DRRM Plan: Rehabilitation & Recovery

An Integrated Performance Task: Physics & Robotics

Submitted by:
Baron Christian U. Castillo
Diego Lorenzo E. Macias
Keith Randall S. Leonardo
Tomas Agustin S. Santos

12C

Presented to:
Sir.John Kenneth D. Sangab
De La Salle Santiago Zobel - Vermosa Campus
January 16, 2017

I. Presentation of Scenario

South Admiral is a village in Paranaque city located at the outskirts of barangay Merville. It has an estimated 950 population size and 38,709 m^2 in total land area. The village is divided into two phases along Daly road. The area to its east is known as phase 1, while the area to the west is known as phase 2. The latter is a recent addition to the village, with many new lots and houses under construction. The village has several key areas, including two gatehouses and the village association headquarters. One gatehouse is located along Daly road and another is located along Edison Avenue. The village association headquarters is located at Roxas Circle. Life in the village is slow and quiet, as the roads are of sufficient width and most traffic passes through Daly road. South Admiral also serves as one of the main entrances to Merville, which may cause increase in periodic traffic due to residents entering and exiting the village.

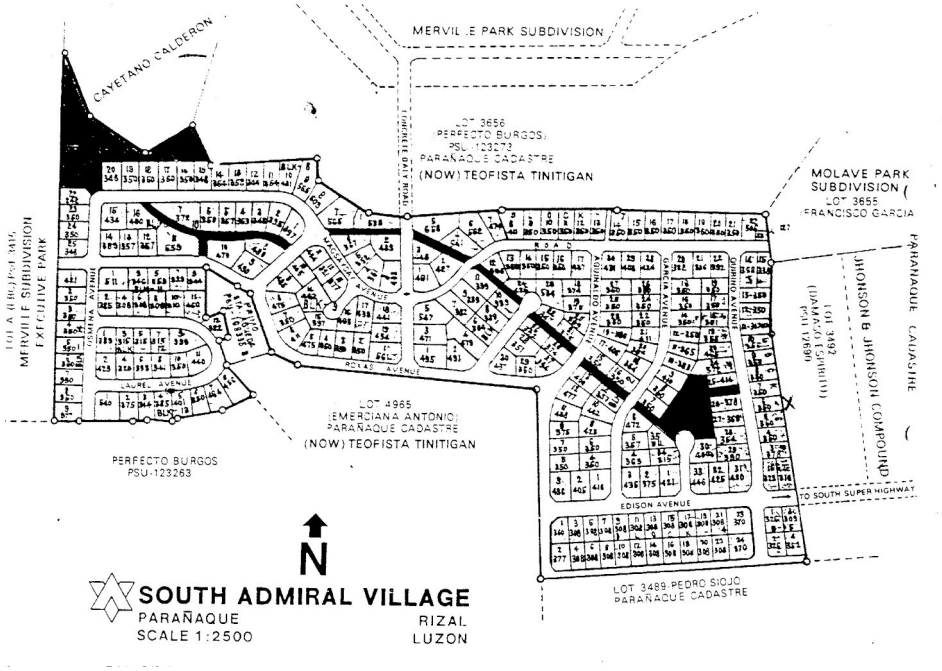


Figure 1.1 Map of South Admiral Village

South Admiral currently classifies incidents into two categories: emergency and disasters. Emergency incidents involve medical and police response, while disasters involve natural occurrences that include earthquakes, floods, fires, and typhoons. In preparation for these incidents, villagers are required to be knowledgeable in the security hotline *(823-8504)*

and emergency numbers. In the event of a disaster, homeowners are required to evacuate to a designated safety area, which is currently the covered court in located in phase 1. However, despite these measures, South Admiral currently lacks several necessities, including equipment to counter such disasters and emergency kits. In particular, they do not have the equipment to salvage or move debris in the event of an earthquake. Worse still, the village does not have access to a medical facility, and the homeowners are required to know important individuals, including doctors, who reside within the village in case of emergencies. Phase 2 of the village is subject to flooding due to lower elevation and the nearby canal in the park. During the yearly typhoons, homeowners are subjected to strong winds and flooding, so villagers are advised to evacuate beforehand to the designated covered court area. There are currently plans to construct a flood basin to mitigate its effects.--jm

Given the problems posed by their current disaster management plan and the lack of some important aspects that would allow it to be effective, we aim to make the village safer for the community. In order to achieve this, certain changes must be made in the regulations implemented by the homeowners association. Additional materials and projects are proposed to improve the overall situation in the area. This will ensure that the residents are prepared in the event of emergency or disaster scenarios.

