayed on the HMD which the operator wears. The displayed image changes depending on the head direction which is measured by the gyroscope attached to the HMD. The operator has an annotation database which consists of the names and the position information of neighboring real objects. Using the database and the current position and attitude of the helicopter, annotations are overlaid on the perspective image which the operator is observing. The direction of the nose of the helicopter, ground speed, map, and the operator’s head attitude are also displayed on the image. The operator holds a controller and controls the helicopter wearing a backpack which contains a laptop PC (Figure 6).

III. Experiment

Using this system, we carried out an experiment to assist search of persons from the image captured by the camera mounted on the helicopter. The experiment was conducted at HEIJYO Palace Site in Nara prefecture. Figure 7 is an overview of the experimental environment. The helicopter took off at position A in Figure 9, and flew around it in a few minutes. Figure 9 also shows the position of textual annotations. Textual annotations are consisted of “Fire_Department”, “Medical_Center”, “City_Office”, “Elementary_School”, “Police_Box”, “Library”, and “Evacuation_Area”. Virtual buildings (Figure 8) are overlaid on the captured image to restore to original state of the city destroyed by the disaster. Additionally, the neighboring map is displayed at the lower left of the image to inform the position of the helicopter.

Figure 10 indicates acquired position, attitude, and altitude data from GPS and gyroscope mounted on the helicopter, and these data are transmitted to the operator through the Wireless LAN during the flight. Figure 11 shows a sequence of snapshots which the operator views. Around “Evacuation_Area” of the textual annotation, we could find persons at the points of a blue circle in Figure 11-(d), (e).

IV. Conclusion

In this paper, an annotation-based rescue assistance system for a teleoperated unmanned helicopter with a
wearable augmented reality environment was proposed. We conducted an experiment to assist a search operation of persons from the image captured by the camera mounted on the helicopter. To support the operation, textual annotations and virtual buildings were overlaid on the captured image, and we could find moving persons in the search area. As future work, we would like to improve the resolution of the omnidirectional camera and the bandwidth of the wireless LAN for acquiring clear and continuous image.

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References


Fig. 11. Snapshots of Generated Image Overlaid Annotations and Found Persons around the Annotation: “Evacuation Area”