Poster Abstract: A Performance Investigation of Thermal Infrared Camera and Optical Camera for Searching Victims with an Unmanned Aerial Vehicle

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ABSTRACT

In search and rescue (SAR) operation, the potential of Unmanned Aerial Vehicles (UAVs) gathers great attention. Existing studies have made various experiments to find victims by a UAVs with a single sensor, e.g., one of an optical camera, a thermal infrared camera, and a radio wave signal. However, the experimental environments are limited to show the performance of the sensor. Since there are various SAR missions, it is difficult to choose the best sensor for all environments. Then, to enhance the UAV performance, we need to consider multiple sensors to find a victim efficiently. In the paper, we investigate optical camera and thermal infrared camera for finding a victim helpfully. In the investigation, we observed the differences between their images by distance and brightness to find a human.

1 INTRODUCTION

UAVs have a lot of superior points than the human. They are very suitable for the SAR mission to go in, where humans sometimes cannot enter. In the SAR mission, UAVs are used or hoped to do victim search, area surveillance, delivery of first aid tools, etc. Although UAVs have superior missions, an operation method is not established and still on the stage of development in Japan. The altitude of UAVs, camera angles, and selection of sensors is dependent on the operator’s skill and intuition.

The sensors used in the SAR mission and the related study [1,3] are generally three, optical camera, thermal infrared camera, and Wi-Fi antenna. The optical camera is the most common UAVs equipment that is attached for not only rescue but also normal flight control. And easily find a human from camera image with manpower. A thermal infrared camera is recently picked up as a SAR tool, because of its character. It can measure a human temperature, even at night, or when a normal camera is useless. Wi-Fi antenna also gathers attention from rescue teams and researchers because most people have smartphones and devices which regularly send radio waves.

Our purpose is to establish the operation method of UAVs based SAR mission with sensors. In this paper, we investigate the characteristics of thermal infrared and optical cameras.

2 RELATED WORK

In a real field experiment of a UAV with an optical camera [1], they find a human from the sky. They checked all images with human eyes roughly and then scrutinized them with a machine. In this operation method, the system is suitable for daytime use and not at night.

Simulation, discussion, and field experiments for a thermal infrared camera [2,3] found humans or wild animals. They used their eyes to check all images to find a thermogenic object in pictures. In this operation method, the system is suitable for evening and night, or daytime in a cold season. They say using the thermal infrared camera at a hot temperature or daytime without a cold season is not good.

The common point of these works is that they used their eyes to find the humans in the picture. The point which must be considered in the SAR mission is who has the responsibility. Although machine learning and human detection system have great evolutions, we cannot put full trust in them, especially in the case of a matter of life or death.

The different point of these works is the altitude of the flight. In related research [1], the UAV with an optical camera flew around 100 meters. But in the related research [3], the UAV flew only about 50 meters due to the short-range of its thermal infrared camera. The thermal infrared camera uses a microbolometer, and this camera is distributed to the civilian market at a lower resolution, and the price is higher than an optical camera. So then, the thermal infrared camera strongly limits the flight altitude of UAVs.

CCS CONCEPTS
- Human-centered computing--Ubiquitous and mobile computing

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3 EXPERIMENT

Scenario
A scenario we suppose is someone has an accident in a mountain. His/her friend finds that he/she gets lost from the party and calls a rescue for search, then the SAR mission starts. UAVs flings at the early phase of the SAR mission, and the victim can notice the UAVs and moves to an open space to be found.

Sensor and Measuring Condition
We used FLIR Lepton 3.5 as a Thermal infrared camera, iPhone XR as optical camera. The camera angle was 45 degrees. We measured a man standing on a grass area from each floor of the building. The distance between the person and the camera varied 4.2, 9.8, 15.5, 21.2, and 26.8m. The experiments were at daytime (14:00, 25℃) and night (19:00, 21℃). The humidity of each measurement was 51% and 72%.

Result
We show only eight pictures in this paper due to the space restriction, as shown in Figure 1 and Figure 2.

Figure 1: Pictures taken from 4.2m away

<table>
<thead>
<tr>
<th>Time</th>
<th>Optical image</th>
<th>Thermal infrared image</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19:00</td>
<td></td>
<td></td>
</tr>
</tbody>
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For the Thermal infrared camera, the person can be seen from the image more clearly at night than daytime in Figure 1. However, at long distances in Figure 2, it is tough to find the person in daytime. To find him, we have to pay great attention. Related work [2] described the performance and valid distance of the Thermal infrared camera. The maximum valid range of the Lepton 3.5 is around 25m. The distance in Figure 2 is 15.5m, and we can still find human in the thermal image clearly appears at night.

For the optical camera, we can find the person easily in the daytime. This is clear because the optical camera is usually used at around 50-100m (Dependent on performance of optical camera). At night in Figures 1 and 2, because our measure place is close to the building’s illumination, the person can be found at night. However, a night image in Figure 1 has a shadow of the building, and the shadow is over the human legs. If we see it carefully, the human legs are faintly seen. But without attention, we cannot find the human legs in the picture. In a real mountain, there is no illumination. So, it is deemed unable to use an optical camera at night in a real situation.

From this result, we can say the next things. We assumed that an optical camera is for daytime and a Thermal infrared camera is for night. But in the thermal infrared image daytime shown in Figure 2, we can find the person when we look carefully. So, if we look carefully or know that human existence in advance, a thermal infrared camera is useful at any time. On the other hand, in the image from an optical camera, we can find humans easily. However, if there is no light source like a real mountain situation, the optical camera is useless at night.

4 Conclusion

From this experiment, we found the two facts in thermal infrared and optical cameras.
- Thermal infrared camera can get a data at daytime and night.
- The utility of an optical camera depends on the situation, where there is sunlight or not.

An optical camera's utility is related to the sunlight very much and is typically useful in daytime. A thermal infrared camera seems useful in daytime and night. As described in Section 2, the thermal infrared camera usually is inferior to the optical camera. So, the flight altitude is determined by the performance of the Thermal infrared camera.

We have a plan to put these sensors on UAVs and conduct measurements like a real SAR mission for future work. And also, we will look for other sensors which can assist thermal infrared and optical camera.

REFERENCES