II. Proposed Solutions to the Problem

A. Construction of Medical Facility (Clinic)

The addition of a clinic would provide long-term and short-term medical treatment for residents. This clinic may provide specialized care for those in need of assistance in response to a disaster. It would allow residents to deal with injuries that cannot be treated at home and would also provide immediate first-aid assistance to different sections of the village. In the event of emergencies, they would be in-charge of delivering medical supplies to residents, as well as post-disaster recovery. Finally, it acts as the general convenience because currently, the nearest medical clinic is located within the neighboring barangay Merville.

B. Extension of Safety and Evacuation Area

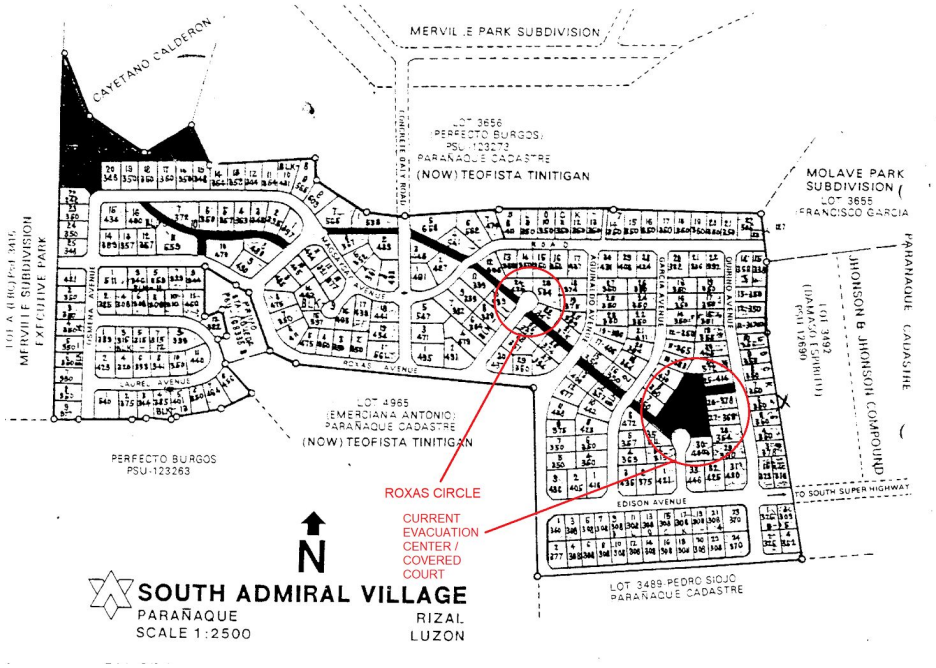


Figure 2.1 Evacuation Areas

The current disaster management plan of South Admiral involves the evacuation of residents and their transfer to the covered court at the east side of the village. The team proposes that during earthquakes, the evacuation area be extended to Roxas Circle, which is roughly at the center of the village. This is beneficial as since it is equidistant from all sides, it improves ease of access for all residents (see figure 2.1), and the village association office is located in the area. The current space in the circle may not be enough to contain all the South Admiral residents. Thus, the nearby roads in the area will be widened to compensate. This will not only be for the purpose of emergencies, as it can improve overall traffic as well.

