



### **PROCEEDING**

## NATIONAL INNOVATION & INVENTION COMPETITION 2019 (NIICe2019)

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA** 



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Siti Zarina Mohd Muji Marlia Morsin Roziah Aziz Radzi Ambar Suratun Nafisah



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### GIS Mapping and Shortest-Path Algorithm for Drone-Aided Flood Rescue Operations

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**Abstract** - Floods are quite common in Malaysia almost every year which occurs mostly during the monsoon season. Thousands are affected by the floods and rescuers are not always quick and efficient enough to save the majority of the victims. This research aims to implement Geographic Information System (GIS) mapping to identify the major parts of an affected state that are more susceptible to floods and the construction of an optimal shortest path algorithm to conduct the rescue operation.

Keywords: Geographic Information System; Shortest-Path Algorithm; K-Means Clustering; Travelling Salesman Problem; Euclidean Distance Algorithm

#### 1. Introduction

Out of the many states in Malaysia, Terengganu is one of the main victims of this natural disaster. The GIS map should aid in allocating further attention on those specific areas that are more vulnerable with the help of a Heat Map generated using K-Means Clustering and Principal Component Analysis (PCA) standardization using four main features which include Population, Distance from Sea (KM), Altitude/Elevation (M) and Annual Rainfall (MM). Each node in the cluster belongs to a town in the state of Terengganu. Moving on to the next phase, multiple drones could then be deployed in to the specific areas for further inspection using live surveillance by a team. Drones are a very useful component in this situation due to their tiny size, versatility and cost. The flood victims would then be pinpointed with the help of grid mapping. Once the victims' positions have been identified, an algorithm would be used to provide an optimal shortest distance path for standby rescue teams to reach all the identified victims in a much shorter period of time. This algorithm constructed is the combination the Travelling Salesman Problem (TSP) and Euclidean Distance algorithm. The goal is to find the shortest possible route to visit each node (victim locations) exactly once and return back to the original location in the shortest-time possible. The proposed mechanism could lead to future rescue operations being more efficient and saving more lives in the process.

In regards to flood risk mapping, multiple papers have been reviewed which focuses on Geographic Information System (GIS) mapping for identifying areas that are prone to flood occurrences. Tehrany, Pradhan and Jebur (2014) targets a specific part of the Terengganu State known as Kuala Terengganu City. The main techniques involved an ensemble weights-of-evidence (Bayesian Model) and Support Vector Machine (SVM) which were applied to 10 flood conditioning factors (flood inventory, slope, stream power index (SPI), topographic wetness index (TWI), altitude, curvature, distance from the river, geology, rainfall, land use/cover (LULC) and soil type) to classify the parts of the city that are more susceptible to floods. The success rate and prediction rate acquired was 96.48% and 95.67% respectively, which indicates that the model was a success. From all the papers that have been reviewed about flood-risk GIS mapping, it can be seen that different forms of techniques have been implemented and some of them have worked exceptionally well. One example would be the SVM model, but in our case, we are implementing an unsupervised learning method and therefore have turned to K-Means learning as our machine learning model. Furthermore, each paper has used a number of different flood conditioning factors which has helped us to get a better idea of both GIS and the type of parameters that we can include for our own research. Some of these factors have been notable as they were commonly used in multiple articles such as slope, topographic wetness index (TWI), altitude, rainfall, land use/cover (LULC) and soil type. Although some of these features are very helpful, relevant data on them are not available to us, thus we have decided to go for Population, Distance from Sea (KM), Altitude/Elevation (M) and Annual Rainfall (MM) as our four main features.

As for the construction of a shortest-path algorithm, multiple articles have been reviewed. In the first article, Alhoula and Hartley (2014) aims to provide a shortest-path algorithm for travelers to determine the best routes to take in order to reach their destination. Based on Dijkstra's Algorithm, they evaluated two implementations which include a static and time dependent network. The results are based on two factors which are the type of network (static or time-dependent) and size of the network (no. of nodes). The execution time of the program for time-dependent networks were much shorter compared to a static network for small, medium and large networks. Each paper has a different type of approach for determining a shortest path and has proven to be beneficial. Due to the scenario and conditions being different, we have opted to implement our shortest-path algorithm using a combination of the Travelling Salesman Problem (TSP) and Euclidean Distance algorithm.

#### 2. Material and Methods

#### 2.1 Tools Used

QGIS, RStudio, Python, Tableau

#### 2.2 Algorithms

- a) GIS Heat Map: K-Means Clustering
- b) Shortest-Path: Travelling Salesman Problem (TSP), Euclidean Distance Algorithm

#### 2.3 Workflow

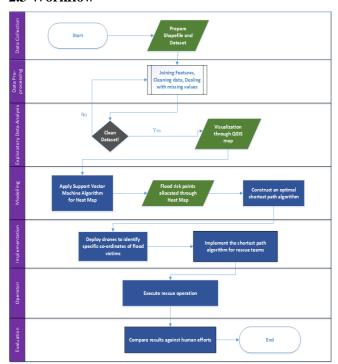


Figure 1. Diagram of project workflow

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#### 3. Result and Discussion

Results have not been acquired yet, as this is a current ongoing project that is being implemented.

#### 4. Conclusion

Conclusion can not be stated unless we have our final result.

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# PROCEEDING NATIONAL INNOVATION & INVENTION COMPETITION 2019 (NIICe2019)

## Universiti Tun Hussein Onn Malaysia

NIICe2019 is the first national innovation competition organised by FKEE. Under theme Towards IR4.0 Through Innovation, NIICe2019 has received numerous supports from various institutions such as Johor State Education Department, Polytecnic and Community College. In addition, NIICe2019 is inspired from the activities organised by the Faculty to promote research and innovation among the students namely, FYP and IDP/EDP showcase.



