

Remote Sensing- Part 2a, Charlotte Knight

by Charlotte Knight

Submission date: 09-Dec-2023 10:15PM (UTC+0000)

Submission ID: 218576220

File name: 18047_Charlotte_Knight_Remote_Sensing-_Part_2a__Charlotte_Knight_542399_1668680138.docx
(3.08M)

Word count: 1227

Character count: 6699

Part 2a Practical Assessment

Contents

Introduction	1
Spot	2
Drone	3
Conclusion.....	4
Table of Figures	4
References.....	4

Introduction

On Thursday 16th November, researchers studied an area of grassland outside of the University Of Wales Trinity St Davids (UWTSD) Swansea campus between 14:00-15:00.

The objective was to survey the scene to determine its suitability as an explosive trials location. In a separate task, 10 inert mines were hidden around the scene, having been preheated in boiling water to maintain a higher temperature than the surrounding environment. Using both a DJI Mavic 2 Drone, and a Boston Dynamics Spot robot, researchers had to pinpoint the GPS coordinates of each mine. This technique simulated how soldiers within Ukraine have been finding Russian mines. During the day, the explosive within the mine absorbs heat, becoming the same temperature as the soil around it. However, during the early evening, the earth rapidly cools down, surpassing the cooling rate of the explosive. This temperature difference allowed the mines to be identified through infrared (IR) cameras, enabling the Ukrainian army to efficiently clear extensive minefields.

Spot is a four-legged remote sensing platform capable of use in both manual operations and autonomous missions. Engineered for versatility and mobility, it is capable of navigating various terrains, including rough or uneven surfaces. It contains a spherical camera capable of 360 degree views as well as an integrated IR thermal camera [1].

The drone features both IR and a 4k resolution visible light cameras, enabling the operator to view in different parts of the electromagnetic spectrum. Capable of flight times up to 31 minutes, and achieving distances of 18km, it offers the operator ample time to fully assess and record the scene around it [2].

The scene, shown in figure 1 featured long grass, shrubs and a pond. Overall, the ground was relatively flat. The weather was clear, with a few clouds and an occasional gust of wind. The conditions were almost ideal for the work, as any rain would have scattered the IR, reducing the image resolution [3].

Charlotte Knight
1907828



Figure 1- Overhead of the scene, with the trial area boundary in orange [4]

Before surveying, the team decided how to divide up the area to make the data collection easier and more manageable. There was various methods available for this, including using grids and spirals. However, lines were chosen as this was more representative of traditional mine disposal methods. The chosen route is shown in figure 2.



Figure 2- A map of the area including the path of the sensor platforms [4]

Spot

Firstly, the team used Spot, controlling it via a tablet as shown in figure 3. Throughout the exercise, the team accompanied Spot on foot to manually confirm sightings. Live data from its thermal camera was also displayed on the tablet, and monitored for thermal hotspots. Spot could only view the area directly in front of it, approximately 2.1m across. This meant the spacing between the lines in figure 2 was narrower than anticipated, taking longer to collect the required data. In addition, Spot had a roll cage around its IR camera. Whilst this protected the camera during motion, it also meant a portion of the image was blocked off, reducing the field of view.

Charlotte Knight
1907828



Figure 3- Spot pictured with its IR camera.

When moving, Spot had a tendency to veer left or right, resulting in gaps and overlaps in the line data. Additionally, it struggled with the terrain, falling over when hitting a knotted section of brambles. This terrain was more challenging than anticipated, draining its battery rapidly. Consequently, Spot was unable to continue its search pattern for the whole area, instead researchers focused its efforts on confirming mine sightings from the drone.

Unfortunately, Spot's thermal camera struggled to spot the mines, as there wasn't a high enough contrast between the mine and its surroundings. Often, human intervention was required to find them. On one occasion, a tree root was glowing far brighter than the mine itself, requiring physical intervention to determine which thermal signature was the item of interest. The difficulty in tracking thermal signatures might be attributed to the mines cooling faster than expected. They may have reached temperature ranges similar to their surroundings before they could be identified.

Once a mine was discovered, researchers imaged the mine on their mobile phones, recording the GPS data for the mines location.

Spot was able to map a wide area in 40 minutes, however, was slowed by its limited field of view. To improve performance, the map lines could be programmed into its system, eliminating the need for an operator. In addition, it could be programmed to detect and identify the mines autonomously, eliminating the requirement for a human in the loop.