C. Search and Delivery Drone

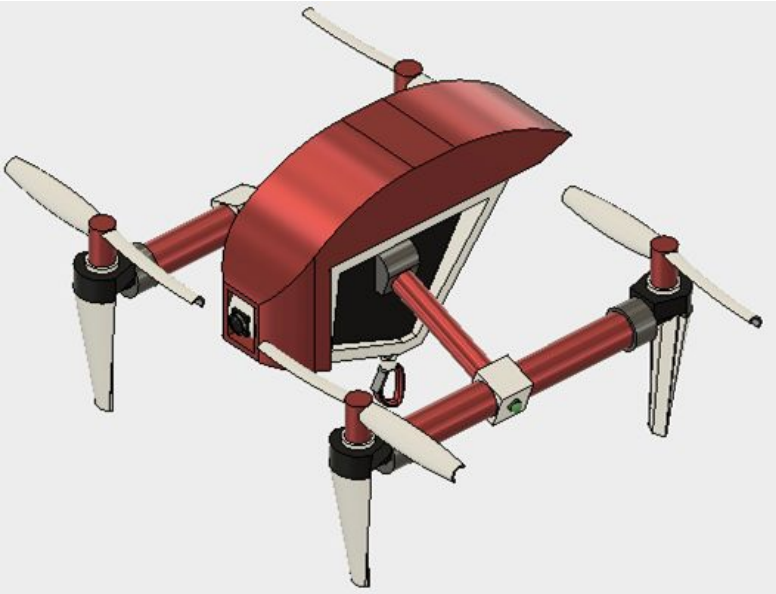


Figure 2.2 Search and Delivery Drone

In the event of an earthquake, a search and delivery drone may be deployed to look for signs of life in collapsed structures (see figure 2.2). The drone utilizes a Passive Infrared Sensor (PIR) and radar technology to detect the motion of heat emitting objects like animals or people (Narayanan, Smith & Gallagher, 2014; Yun & Lee, 2014). In order to maneuver in the air while hovering on its own through its artificial intelligence, it uses an internal gyroscopic sensor to maintain its balance and evenly distribute power to each of its four propellers. Four ultrasonic sensors placed at the sides of the drone would allow it to detect obstacles in its path and adjust its trajectory accordingly.

Applications of the drone may include searching for missing persons and disaster analysis. The drone has two modes of operation: control and autopilot. The artificial intelligence will allow it to scan buildings and send feedback to control personnel regarding the location of potential disaster survivors. In addition, the drone is capable of delivering medical and food supplies to people trapped in heavily flooded areas. This is particularly effective for high-rise structures, allowing rescue personnel to determine the floors in which people are trapped or unable to escape.

