Department of Computer Science and Engineering
College of Engineering
Qatar University

Senior Project Report

Intelligent Mobile Target Visitation of a UAV using DRL: A Practical Implementation of the Work by Hendawy *et al.*

Project Group Members

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This project report is submitted to the Department of Computer Science and Engineering of Qatar University in partial fulfillment of the requirements of the Senior Project course.

Declaration

This report has not been submitted for any other degree at this or any other University. It is solely the work of us except where cited in the text or the Acknowledgements page. It describes work carried out by us for the capstone design project. We are aware of the university's policy on plagiarism and the associated penalties and we declare that this report is the product of our own work.

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Abstract

Hello, here is some text without a meaning. 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. 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.

Acknowledgment

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Table of Contents

List of Figures

List of Tables

1 Introduction and Motivation

1.1 Problem statement

Hello, here is some text without a meaning. 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. 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.

1.2 Project significance

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1.3 Project objectives

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2 Background and Related Work

2.1 Background

Hello, here is some text without a meaning. 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. 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.

2.2 Related work

The third and final concept of the project is hardware realization for drone visits. The hardware part is essential in the implementation in the real world , where the simulation sometimes strays from the truth. There is a lack of hardware implementations in the field of research regarding drones with deep reinforcement learning (DRL) ,and most of the research papers focus on the simulations. According to the literature review, the convolutional neural network (CNN) models were used in the majority of the papers for object detection. Also, the controller boards and custom drone kits were used instead of commercial drones. Those kits give the researcher and user more flexibility since the drone is customizable in hardware and software.But in our design, we will use a commercial drone so that we focus on the DRL, not the actual drone build process.

The use of a microcomputer with Quadcopter unmanned aerial vehicles (UAVs) and autopilot software will help in the hardware implementation part. Khan, Tufail, Khan, *et al.* used the drone in the agriculture field to spray pesticides and monitor the crops. Unlike our work, the drone was limited to specific boundaries and fixed targets such as crops. They used a Raspberry Pi microcomputer board attached to the drone , which will handle two different operations. Firstly, it will control the drone using an open-source software called Arducopter autopilot which will handle the trip of the drone and autonomous flight option. The second operation is to deal with the Intel neural computer stick 2, which will deploy the CNN model and deal with the computation part [1]. Although this work is close to ours, there are some differences, one of them is using a custom drone which is not considered since we are limited in time. Since we will use the Anafi drone, the Olympe program will take control of the drone, which will be installed on the Raspberry Pi. Finally, using CNN only is not enough without DRL which makes the drone more intelligent and accurate.

A helpful example that uses a commercial drone with an onboard computer and uses SDK with image processing techniques. The hardware architecture in Wang, Gu, Huang, *et al.* work for this paper includes a DJI commercial drone and an onboard computer called manifold, which is from the same manufacturer. Also, onboard sensors like camera,GPS and inertial sensor are included. Finally, external battery for the manifold computer and Wi-Fi adapter that is used for connection between the drone and the onboard computer. This hardware architecture is inspirational , and our design is somehow close to it with minor changes in the onboard computer and without the existence of the sensors.Image and video processing techniques were used, such as segmentation to keep detecting moving targets was presented in [2]. For the navigation part, they used predetermined waypoints related to historical path cost. However, in our work, probability and mobility patterns will be used to guess the target's location.

An embedded system connected and attached to the UAV and uses mobility pattern recognition, which shortens response time and saves transmission bandwidth. Wang, Zhao, Yang, *et al.* work used a quadrotor UAV supported with GPS module and a Pix Hawk flight controller. The power sources in the architecture were two lithium batteries, one for the drone and one for the embedded system. The system uses NVIDIA Jetson development kits which give enough computing power for the processing and communication between the flight controller and the system. The Jetson board is connected to the flight controller using serial communication while connected to the ground controller using Wi-Fi. Communication tools and protocols used in Wang, Zhao, Yang, *et al.* work will help us to determine the best way to communicate between the development board and the drone without any delay or interference [3].

3 Requirements Analysis

3.1 Functional requirements

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3.2 Design constraints

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3.3 Design standards

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3.4 Professional code of ethics

