Project log

Extended project qualification – Swarm communication

# Document introduction

This document servers the purpose to keep track of progress. This is an informal document, personal thoughts etc.

# Log

## Introduction to the possibility of an EPQ – 19/09/2018

Initial interest in EPQ sparked many ideas.

Initial idea consisted of some form of trajectory simulation which takes into consideration aerodynamics.

After careful research, aerodynamics deemed to be a challenging task, which could not provide results in the specified time period.

Another idea that sparked was swarm simulation:

A simulation software that will simulate the interactions and collaboration of many entities in a space based on parameters (cameras, sensors, positional awareness received through a potential ‘flagship’ type entity.

This could be compared to a fleet, of ships for example. There may be a ‘flagship’, which is the commanding unit for all other ships in the fleet, which is controlled by a higher authority.

## Ideas – 20/03/2018

The possible big questions:

“How can drones improve modern life in modern civilisations?”

“The possible applications of swarm-controlled drones”

**Possible future applications:**

Environment control:

Drones equipped with appropriate climate control equipment could monitor the climate of a city, possibly including factors such as temperature, carbon dioxide concentration, humidity etc. for accurate real-time weather updates and climate data.

In the nearby future if not today, drones could contain special features which will essentially ‘scrub’ carbon dioxide out of air (especially in highly congested cities).

Goodyear, a tyre company, has been developing many prototypes. One of the recent ones include a 3D-printed tyre “Oxygene”, which is partly made from living moss, which absorbs moisture from the air (as well as CARBON DIOXIDE), to convert into oxygen. Potentially, this technology (based on mass of the moss) could be incorporated into the drones, which will fly around a city, recycling carbon dioxide into oxygen. 1 drone may not be efficient, but a swarm of many drones could make a difference.

Gunseli Yalcinkaya. “Goodyear's ‘Living’ Car Tyre Converts Carbon Dioxide into Oxygen.” Dezeen, Dezeen, 13 Mar. 2018, www.dezeen.com/2018/03/09/goodyear-oxygene-tyre-converts-carbon-dioxide-into-oxygen-geneva-motor-show/

Emergency services:

**Law enforcement:**

Drones could potentially use A.I to track suspects (instructed by user probably). Since all drones are connected, then they would communicate the position of the suspect relative to the positional awareness of the drones, so that specific drones could predict the path and position themselves there (and possibly other drones) so the suspect will be tracked seamlessly between a network of aerial cameras.

Using real-time traffic data, drones could observe highly congested areas of a city which are flagged with a high accident rate, for any accidents.

**Emergency services:**

Using GPS and other positional awareness, drones could speed up the deployment and travel towards the wounded in many ways:

If a drone recognises as accident (either by video footage or if a person calls emergency services, the drone will scout the area for the caller, to provide emergency services with the exact location and nature of the problem.

Search and rescue:

Heavier aerial drones could harness the technology such as the FINDER.

“The Department of Homeland Security's Science and Technology Directorate, Washington, and NASA's Jet Propulsion Laboratory in Pasadena, Calif., have developed a new radar-based technology named Finding Individuals for Disaster and Emergency Response, or FINDER.

FINDER was created to detect a human heartbeat buried beneath 30 feet (9 meters) of crushed material, hidden behind 20 feet (6 meters) of solid concrete, and from a distance of 100 feet (30 meters) in open space.”

Such technology could be transported (or equipped) by either heavy drones or swarms of smaller drones the help with search and rescue.

Greicius, Tony. “New Technology Can Detect Heartbeats in Rubble.” NASA, NASA, 30 Apr. 2015, www.nasa.gov/centers/jpl/news/finder20130917.html.

Whitney Clavin 818-354-4673 Jet Propulsion Laboratory, Pasadena, Calif. whitney.clavin@jpl.nasa.gov 2013-282

**Smart city:**

Drones have many different applications in a smart city scenario:

Of course, they could collect real-time data about the city using A.I such as traffic, weather, statistics based on where people shop, patterns in traffic etc.

Drones could redistribute cell service.

With the recent development in 5G, a new generation of cell service, it can provide between 1Gb/s up to 10Gb/s (according to 5G.co.uk, accessed on the 20/03/2018). However, it does not travel far (due to the higher frequency used I presume). Therefore, drones could potentially redistribute the signal so more areas are reached (especially indoor areas)

## 28/03/2018

Started to plan possible artefact, built in Unity3D using C#. Unity3D is a nice framework and takes a lot of the workload such as threads, memory management and any visuals so I can focus on the backend.

It will be able to be ran on Windows, Android and WebGL.

## 06/05/2018

I’ve decided on a draft title for my project:

“What are the possible applications of Swarm A.I in the various industries and infrastructures available now, and in the near future?”

## 04/07/2018 – Unanimous

Upon searching for the various different current applications of Swarm A.I, I’ve accessed Unanimous AI’s website [https://unanimous.ai/ Date accessed: 04/07/08].

Unanimous utilises swarm A.I to amplify real-life data to predict outcomes. They gather a large group of individuals “locations all around the world, to login to our [Unanimous] Swarm® platform and participate as part of a real-time closed-loop intelligence moderated by AI algorithms. The system, which includes our web-based clients for desktop and mobile computers, a cloud-based server that moderates sessions with real-time Swarm AI algorithms, and backed processing using neural-networks,”.