Drone

Using a drone, the scene was also surveyed through live visual data being sent back to the operator, being saved as a series of images for later analysis. The drone hovered at 30-50m throughout the exercise. The wider camera angle meant the scene could be surveyed much faster than Spot, taking about 5 minutes to survey the entire area. This allowed quick identification of some mines out in the open. However, the drone was often fooled by mines hidden within the scrubland, or underneath objects such as tennis balls.

Charlotte Knight
1907828

Figure 4 shows the 4k and thermal imaging camera data, taken at approximately 30m altitude. As seen, the resolution is incredibly low, making specific details hard to make out. Whilst the drone could have been flown lower, as there was researchers on the ground, this could have introduced more risks into the experiment.

Similarly to Spot, the mine cannot be seen clearly on the IR camera, and required the 4k camera to discover its location, as shown in figure 4.

Despite these setbacks, the drone was able to cover the whole site quickly, with the data collection taking only 20 minutes.

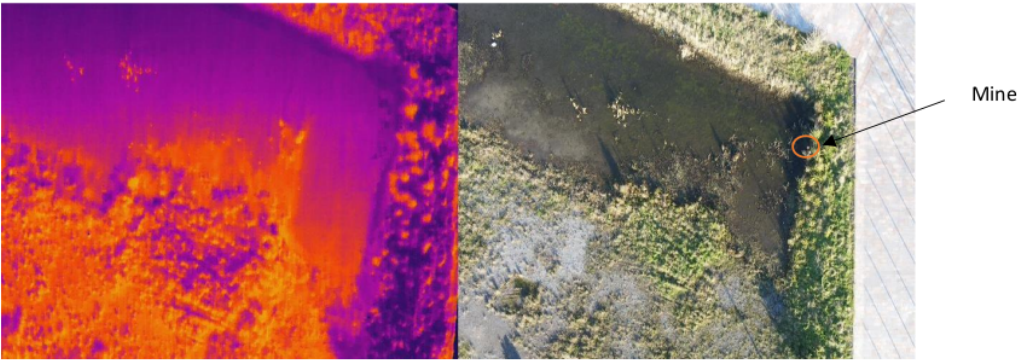


Figure 4- A comparison between the drones 4k camera and IR photography

Conclusion

Overall, using both sensor systems in parallel was successful. The drone was able to quickly display the whole scene, easily spotting potential mine locations. Then, Spot was able to get closer on the ground, providing the operator with exact location coordinates on each discovered mine. In the end, the assessment was a success, with all the mines having been detected by at least one of the sensing systems. Both systems, however required an operator in the loop to control it. This could rapidly increase the cost, risk and time associated with further missions.

Table of Figures

Figure 1- Overhead of the scene, with the trial area boundary in orange [4]	2
Figure 2- A map of the area including the path of the sensor platforms [4]	2
Figure 3- Spot pictured with its IR camera	3
Figure 4- The drones 4k and IR camera footage compared	4

References

Charlotte Knight
1907828

- [1] Boston Dynamics , "Spot," Boston Dynamics , [Online]. Available: <https://bostondynamics.com/products/spot/#item2>. [Accessed 6 12 2023].
- [2] DJI, "DJI Mavik 2 Specs," DJI, [Online]. Available: <https://www.dji.com/uk/mavic-2/info#specs>. [Accessed 6 12 2023].
- [3] Teledyne FLIR, "Can Thermal Imaging See Through Fog and Rain?," Teledyne FLIR, 30 12 2020. [Online]. Available: <https://www.flir.co.uk/discover/rd-science/can-thermal-imaging-see-through-fog-and-rain/#:~:text=Fog%20and%20rain%20can%20severely,the%20infrared%20signal%20is%20diminished..> [Accessed 6 12 2023].
- [4] Google Maps, "Google Maps," Google Maps, [Online]. Available: <https://www.google.com/maps/place/Swansea/@51.6164012,-3.928042,209m/data=!3m1!1e3!4m6!3m5!1s0x486e45555a4e97b1:0x3d77128e2fe7cb74!8m2!3d51.62144!4d-3.943646!16zL20vMGNrNnl?entry=ttu>. [Accessed 6 12 2023].
- [5] K. Roudebush, "What is the Warmest Time of the Day?," Wise Geek, 6 11 2023. [Online]. Available: <https://www.wisegeek.com/what-is-the-warmest-time-of-the-day.htm>. [Accessed 6 12 2023].

Remote Sensing- Part 2a, Charlotte Knight

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5
