Localization of an UAV for Crack Detection in Railway Tracks

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October 7, 2022

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Introduction

- UAV applications: sports, partys, get in places where human intervation might be difficult.
- Main goal: detecting cracks in a railway track using concepts of image processing.

Introduction

- Study's based in India.
- There's a vast railway network.
- It's been increasing in a rapid pace, however its infrastructure's not been able to follow it.
- It causes severe loss of valuable human life and property.

Introduction

Techniques used for damage detection:

- graphical inspection;
- non-destructive testing technologies (acoustic emission, ultra-sonic techniques, etc); and
- shuddering based global methods.

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Two-fold objective

- Reduce risk of rail accidents; and
- reduce manned labor required to identify cracks along railway tracks.

MCL Algorithm

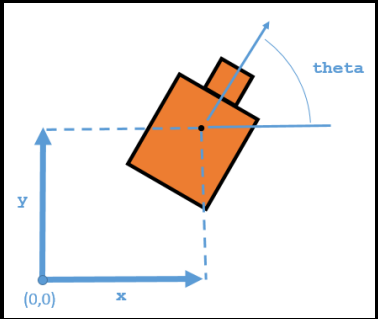
GOAL: localizing the position of the UAV at a given instant of time.

How does it work?

- Estimates its position and orientation as it moves;
- the first interaction assumes a uniform distribution;
- the later ones gets more precise as the UAV moves.

MCL Algorithm (State Representation)

- three element vector (x, y, θ);
- initial input;
- mean of the highest weighed cluster of particles.



MCL Algorithm (Initialization of Particles)

Global Localization

- initial position is unknown;
- particles uniformly distributed;
- more particles needed, less performance.

Initial pose

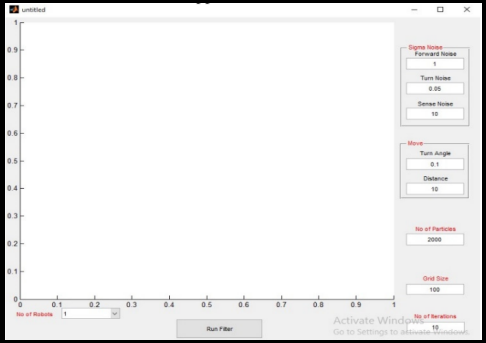
- initial location is given;
- more particles acummulated at the initial pose;
- less number of particles needed, more performance.

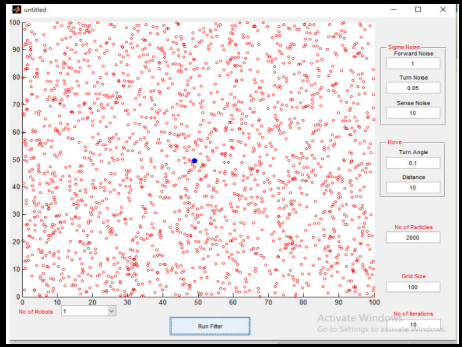
MCL Algorithm (Resampling Particles)

- *UpdateThreshold:* minimum amount of necessary change in the three element vector.
- *ResamplingInterval:* defines the number of necessary updates for particle resampling.

2D Localization of UAV

MATLAB usage:





2D Localization of UAV

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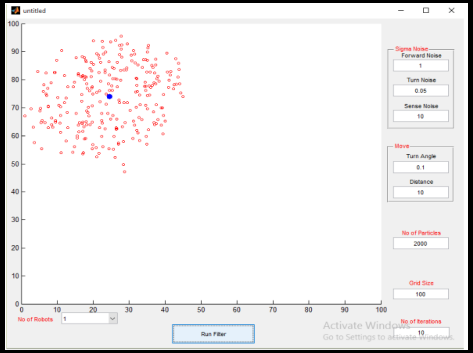
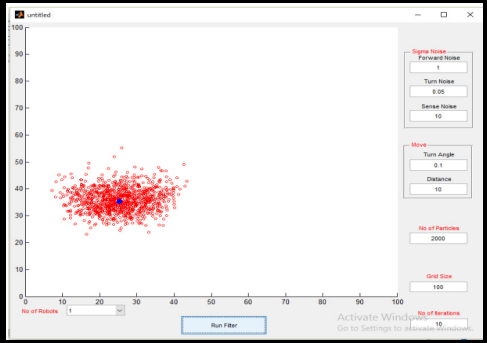




