Localization of an UAV for Crack Detection in Railway Tracks

Gabriel D. Silva

gd.silva@unesp.br

unesp

UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
Câmpus de Ilha Solteira

October 10, 2022

1. Introduction
2. MCL Algorithm
3. 2D Localization of UAV
4. Simulation Results
5. Conclusion and Future Work

1 Introduction

2 MCL Algorithm

3 2D Localization of UAV

4 Simulation Results

5 Conclusion and Future Work

Introduction

- UAV applications: sports, partys, get in places where human intervation might be difficult.
- E.g.: 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.

Introduction

Techniques used for damage detection:

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

Introduction

Techniques used for damage detection:

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

Two-fold objective

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

1 Introduction

2 MCL Algorithm

3 2D Localization of UAV

4 Simulation Results

5 Conclusion and Future Work

MCL Algorithm

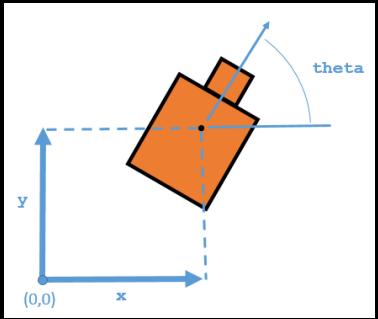
GOAL: localizing the position of the UAV.

How does it work?

- Estimates its position and orientation;
- first interaction: uniform distribution;
- the later ones gets more precise.

MCL Algorithm (State Representation)

- three element vector;
- initial input;
- mean of the highest weighed cluster of particles.



MCL Algorithm (Initialization of Particles)

Global Localization

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

Initial pose

- initial location is given;
- more particles acummulated at the initial pose;
- 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.

1 Introduction

2 MCL Algorithm

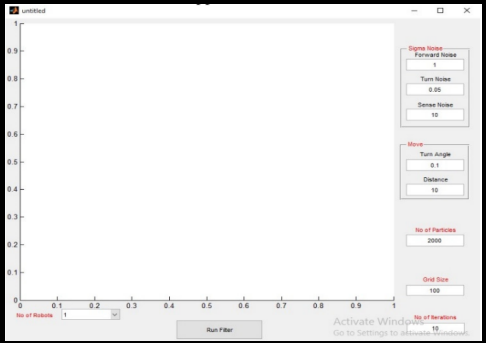
3 2D Localization of UAV

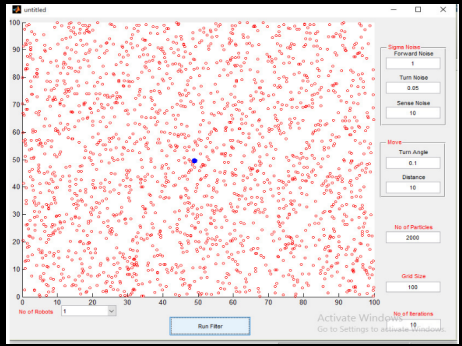
4 Simulation Results

5 Conclusion and Future Work

2D Localization of UAV

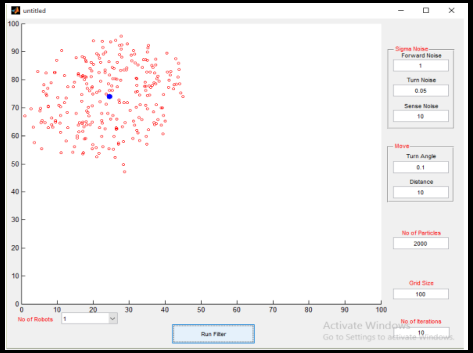
MATLAB usage:

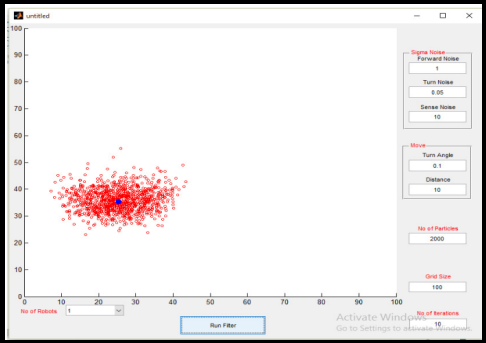




2D Localization of UAV

MATLAB usage:





