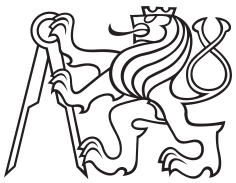
Bachelor Project



Czech
Technical
University
in Prague

F3

Faculty of Electrical Engineering
Department of Cybernetics

Drone detection using neural networks from combined RGB camera and LiDAR data

Adam Škuta

Supervisor: Matouš Vrba
Supervisor–specialist: Martin Saska
Field of study: Mathematical Engineering
Subfield: Mathematical Modelling
February 2017

Acknowledgements

Děkuji ČVUT, že mi je tak dobrou *alma mater*.

Declaration

Prohlašuji, že jsem předloženou práci vypracoval samostatně, a že jsem uvedl veškerou použitou literaturu.

V Praze, 10. February 2017

Abstract

Keywords: word, key

Supervisor: Matouš Vrba
Ústav X,
Uliční 5,
Praha 99

Abstrakt

Klíčová slova: slovo, klíč

Překlad názvu: Moje bakalářka se strašně, ale hrozně dlouhým předlouhým názvem — Cesta do tajů kdovíčeho

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1.1 Camera model

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Task

Chapter 2

Dataset

The dataset for this work can be generated in two ways. The first is real-life drone shots mixed with point clouds from LiDAR mounted on top of a drone. The second is generating a dataset using a realistic virtual environment where a drone, camera and LiDAR are being emulated very close to their real-life counterparts. An advantage to this approach is that a great variety of environments can be chosen a lot of them often inaccessible otherwise (power plant, airport, snowy mountains out of season etc.). Therefore this approach will be chosen for the task.

2.1 Unreal Engine

Unreal Engine is a software tool used for creating realistic 3d environments, most often used as a video game engine. It is written in C++ and open-source supporting a variety of pre-built environments and assets. For this work three diferent environments will be used for the creation of the dataset:

citation https://www.unrealengine.com/en-US/features

- exact name. Snow
- exact name. Park

exact name. City centre

Pictures of the environments

Together

exact number of pictures

pictures and labels were generated using two drones. One drone was equipped with RGB camera and LiDAR sensor and was responsible for taking the pictures and pointclouds from LiDAR. The second one was used as a model for drone detection.

2.2 AirSim

airsim zdroj

Open-source plugin for Unreal Engine called AirSim was used for the generation of the dataset. It simulates realistic flight motions of drones as well as seven types of sensors , including RGB camera and LiDAR used for this task. AirSim supports both a C++ API as well as Python API, latter which was used for controlling the motion and capturing the dataset. Location of the second drone was generated through API call, which produces a location of the drone in global coordinate system of the map, which is later transformed to the local coordinates of the first drone carrying the LiDAR and RGB sensors.. The capturing drone traveled on each map on a 3d cube grid:

Transformacna matica?

Grafika kocky po ktorej lietal dron

Part III

Your Party

Chapter 3

Heading on Level 0 (chapter)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. $\sin^2(\alpha)+\cos^2(\beta)=1$. If you read this text, you will get no information $E=mc^2$. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. $\sqrt[n]{a}\cdot\sqrt[n]{b}=\sqrt[n]{ab}$. This text should contain all letters of the alphabet and it should be written in of the original language. $\frac{\sqrt[n]{a}}{\sqrt[n]{b}}=\sqrt[n]{\frac{a}{b}}$. There is no need for special content, but the length of words should match the language. $a\sqrt[n]{b}=\sqrt[n]{a^n b}$.

3.1 Heading on Level 1 (section)

Hello, here is some text without a meaning. $\mathrm{d}\Omega=\sin\vartheta\mathrm{d}\vartheta\mathrm{d}\varphi$. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. $\sin^2(\alpha)+\cos^2(\beta)=1$. This text should contain all letters of the alphabet and it should be written in of the original language $E=mc^2$. There is no need for special content, but the length of words should match the language. $\sqrt[n]{a}\cdot\sqrt[n]{b}=\sqrt[n]{ab}$.

3.1.1 Heading on Level 2 (subsection)

Hello, here is some text without a meaning. $\frac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\frac{a}{b}}$. This text should show what a printed text will look like at this place. $a\sqrt[n]{b} = \sqrt[n]{a^n b}$. If you read this text, you will get no information. $\mathrm{d}\Omega = \sin\vartheta \mathrm{d}\vartheta \mathrm{d}\varphi$. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. $\sin^2(\alpha) + \cos^2(\beta) = 1$.

Heading on Level 3 (subsubsection)

Hello, here is some text without a meaning $E = mc^2$. This text should show what a printed text will look like at this place. $\sqrt[n]{a} \cdot \sqrt[n]{b} = \sqrt[n]{ab}$. If you read this text, you will get no information. $\frac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\frac{a}{b}}$. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. $a\sqrt[n]{b} = \sqrt[n]{a^n b}$. This text should contain all letters of the alphabet and it should be written in of the original language. $\mathrm{d}\Omega = \sin\vartheta \mathrm{d}\vartheta \mathrm{d}\varphi$. There is no need for special content, but the length of words should match the language.