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3.5 Assumptions

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4 Proposed Solution

4.1 Solution overview

4.2 High level architecture

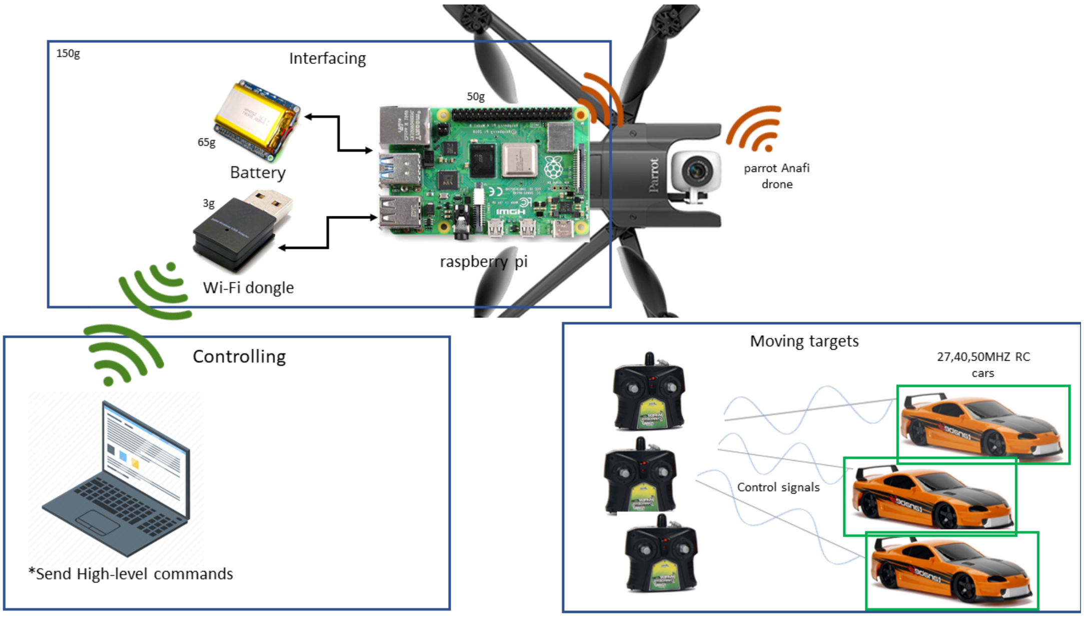

Figure 1: High-Level Architecture

4.3 Hardware/software to be used

5 Proof of Concept

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6 Market Research and Business Viability

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7 Project Plan

7.1 Project milestones

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7.2 Project timeline

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7.3 Anticipated risks

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8 Short Guide

Please read the guides available online about the right way to write LaTeX such as how to include a math symbol in text (e.g. x not x) and a proper noun with all capitals (e.g. SQL not SQL).

Below are examples of different constructs in a report. You can copy-paste and change the content. For more information, refer to the relevant package manual in CTAN.

8.1 Abbreviations

To add an abbreviation (e.g. UAV), append the following line in the list of abbreviations portion in main.tex:

```
\newacronym{uav}{\textsc{uav}}{unmanned aerial vehicle}
```

To use the abbreviation, there are 3 ways to do so:

1. In a normal case: `\gls{uav}`
2. For its plural form: `\glspl{uav}`
3. In the beginning of a sentence: `\Gls{uav}`
4. A combination of cases 2 and 3: `\Glspl{uav}`

For example:

> An UAV has many unique features. UAVs have been used in many different applications.

8.2 Figure

Figure 2: The arch linux logo

8.3 Equations

$$
\begin{aligned}
E_p &= mgh = mg(x_f - x_i) && (1) \\
E_k &= E_t + E_r \\
E_t &= \frac{1}{2}mv^2 && (2) \\
E_r &= \frac{1}{2}I\omega^2 && (3) \\
I &= \frac{1}{2}MR^2 && (4) \\
\omega &= \frac{v}{r} \\
E_k &= \frac{1}{2}mv^2 + \frac{1}{2}I\left(\frac{v}{r}\right)^2 && (5)
\end{aligned}
$$

where E_p is the potential energy, E_k the kinetic energy, E_t the translational energy and E_r the rotational energy.

$$
\begin{aligned}
\frac{\partial E_p}{\partial m} &= \frac{\partial}{\partial m}(mgh) \\
&= gh \\
\frac{\partial E_p}{\partial g} &= \frac{\partial}{\partial g}(mgh) \\
&= mh \\
\frac{\partial E_p}{\partial h} &= \frac{\partial}{\partial h}(mgh) \\
&= mg
\end{aligned}
$$

8.4 Simple table

Table 1: Slope, intercept and their uncertainties

Slope		Intercept (J)	
Value	Error	Value	Error
1.0933	0.0300	0.0148	0.0157

8.5 Table from a csv file

Table 2: Translational and rotational energies.

m	v_m	E_t	δE_t	E_r	δE_r
kg	$\mathrm{m\,s^{-1}}$	J	J	J	J
0.055	0.17	0.000 79	0.000 01	0.280	0.007
0.075	0.20	0.001 50	0.000 02	0.387	0.010
0.095	0.23	0.002 51	0.000 03	0.512	0.013
0.115	0.25	0.003 59	0.000 03	0.605	0.015
0.135	0.27	0.004 92	0.000 04	0.706	0.018

