This PhD thesis explores the possibility to detect landmines utilizing hyperspectral imaging. By using this innovation, we can get at every pixel of the image spectral information in many wavelengths. In this way, at every pixel we acquire a reflectance range that is utilized as a unique signature to recognize the materials of that pixel, and essentially in our project help us to identify the presence of landmines.

The proposed procedure functions as follows: a preconfigured drone will convey the hyperspectral camera. This customized drone is responsible of flying over the zone to be cleared of landmines to acquire image from a safe distance. Different image processing tools will be used to detect the landmine from the image. When the presence of a mine or explosives is suspected, an alert sign is sent to the base station giving data about the landmine type, its location and the clear path that could be taken by the mine removal team for demining process.

There are several reasons why hyperspectral imaging advantages over other demining methods has: first, this method is safer than the other methods due to the absence of persons in the demining area. Second, using this method we can scan a large area in a single day. Finally, this technique is able to identify each type of landmine even when the difference between landmines is small.

First, a brief presentation that focus on the problem of landmine referring to some statistics taken from the UN organization is addressed. Also, different types of used landmines are presented. In addition, dimensionality reduction in hyperspectral imaging is presented. A summary of all detection techniques used in hyperspectral imaging is presented with the advantages and disadvantages of each method. How to improve the performance of existing detection methods in terms of complexity and detection rate is then discussed.

In this work, we study the importance of dimensionality reduction in hyperspectral imaging, by developing a new bands selection method. Also, we give a summary about detection techniques in hyperspectral imaging, identifying what are the most performing methods that give high detection probability with low false alarm rate. These methods are tested in different scenarios with different statistical and linear unmixing based methods. In addition, we introduce the use of pixel intensity methods in order to detect rare pixels at subpixel level: this will reduce the number of pixels in the images, meanwhile reducing the complexity and improving the performance of different existing target detection methods.

An investigation of the impact of dimensionality reduction using multicriteria and net analyte signal methods are also provided. A comparative study was made based on computational time and detection performance after image reduction.

In a field experiment, we study how the spectral signature of landmines is affected depending on different environmental factors affecting the area where the landmine is planted (soil, grass, etc.). We take the signature of different landmine types in different conditions:

- In the lab
- Landmine covered by grass
- Landmine covered by soil

Also, a hyperspectral image is acquired from a real area containing mines buried in different conditions in either soil or grass. Dimensionality reduction and target detection are applied to this image to study the possibility to detect landmine in a realistic scenario. Finally, a brief introduction about thermal infrared hyperspectral imaging, we discuss the advantages of this technique to detect fully buried objects, especially landmines in different scenarios.