Heading on Level 4 (paragraph). Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. $\sin^2(\alpha) + \cos^2(\beta) = 1$. If you read this text, you will get no information $E = mc^2$. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. $\sqrt[n]{a} \cdot \sqrt[n]{b} = \sqrt[n]{ab}$. This text should contain all letters of the alphabet and it should be written in of the original language. $\frac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\frac{a}{b}}$. There is no need for special content, but the length of words should match the language. $a\sqrt[n]{b} = \sqrt[n]{a^n b}$.

3.2 Lists

3.2.1 Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list

Example for list (4*itemize)

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list
      - Second item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

3.2.2 Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list
4. Fourth item in a list
5. Fifth item in a list

Example for list (4*enumerate)

1. First item in a list
    a. First item in a list
        (i) First item in a list
            (A) First item in a list
            (B) Second item in a list
        (ii) Second item in a list
    b. Second item in a list
2. Second item in a list

3.2.3 Example for list (description)

First item in a list

Second item in a list

Third item in a list

Fourth item in a list

Fifth item in a list

Example for list (4*description)

First item in a list

First item in a list

First item in a list

First item in a list

Second item in a list

First item in a list

Second item in a list

Second item in a list

Foo	Bar
foo1	bar1
foo2	bar2

Table 3.1: Foobar.

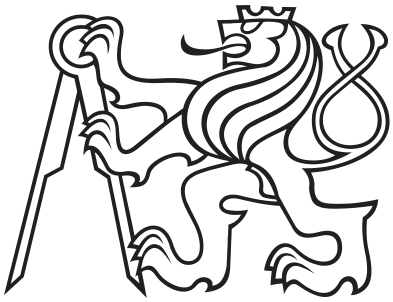

Figure 3.1: Black logo of the CTU in Pragueueue.

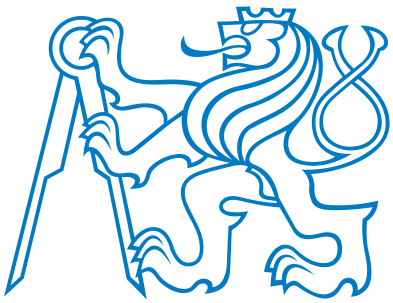

Figure 3.2: Blue logo of the CTU in Pragueueue.

Chapter 4

Conclusions

4.1 Test — this is just a little test of something in the table of contents

4.1.1 Yes, table of contents

Theorem 4.1. 1. *Bla*

2. *Blo*

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis interdum facilisis urna, at tincidunt leo consectetur non. Maecenas bibendum mi vitae libero pharetra, ac ullamcorper nulla pellentesque. Sed sit amet massa nunc. Aenean placerat a est sodales sagittis. Quisque purus nibh, auctor ut consectetur at, suscipit non erat. Donec condimentum porttitor risus, vitae fringilla lectus tincidunt nec. Nulla leo quam, commodo eu ornare non, iaculis sed nulla. Duis gravida lacus quis purus sodales, vitae malesuada justo ultricies. Vestibulum nisl nulla, commodo non pellentesque a, fringilla a risus. Ut quis magna nulla. Mauris vitae ultricies ante, in consectetur justo.

Proof. 8 Bla

1. Blo

□

Appendices

Appendix A

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Appendix B

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Katedra: matematiky Akademický rok: 2008/2009

ZADÁNÍ BAKALÁŘSKÉ PRÁCE

Pro:	Tomáš Hejda
Obor:	Matematické inženýrství
Zaměření:	Matematické modelování
Název práce:	Spřátelené morfismy na sturmovských slovech / Amicable Morphisms on Sturmian Words

Osnova:

1. Seznamte se se základními pojmy a větami z teorie symbolických dynamických systémů.
2. Udělejte rešerši poznatků o sturmovských slovech: přehled ekvivalentních definic sturmovských slov, popis morfismů zachovávajících sturmovská slova, popis standardních párů slov.
3. Zkoumejte vlastnosti párů spřátelených sturmovských morfismů, pokuste se popsat jejich generování a počty v závislosti na tvaru jejich matice.

Doporučená literatura:

1. M. Lothair, Algebraic Combinatorics on Words, Encyclopedia of Math. and its Applic., Cambridge University Press, 1990
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Adresa pracoviště:	Fakulta Jaderná a fyzikálně inženýrská Trojanova 13 / 106 Praha 2

Konzultant:

Datum zadání bakalářské práce:	15.10.2008
Termín odevzdání bakalářské práce:	**7.7.2009**

V Praze dne 17.3.2009

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Vedoucí katedry Děkan