

**SÃO PAULO STATE UNIVERSITY**  
School of Engineering of Ilha Solteira

**TITLE**



**Research Report – Iniciação Científica**

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**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 (6).

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 (7) 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. (8) used a MATLAB<sup>®</sup> 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

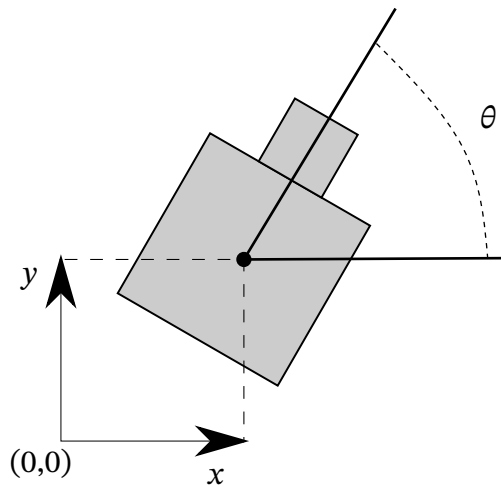
Railway transportation was definitely one of the most important inventions of the human being. It makes great distances seem to be shorter than they really are due to its fastness and capacity to support weight, that is, it's able to carry people and groceries as it travels. Developed in the nineteenth century, the working principle is simple: it's a structure consisting of parallel lines of rails with their sleepers, fittings and fastenings to provide a road for the movement of locomotives and wagons for the transportation of passengers or/and freight (5).

### 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. (8) implemented a way to do it based on MCL method through MATLAB, where a three element vector  $(x, y, \theta)$  is provided giving the initial pose.



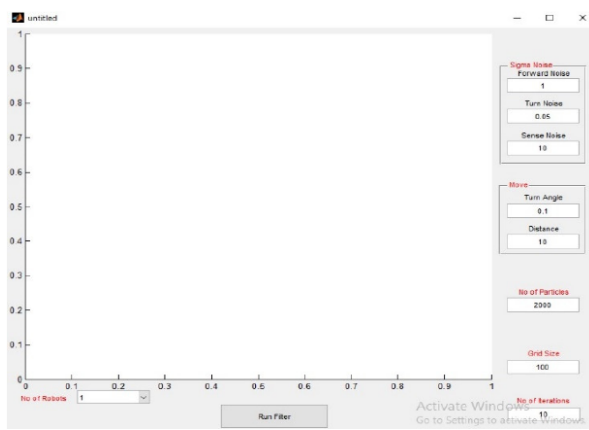
**Figure 2.3.1.** State representation of UAV

To assume the first iteration to detect the UAV position, it's needed either to give

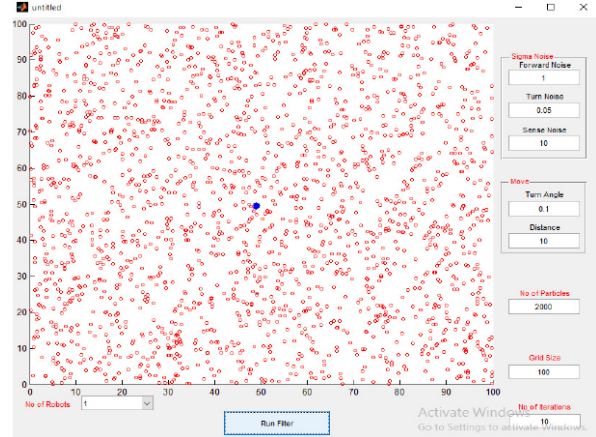


the initial coordinates or let the algorithm detect where it might be. The later one is less performatic due the necessity to resample the particles more times to localize its pose.

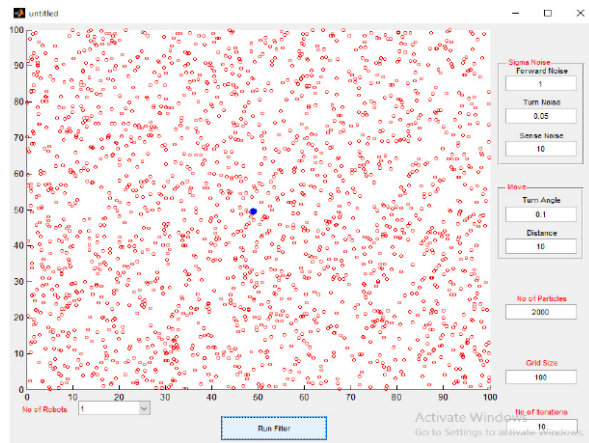
Localized the UAV, the algorithm will verify when it'll need to resample the particles once more. This way, *UpdateThreshhold* MATLAB function defines the minimum amount of change required in the three element vector to trigger the update, i.e., if  $x$ ,  $y$  or  $\theta$  changes by more than this 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.



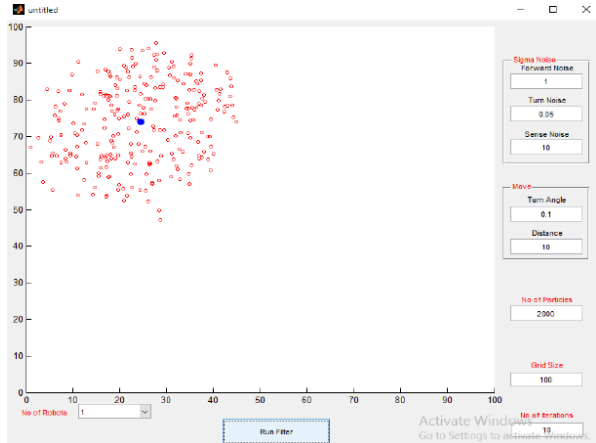
(a) GUI Layout; Source: Sushant et al. (8)



(b) First iteration; Source: Sushant et al. (8)



(c) Second iteration; Source: Sushant et al. (8)



(d) Third iteration; Source: Sushant et al. (8)

**Figure 2.3.2.** GUI interface to locate the UAV pose.

## 2.4 Crack Detection

$$A \oplus B = \{z \mid (B')_z \cap A \neq \emptyset\} \quad (2.4.1)$$

$$A \ominus B = \{z \mid B_z \subseteq A\} \quad (2.4.2)$$

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