III. Justification of the Proposal

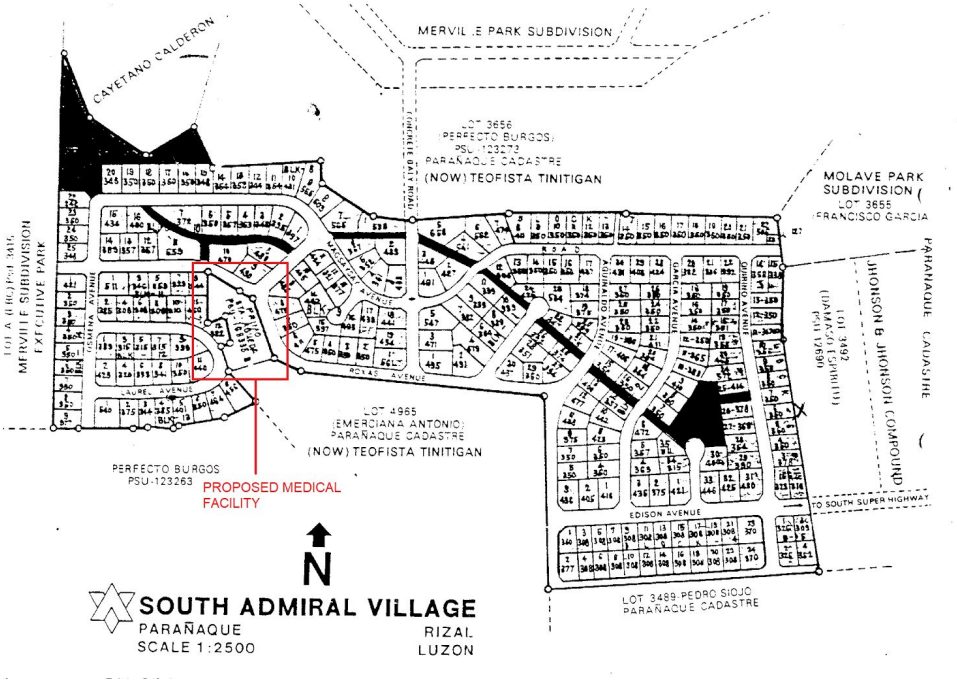


Figure 3.1 Medical Facility Location

The proposed clinic would be two-stories tall. There will be sections of the building dedicated to minor injuries, surgery, x-rays, laboratories, and general physician check-ups. There will also be a section of the building dedicated to the storage of medical supplies, both for the clinic itself and for post-disaster recovery scenarios. The primary limitations of this proposal include the total cost and time needed for the construction of the clinic building. Despite this, the medical facility would greatly improve South Admiral's overall disaster response and recovery features. It would be beneficial to its residents, as providing healthcare in the village can help them treat serious injuries without traveling long distances within the neighboring barangay. Its location at the center of phase 2 would make its accessibility more difficult for residents from phase 1. However, there is already a plot of land available for its construction, allowing it to be more cost-effective (see figure 3.1).

The additional evacuation area would allow more residents to gather at a specific area suitable for specific disasters. This makes the process of post-disaster management easier for officials, as they could easily take note of missing persons and alike. This newly designated

area would be located in Roxas Circle near the village headquarters, and it will primarily be for earthquakes. Its location near phase 2 allows easier accessibility to its residents both to the left and right of Daly road. In addition, Roxas Circle is safer in comparison to the covered court because of its open space, reducing the risk of collapsing structures in the event of earthquake aftershocks or fires. However, in the event of typhoons and flooding, the evacuation area will remain at the covered court.

The implementation of a search and delivery drone will be will be advantageous for the village, especially post-disaster. The relatively small size of the village allows an aerial drone to quickly maneuver around and search for missing persons. It is able to swivel the camera up and down and the drone can rotate with its four propellers for maximum visage in a large area being scanned (see figure 3.2). It is not limited by uneven terrain due to its flight capability; however, it is still susceptible to being influenced by strong winds.

