SÃO PAULO STATE UNIVERSITY
School of Engineering of Ilha Solteira

TITLE

Research Report – Iniciação Científica

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UNESP

Ilha Solteira – SP

2022

RESEARCH REPORT

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Keywords: word, word, word.

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1 INTRODUCTION

UAV has been used for several applications, such as entertainment, sports transmissions and commercial applications. However, historically, it was primarily designed to achieve military goals, including unmanned inspection, surveillance, reconnaissance, and mapping of inimical areas. Over time, its applications extended to other areas, like geomatics, for data collecting through photogrammetry. This way, collecting images using UAV provides a bunch of applications in the aerial close-range domain, making it a low-cost alternative to the traditional manned aerial photogrammetry for mapping or detailed 3D recording information and being a valid complementary solution to terrestrial acquisitions (5).

In Brazil, UAV is widely used in agricultural situation, therefore, tracking, monitoring and collecting information in real time from remote areas for agriculture and livestock are quite relevant. Abade et al. (1) showed the development and construction of an UAV able to board remote sensing applications with images and radio frequency for this purpose. Still with the same bias, but targeting another aspect, Otake (6) used UAV to generate cartographic products for agriculture purpose. The main goal was to detect failure of planting, the projection of contour lines and the elaboration of use of soil map.

In such manner, the use of UAV equipped with cameras to access places where human access might be difficult is a way to spend less effort in many contexts, decreasing the chances of accident and spare financial recourses. Dadrasjavan et al. (3) considered the use of UAV useful for acquiring reliable information about the pavement of the road and monitoring any kind of crack on it by selecting key frames and generating ortho-image. Non road regions in the scene are discarded and crack elements are extracted. Subsequently, through Support Vector Machine (SVM) classification true cracks are detected. On the other hand, Sushant et al. (7) used a MATLAB® implementation to both localizing the position of the UAV and detect cracks in railway tracks. For the first goal, a Monte Carlo Localization (MCL) method was carried out for the software senses its position and for the second goal, and software method was able to detect the railway cracks comparing the intensity of the color of the image. Lesiak (4) also bring the attention to the inspection and maintenance of railway infrastructure with the use of UAV and its implementation.

Hence, it's clear the demand of UAVs in various sceneries, in special to assist detecting damages in specific types of structures. Not only understand and determine the method is crucial, but also the way that it's implemented and its viability.

1.1 Objective

To develop a process to obtain and analyze aerial images to detect railway cracks.

2 METHODOLOGY

2.1 Railway

The human being always needed to move from one place to another. Since prehistory, either to run away from a predator or to obtain food, it's intrinsic to the humanity the idea to get out of point A to a certain point B. As the evolution was passing, many couldn't keep themselves alive due to the sagacity of the predator, so a way to contour this was to improve the means of transportation.

Today, one of the most used means of transportation is train. Highly used around the world to transport people as well as products, trains are one of the most important ways to get things from one place to another.

2.2 The Social Issue

2.3 UAV Localization

There are three main ways to detect cracks: graphical inspection, non-destructive testing technologies and shuddering based global methods (2). The UAV usage for this purpose fits in the first way, i.e., graphical inspection.

To have a complete approach, it is needed to localize the UAV initially. Sushant et al. (7) implemented a way to do it based on MCL method through MATLAB, where a three element vector (x, y, θ) is provided giving the initial pose.

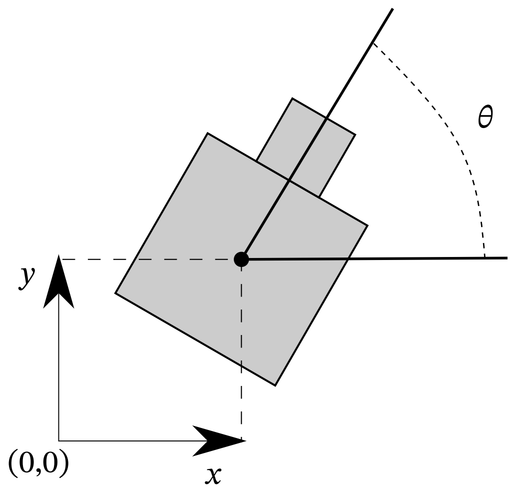
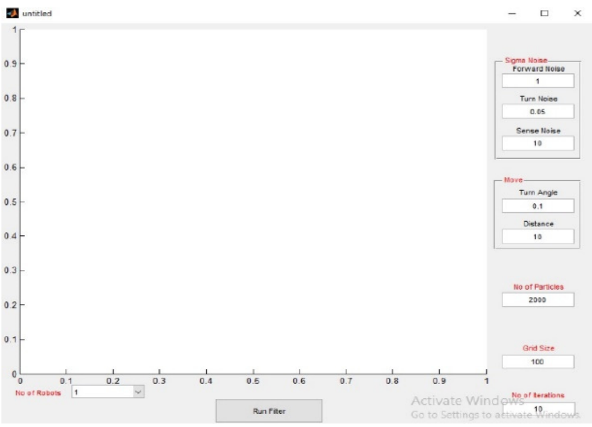