To explain, buy gathering a large group of people, they are presented a question and different outcomes. These people then argue and present their opinion. Then the A.I algorithms after the effect of each person on real-life data and statistical knowledge to amplify the different knowledge, answering a question with a percentage certainly for each outcome. This video [https://www.youtube.com/watch?v=A-\_8FZ8-D7A] is sourced from their website, which you may view to get their explanation.

I’ve joined their mailing list to keep on track with their research. In the optional message box, I’ve mentioned I am doing an EPQ in swarm A.I, and therefore I am intrigued and would like to know more.

## 06/07/2018 – Received message

I’ve received a message from Gregg Willcox, a Unanimous employee from their R&D department.

“Hi Karol, …... It's great to hear that you're working on an EPQ related to swarming. …… Can you tell me more about what you're doing?”

E-Mail received on 06/07/2018

Therefore, I’ve replied with my ideas and details of my project, and asked for him to explain their swarm A.I solution. Waiting for response.

## 08/07/2018

I’ve received a reply:

“The first thing to know about Unanimous is that we amplify intelligence: we create hive minds (swarms) of humans. Unlike a traditional AI company, we believe that humans are smart... really smart, and we know that humans are smarter when they work together. So we connect people from all over and answer challenging questions... and what we're finding is that the resulting Swarm system is incredibly accurate.

How do we make a swarm of humans? We gather a group of humans, network and connect them in real-time, then ask a question (e.g. Who will win the US presidency in 2020?). We've created an environment which allows humans to swarm: to discuss, debate, and come to group consensus in answering any question, much in the same way that bees swarm. We use AI algorithms to moderate the debate.

Here's a blog post that has some GIFs of our system. https://unanimous.ai/sweet-sixteen-2018/. Every human controls one magnet, expressing their view and the strength of that view in real-time”

E-Mail received on 08/07/2018

## 17/07/2018

I’ve officially started the EPQ project.

Ideas for working title:

“The possible applications of Swarm A.I in the various industries and infrastructures available now and in the near future”

## 23/11/2018

My project seems that it might be too complicated for me, as well as the pressures from A-Level. I think I will shift the focus of the project from the A.I to maybe, communication protocols? Like a simulation program in which I demonstrate some, organisational ideas? Like the structure of a network of swarm agents, how they communicate, maybe I will implement something like blockchain?

## 07/12/2018

Decided on the working title:

“How can Swarm Communication found in natural systems be utilised?”

## 31/01/2019

Catch up with my supervisor, who approved my working title and my course of action for the project.

Artefact wise: I have started programming the application prototype, including GUI for a, visual representation of the advanced backend.

Right now, I will begin research on blockchain and encryption, as well as swarm applications, I will conduct a general survey to aid my project report.

## 05/02/2019

Research on blockchain and cryptography:

Blockchain source:

Narayanan, A., Bonneau, J., Felten, E., Miller, A. and Goldfeder, S., 2016. *Bitcoin and cryptocurrency technologies: A comprehensive introduction*. Princeton University Press.

@book{narayanan2016bitcoin, title={Bitcoin and cryptocurrency technologies: A comprehensive introduction}, author={Narayanan, Arvind and Bonneau, Joseph and Felten, Edward and Miller, Andrew and Goldfeder, Steven}, year={2016}, publisher={Princeton University Press}}

Cryptography:

Penard, W., Werkhoven van, T., (2007). ‘On the Secure Hash Algorithm family’, in Tel, G., *Cryptography in Context*. Utrecht University, pp 1-18

## 15/02/2019

Mid-project review

Final title:

“How can the mechanics behind swarm communication be implemented in networks of technological individual systems such as drones”

Still working on the artefact.

## 22/03/2019

Catch up with supervisor for my Project product review

The supervisor is happy with my progress as long as I can deliver the completed project by due date (12/04/2019).

Due to the time frame, exams and school pressure, the artefact will not be as feature rich as intended. I am determined however to program and demonstrate my algorithms, if in the most basic of forms. The intended aim of the project is to:

* Simulate a network of individual systems NOT dependant on a centralised source; the individuals can connect and exchange/distribute data amongst the network.
* Transfer and distribute data such as variables and commands amongst the network using blockchain technology and cryptographic hashing. The exact implementation method is still being planned, not sure YET how I will implement it successfully.

## 25/03/2019

Completely re-written the project to allow easier and much cleaner implementation of future features, as well as started using version-control system called ‘Git’, using the provider ‘GitHub’. Link: <https://github.com/K-Karol/Swarm-Communication>

This will allow to track my changes and make it easier to manage the project, and allows it to be viewed online (source code and other builds)

## 27/03/2019

Finished working on the basic visuals engine. This will provide a primitive, yet helpful visualisation of the network. Plus the console was re-written so a different command syntax and more features.

## 01/04/2019

Started the blockchain branch – In this module I will finally attempt to finish the project. I will try to implement and test my ideas using this project.

## 06/04/2019

I’ve created and distributed a survey collection the opinion of my peers and people who have completed the survey. The survey is intended to collect the opinions and test the general knowledge of people on this technology. More information in my project report

## 11/04/2019

The blockchain branch is ‘finished’. I didn’t manage to code some extra features such as end-to-end encryption, distributing commands and their execution, sharing blocks to specific agents etc. HOWEVER, the core principle or transmitting data across the network has been programmed.

Now I will finish the project report. The project report will include:

* Introduction to the topic, terminology and ideas
* Planning: Algorithms, Flowcharts and more
* Artefact: implementation of my planning
* Analysis: What have I missed, what would I have done differently if I had the time.
* The question: How does this apply to the question? Analysed survey
* Conclusion.