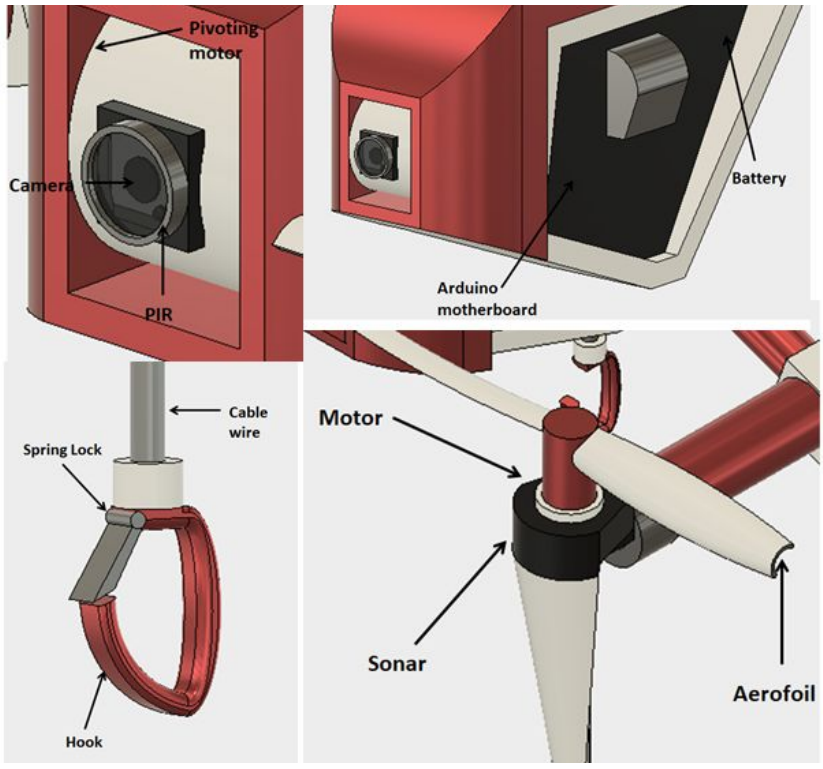


Figure 3.2 Drone Components

Similar drone designs are currently being used both for civilian and military purposes. The proposal is inspired by that used by Amazon Prime Air, which is used to deliver goods weighing a maximum of 2.25 kg in less than 30 minutes (Amazon, n.d.). It has a similar "quadcopter" design. Various cameras and sensors were similarly used by the JTT industrial drone to search for victims and survey areas (Shenzhen JTT Technology Co., n.d.). It is deployed in the event of various types of disasters, including fires and forest rescue. It is able to detect the presence of people with its PIR sensor, which is used for heat tracking. The AltiGator Aerial View Aircraft inspired the usage of infrared sensors based on its usage for searching for crime suspects as well as victims within buildings (AltiGator, n.d.).

IV. Elaboration of Planning and Implementation

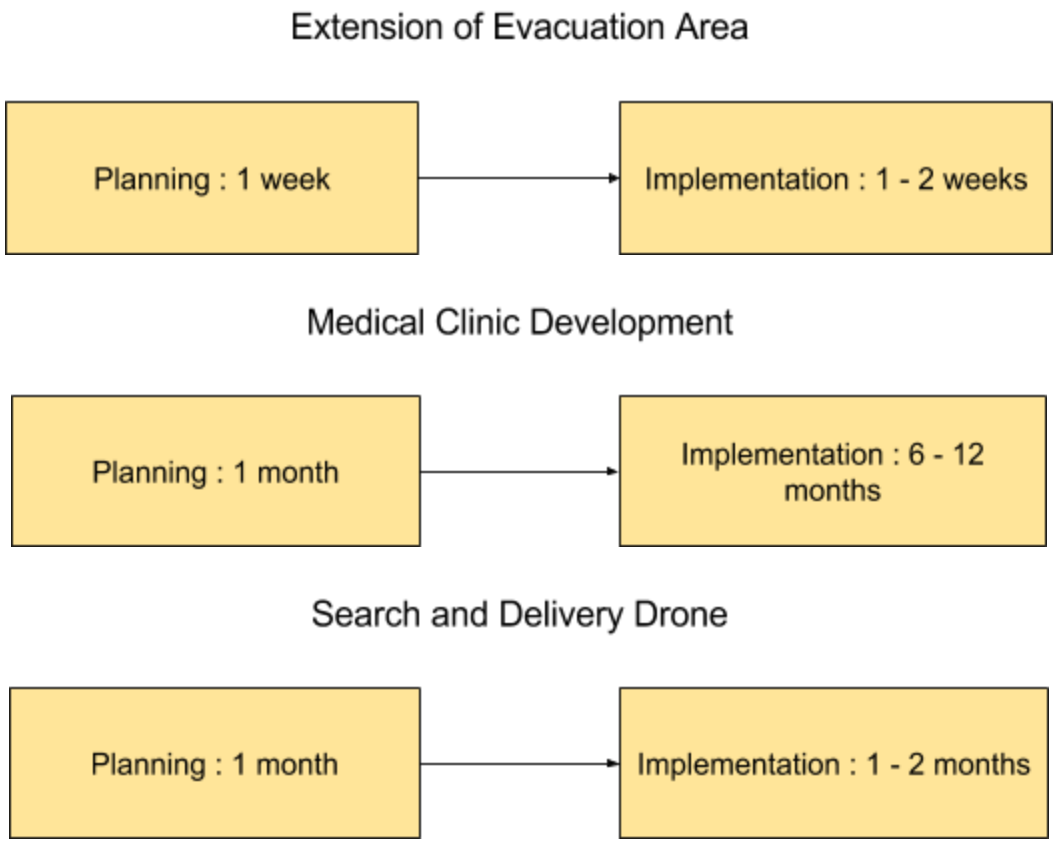
A. Drone Mechanics and Scientific Support