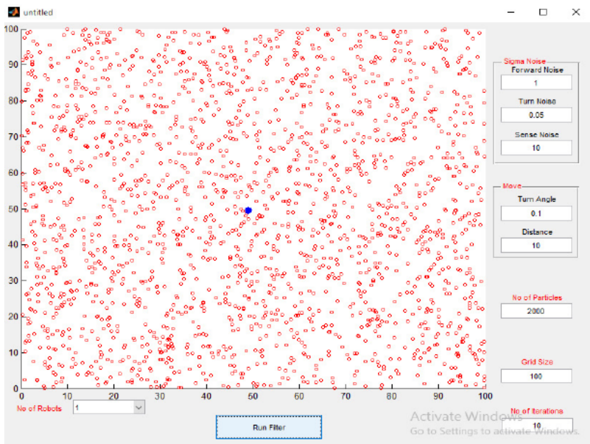
Figure 2.3.1. State representation of UAV

To assume the first iteraction to detect the UAV position, it's needed either to give the initial coordinates or let the algorithm detect where it might be. The later one is less performatic due the necessity to resample the particles more times to localize its pose.

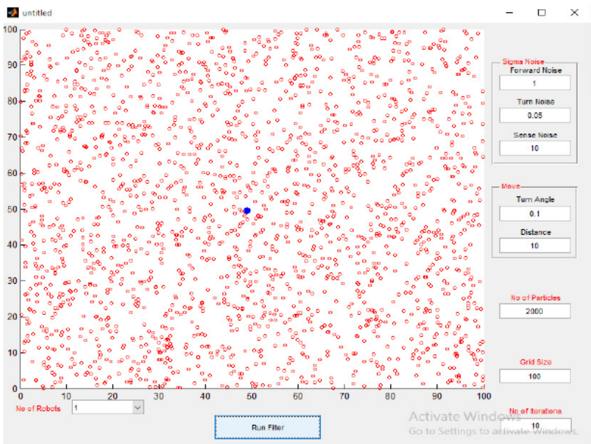
Localized the UAV, the algorithm will verify when it'll need to resample the particles once more. This way, *UpdateThreshhold* MATLAB function defines the minimum amount of change required in the three element vector to trigger the update, i.e., if x, y or θ changes by more than this minimum defined amount, an update will be triggered. The *ResamplingInterval* function defines the number of updates necessary for the particle resampling, because not all variation means a real variation in the UAV pose, they just might be some random noises.



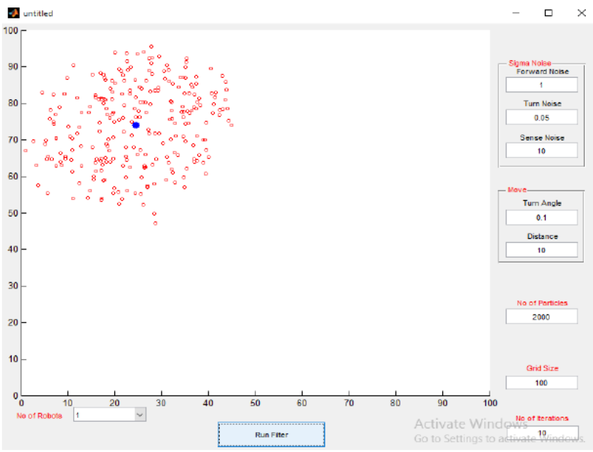
(a) GUI Layout; Source: Sushant et al. (7)



(b) First iteraction; Source: Sushant et al. (7)



(c) Second iteraction; Source: Sushant et al. (7)



(d) Third iteraction; Source: Sushant et al. (7)

Figure 2.3.2. GUI interface to locate the UAV pose.

2.4 Crack Detection

$$A \oplus B = \{z \,|\, (B')_z \cap A \neq \varnothing\} \tag{2.4.1}$$

$$A \ominus B = \{z \,|\, B_z \subseteq A\} \tag{2.4.2}$$

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