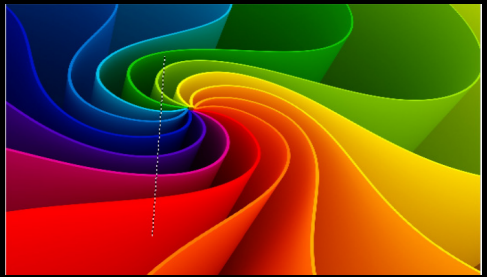
Simulation Results

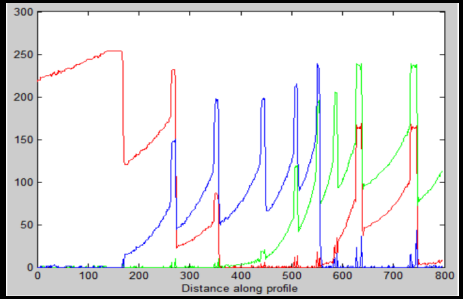
UAV Characteristics

- 8 MP Digital camera;
- average speed: 33 mph;
- 20 frames/sec (1 minute = 1200 frames);
- UAV must be equipped with flash lights;

Simulation Results

- *improfile:* find the intensity profile of an image along a line segment.[1]

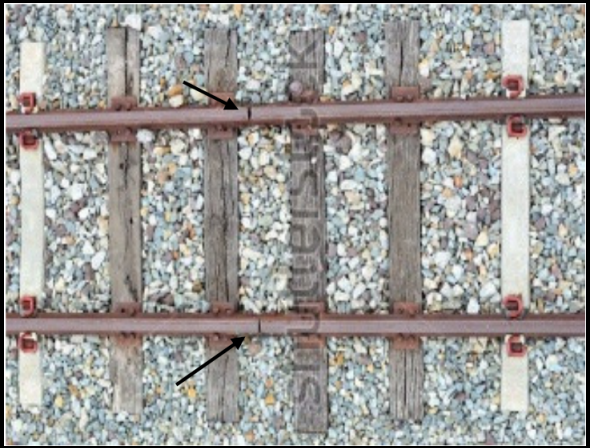




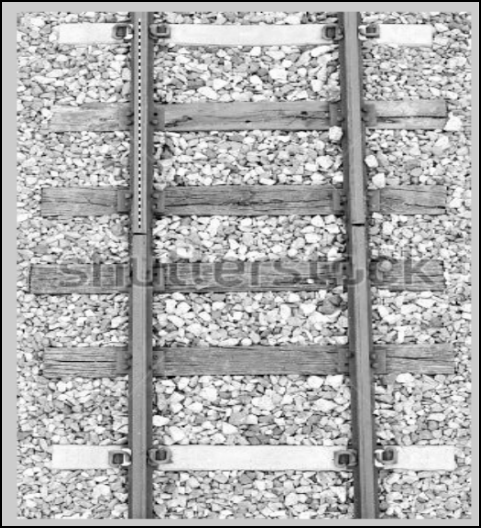
[1] Works with grayscale and RGB.

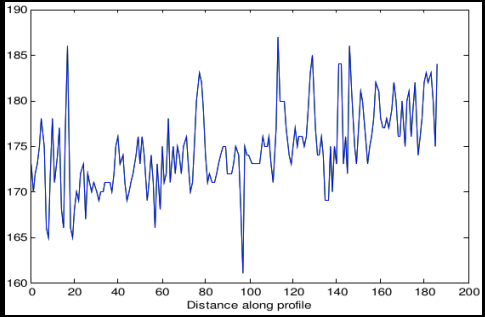
Simulation Results

For crack detection in a railway track:



Simulation Results





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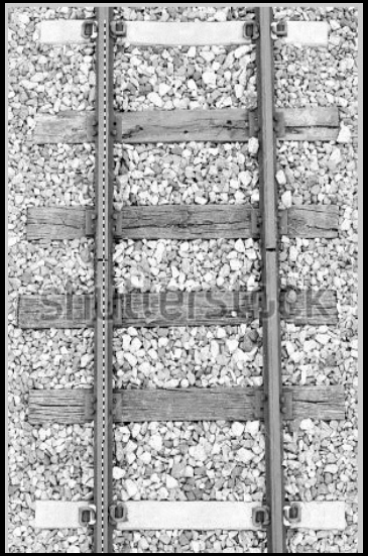

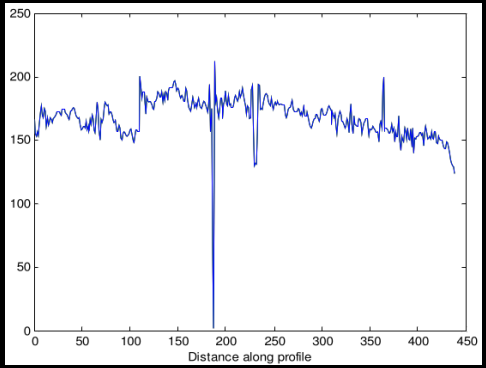

Conclusion and Future Work

- Simple solution to detect cracks along railway lines using localization and image processing.
- Possible effects that the UAV is subjected to by the presence of electric wires above the tracks.
- Smartphone application can also be developed for monitoring the motion and position of the UAV.