Various scientific concepts were taken into consideration in the planning of the proposal. This was done to minimize cost and maximize effectiveness when deployed or implemented during emergencies. The following table describes the specific concepts used in designing certain aspects of the search and delivery drone:

Concept	Explanation
Applied Force	Each propeller takes a specific shape, known as an aerofoil, to uses applied forces to push incoming wind downward and assist in lifting the drone (Woodford, 2017). In order to rotate or move across the x, y, and z axes, two of the propellers must exert more force than the others to eliminate equilibrium (Allain, 2017).
Equilibrant Forces	The spatial distribution of the four propellers would allow the robot to balance despite carrying a heavy load. Each propellor contributes angular momentum, forcing the body to spin toward the opposite direction (Allain, 2017). The placement of two clockwise and two counterclockwise rotating propellers reduces angular momentum, preventing it from swerving and allowing it to maintain equilibrium.
Tension	The cable and hook from which medical supplies are attached for delivery, as well as

	the frame of the drone, are constructed out of metal to increase their tensile strength. This reduces the strain caused by the tension exerted when a heavy load is lifted.
Friction	The propeller axles and the motors they are connected to must have a low coefficient of friction to allow smooth motion and less resistance as it spins. This allows greater rotational momentum in each of the blades as it moves and an increase in the overall efficiency of the craft, especially since it must be capable of carrying a weighted load.
Velocity and Sound	The drone is able to estimate the distance between itself and an obstacle using an ultrasonic sensor. It emits a sound and records the time it takes for the sound to bounce back. The robot uses this value to calculate distance with the formula $d = rt$.

B. Timeline



The initial planning for the proposals will take an estimated 1 month maximum. The implementation time for each proposal varies, however. The first proposal that will be executed would be the extension of the evacuation area, since this takes the least amount of time to be implemented. Next would be the construction of the new medical clinic in the phase 2 area. This is to be prioritized over the drone due to the scale and overall cost of the project. Finally, the design of the drone will be finalized and several models will be constructed to be used during disasters. Overall, the entire proposal implementation expected to be completed within one year.

C. Budget and Funding

Table 4.1 Estimated Budget Statement

	Unit Cost	**QTY**	**Total Price**
Medical Clinic			
Material Costs and Fees	Php 750,000	1	Php 750,000
Construction	Php 3,000,000	1	Php 3,000,000
Medical Equipment	Php 620,000	1	Php 620,000
Drone			
PIR Sensor	Php 150	1	Php 150
Ultrasonic Sensor	Php 150	4	Php 600
Gyroscopic Sensor	Php 443	1	Php 443
Propeller Blades	Php 250	4	Php 1,000
Arduino Board	Php 1,450	1	Php 1,450
AdaFruit Board	Php 750	1	Php 750
Drone Frame (Custom Models)	Php 2,500	1	Php 2,500

GRAND TOTAL	**Php 4,276,893**

Table 4.1 shows the estimated costs for the execution of the proposal. Initial funding is expected to come from government funds as well as the taxes paid by the homeowners. Recently, the government has allocated over 458.61 billion pesos on infrastructure development. This can be used primarily for the construction of the clinic, while other funding sources would be allocated to the material costs of the drone. The village will also be encouraged to invite third-party investors to contribute funding to the projects. Steady financial support is planned to come from large businesses including Maynilad and Meralco. This will ensure that the facilities, most especially the clinic, continuously receive funding for improvements and maintenance over the next few years.

D. Implementation Steps

Before the implementation of the proposal, there will be a community gathering at the covered court area to discuss the changes to be made in the disaster risk management plan. There will be a feedback system to encourage villagers to participate in the improvement of the current plan. Once the implementation rules are explained, implementation of the proposal may begin.