8.6 Graph from a csv file

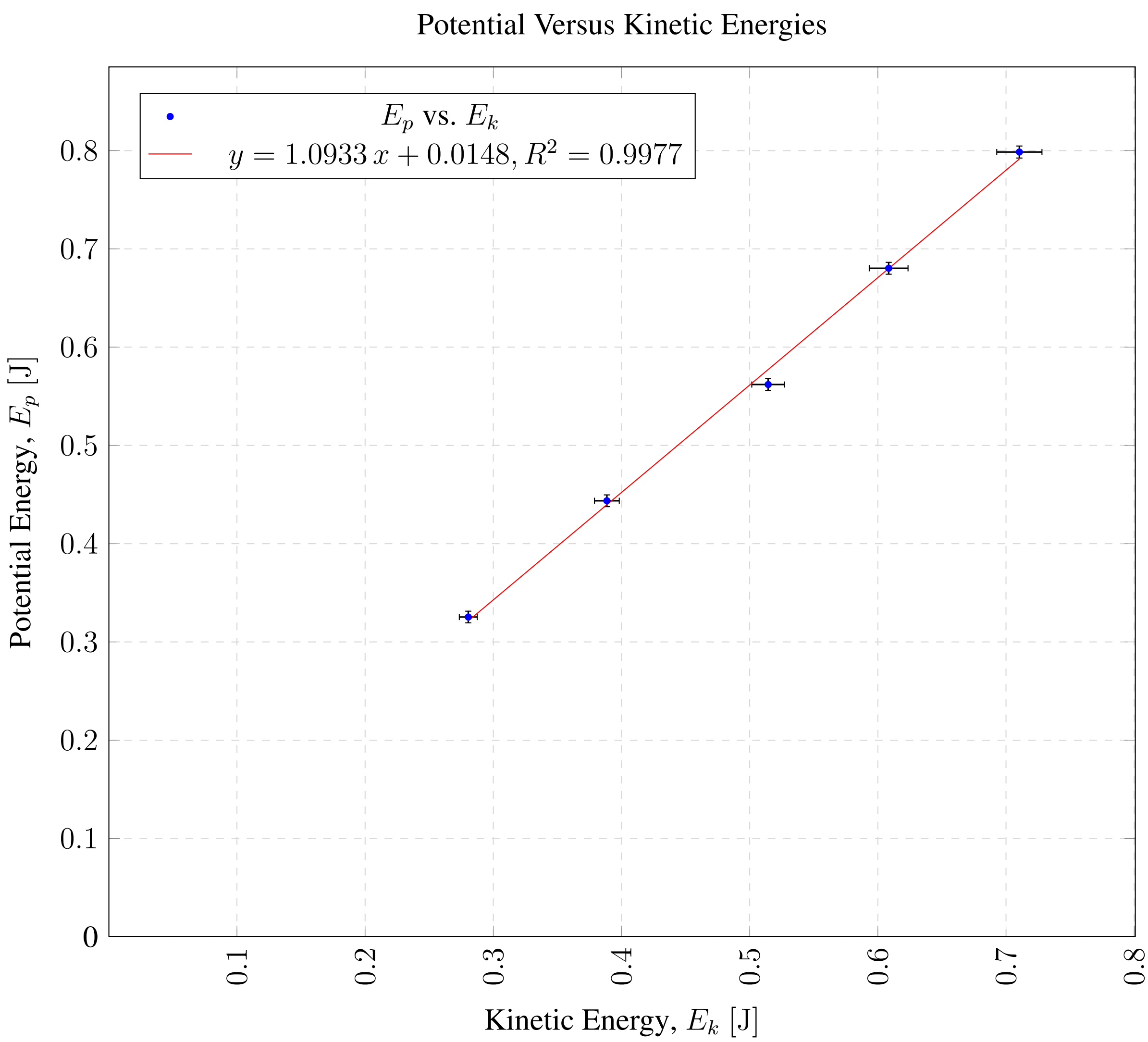

Figure 3: The relationship between potential and kinetic energies.

8.7 Citations

- **in-text citation**: use \cite{dirac} to produce [4] or \textcite{dirac} to produce Dirac [4]
- **citation in parentheses**: \parencite{knuthwebsite} produces [5] (for IEEE, this has no difference to the \cite{} command above.)

8.8 Cross-references

Label using suitable names with the following format: figure \label{fig:<name>}, tables \label{tab:<name>}, sections \label{sec:<name>} and equations

\label{eq:<name>}.

Then when cross-referencing, use \cref{<type>:<name>} (or \Cref{<type>:<name>} when used at the beginning of a sentence)

References

[1] S. Khan, M. Tufail, M. Khan, Z. Khan, J. Iqbal, and A. Wasim, "Real-time recognition of spraying area for uav sprayers using a deep learning approach," Apr. 2021. DOI: 10.1371/journal.pone.0249436.

[2] Q. Wang, J. Gu, H. Huang, and Y. Zhao, "Online drone-based moving target detection system in dense-obstructer environment," IEEE, Dec. 2018. DOI: 10.1109/PADSW.2018.8644908.

[3] C. Wang, R. Zhao, X. Yang, and Q. Wu, "Research of uav target detection and flight control based on deep learning," IEEE, May 2018. DOI: 10.1109/ICAIBD.2018.8396188.

[4] P. A. M. Dirac, *The Principles of Quantum Mechanics*, ser. International series of monographs on physics. Clarendon Press, 1981, ISBN: 9780198520115.

[5] D. Knuth. "Knuth: Computers and typesetting." (), [Online]. Available: http://www-cs-faculty.stanford.edu/~uno/abcde.html.

Appendix

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