Ant Nests detection under Forest Coverage by Drone Borne Radar Survey

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Abstract—This work presents unprecedented results for ant nest detection in industrial forests from data collected by a drone-borne tomographic radar. The data acquisition was carried out in commercial eucalyptus forests where several ant nests were identified. The P-band data were collected performing helical flight trajectories and SAR images were obtained using a fast back-projection algorithm. Then, a convolutional neural network was trained to estimate the ant nest locations, reaching a success rate of 80% in a validation dataset.

Keywords-SAR imaging; ant nest; tomographic mapping

I. INTRODUCTION

Leaf-cutting ants build underground nests, which are made up of chambers, and are dangerous for forest productivity. A 3-year-old nest can occupy an area of 100 to 200 m^2 and have chambers down to a depth of 7 m [1].

This article reports the results of the ant nest detection from remote monitoring carried out with a drone-borne tomographic radar performing helical trajectories to obtain tomographic information of the eucalyptus forest area. Finally, a convolutional neural network (CNN) is used to estimate the ant nest locations from SAR images.

II. METHODS

Five-year-old industrial eucalyptus forests belonging to the company Klabin were mapped with a multiband drone-borne tomographic radar [2]. From fieldwork in the monitored area, ant nest of different sizes was found and georeferenced using a conventional GPS for reference data. Five areas were mapped with helical trajectory flights ranging from 120m to 80m in height to obtain tomographic information. The data from the P band was processed using a fast back-projection algorithm [3]. For each area, a set of eight SAR images representing an area of 100x100m from the surface to 2.1m underground was obtained.

A CNN was proposed to detect ant-nests in SAR images. The five sets of SAR images were divided into sub-images of 12x12m with a stride of 4m, obtaining a total of 2420 sub-images sets of 60x60x8 pixels. The neural network has two convolutional layers of 9x9x64, a max-pooling layer, a convolutional layer of 5 x 5 x 128, a dense layer of 115200 neurons, a dense layer of 32 neurons, and an output layer of a sigmoid neuron. Hidden layers have a rectified linear unit (ReLU) as the function activation. The network was trained using the binary cross-entropy loss function and the Adam as the stochastic optimization method.

III. RESULTS

The training dataset comprises the sub-images sets of four areas, leaving one area for the validation dataset. The estimation of the ant nest position in the training dataset achieved a hit rate of 100% and a false alarm rate of 0%. The result of the validation dataset is presented in Figure 1.

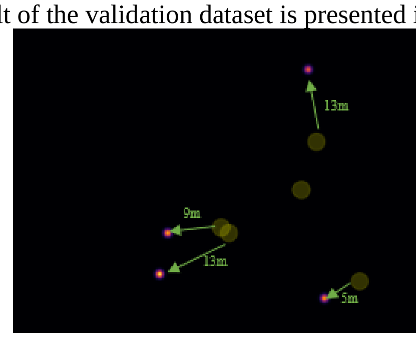

Figure 1. Ant nest's position: actual positions in yellow, estimated positions purple.

The results of the validation dataset have a planimetric error, which is the distance between the actual and estimated ant nest position, between 5 m and 13 m. A hit rate of 80% and a false alarm rate of 0% were achieved.

III. CONCLUSIONS

This paper presents the results of estimating the ant nest position from tomographic SAR images, showing that SAR systems have great potential for detecting ant nests in industrial forests. In future works, we hope to estimate the ant nest positions with a planimetric error of fewer than 5 m and a hit rate greater than 80%.

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