Residents are encouraged to leave the household and travel to the evacuation area at either Roxas Circle or the covered court for earthquakes and typhoons or floods respectively. They will be grouped according to their residence at either phase and village officials will perform a head count and other preliminary checks to determine whether or not there are missing persons. Doctors from the clinic and other licensed and knowledgeable personnel would help distribute medical kits and tend to the wounded, while the remaining personnel will utilize the search and delivery drone to search for possible missing persons and deliver goods and supplies to them.

E. UN Sustainable Development Goals

The Sustainable Development Goals were created by the United Nations as a plan to end poverty, protect the planet, and improve lives within communities. Each goal tackles a specific problem, and they are meant to be achieved by the year 2030. The proposed solutions to the disaster management plan of South Admiral Village contribute to the achievement of these goals. In particular, the mentioned proposals help solve the following:

Goal 3: Good Health and Well-Bring

This focuses on improving life-expectancy for all ages and reducing the mortality rate within a community. The development of a local clinic makes it possible for the residents to properly treat injuries and illnesses without needing to travel far distances. It will provide necessary assistance in post-disaster situations, including the distribution of goods and medical supplies. In addition, the proposed search and delivery drone makes these supplies accessible to people who are not within the vicinity of the evacuation area, including those who are trapped due to floods and collapsed structures.

Goal 9: Industry, Innovation, and Infrastructure

This focuses on civil and technological innovation within the community. The proposed drone is composed of various existing technologies to improve post-disaster management, including infrared and ultrasonic sensors to detect signs of life in collapsed structures, as well as the delivery of goods and supplies to unreachable or trapped residents. The construction of a local clinic and the widening of roads improve the infrastructure of South Admiral Village, improving traffic and allowing residents to have access to local healthcare services.

V. References

Dunbar, B. (2015, May 27). *What Is a Helicopter?.* Retrieved January 15, 2018, from https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-helicopter-58.html

Woodford, C. (2017, December 04). *How does a helicopter work?* | *Who invented helicopters?* Retrieved January 15, 2018, from http://www.explainthatstuff.com/helicopter.html

Allain, R. (2017, June 02). *How Do Drones Fly? Physics, of Course!* Retrieved January 15, 2018, from https://www.wired.com/2017/05/the-physics-of-drones/

Narayanan, R. M., Smith, S., & Gallagher, K. A. (2014). *A Multifrequency Radar System for Detecting Humans and Characterizing Human Activities for Short-Range Through-Wall and Long-Range Foliage Penetration Applications.* Retrieved January 15, 2018, from https://www.hindawi.com/journals/ijmst/2014/958905/

ScienceDirect (2016, April 21). *Radar based detection and tracking of a walking human.* Retrieved January 15, 2018, from https://www.sciencedirect.com/science/article/pii/S1474667016350960

IEEE Xplore Digital Library (n.d.). Retrieved January 15, 2018, from http://ieeexplore.ieee.org/document/4472790/

Yun, J., & Lee, S. (2014). *Human Movement Detection and Identification Using Pyroelectric Infrared Sensors.* Retrieved January 15, 2018, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4063065/

Amazon (n.d.). Retrieved January 15, 2018, from https://www.amazon.com/Amazon-Prime-Air/b?node=8037720011

Shenzhen JTT Technology Co. (n.d.). *Forest Rescue*. Retrieved January 15, 2018, from http://en.jttuav.com/article/detail/86.html

Shenzhen JTT Technology Co. (n.d.). *Firefighting.* Retrieved January 15, 2018, from http://en.jttuav.com/article/detail/17.html

AltiGator. (n.d.). *Drones for search & rescue missions.* Retrieved January 15, 2018, from http://altigator.com/drones-for-search-rescue-missions/

Cepeda, M. (n.d.). *P458-B DPWH budget to fund 'most ambitious' PH infra program in 2017*. Retrieved January 15, 2018, from https://www.rappler.com/business/industries/208-infrastructure/144606-dpwh-proposed-budget-2017

World Health Organization (n.d.). Retrieved January 15, 2018, from http://www.who.int/medical_devices/survey_resources/medical_devices_by_facility_health_center_kenya.pdf