1 Introduction

2 MCL Algorithm

3 2D Localization of UAV

4 Simulation Results

5 Conclusion and Future Work

Simulation Results

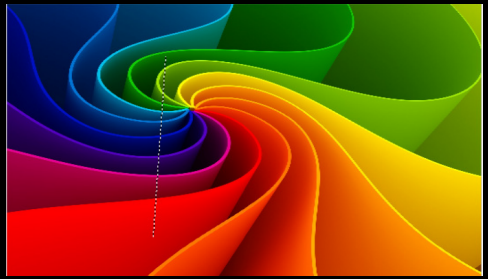
UAV Characteristics

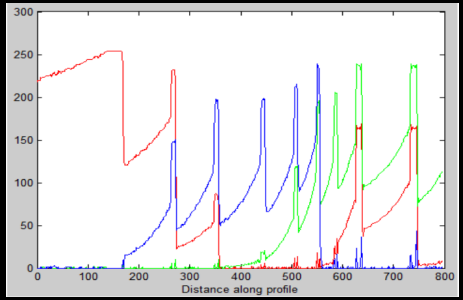
- 8 MP Digital camera;
- average speed: 33 mph;
- 20 frames/sec;[1]
- UAV must be equipped with flash lights;

[1] 1200 frames per minute

Simulation Results

- *improfile:* find the intensity profile of an image along a line segment.[2]

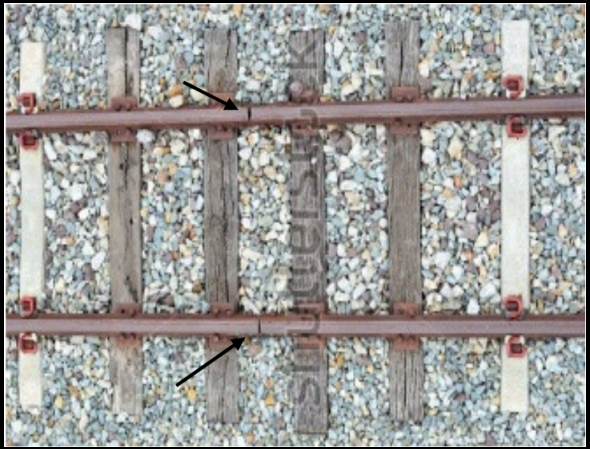




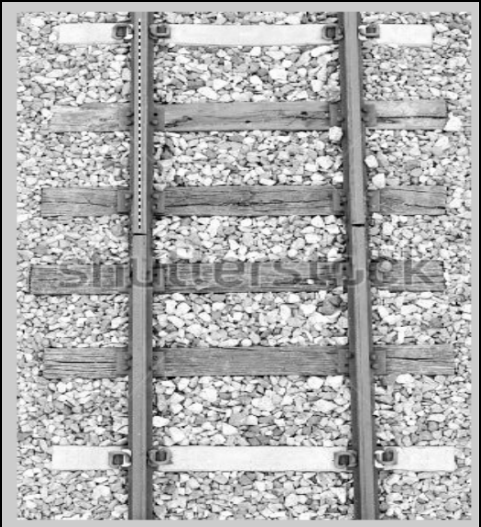
[2]Works with grayscale and RGB.

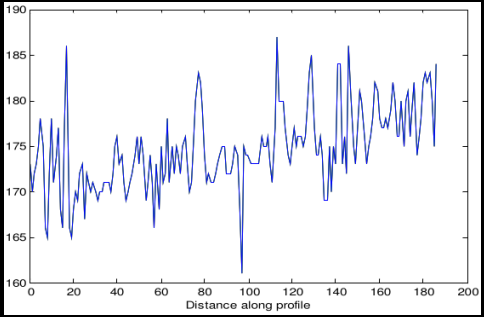
Simulation Results

For crack detection in a railway track:

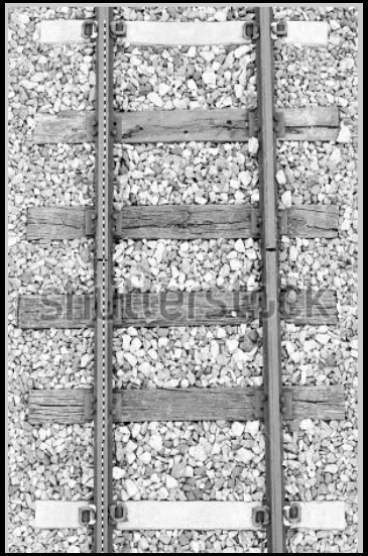


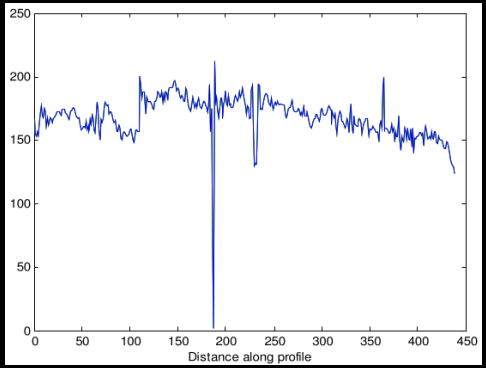
Simulation Results





Simulation Results





1 Introduction

2 MCL Algorithm

3 2D Localization of UAV

4 Simulation Results

5 Conclusion and Future Work

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.