UNMANNED AMPHIBIOUS ROBOT IN AIDING POST-TYPHOON HEAVY FLOODING REPONSE USING LORA-BASED COMMUNICATION AND YOLOV5

Gabriel Lyane P. Arevalo[1], Aviegail B. Bobadilla[2], Rajan Mole D. Macaraig[3], Felix Christofer G. Valdez[4], Eufemia A. Garcia[5], Charles G. Juarizo[6]

1, 2, 3, 4 Project Students, Department of Electronics Engineering, Pamantasan ng Lungsod ng Maynila

5,6 Faculty Members, Department of Electronics Engineering, Pamantasan ng Lungsod ng Maynila

glparevalo2020@plm.edu.ph[1], aviegailbobadilla0711@gmail.com[2], rmdmacaraig2020@plm.edu.ph[3], fcg.valdez07@gmail.com[4], eagarcia@plm.edu.ph[5], cgjuarizo@plm.edu.ph[6]

ABSTRACT

In the Philippines, about twenty (20) typhoons occur annually, causing heavy flooding which poses risks that lead to injuries and casualties despite preparedness measures. This study addresses the problem of hindered rescue efforts due to limited resources, dangerous access to flooded areas, and damaged communication infrastructures by introducing an innovative solution: an unmanned amphibious robot for search and monitoring tasks. The developed robot is capable of locating human presence and help needed while providing a live video feed. Evaluations demonstrated the capabilities of the robot to navigate both on land and water with respective speeds of 1.2 m/s and 0.205 m/s over a 120-m LoRa communication. The live video feed quality highlights the feasibility of a 4G LTE network for real-time display. The trained YOLOv5 model had high accuracy in detecting human presence and help needed over 3.5m and 7m distances with 90% and 93.33%, respectively. GPS coordinates reception yields good results in open areas only. Seamless integration of data from the robot to the local website, offering accessible data. Limitations arose when live video feed streaming and YOLOv5 processing were done simultaneously. This research contributes to aiding post-typhoon heavy flooding response by developing an unmanned amphibious robot, offering insights into its performance and potential for real-world applications in disaster response scenarios.

Keywords: Heavy flooding, LoRa, Machine Learning, Unmanned Amphibious Robot

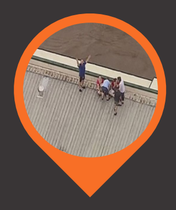
INTRODUCTION

Background of the Study

Limited rescue equipment

Inspection relies on communication

Delayed search and rescue



Objectives

- To construct an unmanned amphibious robot capable of traveling on both land and water
- To configure a robot capable of providing a live video feed
- To develop a robot capable of locating human presence and help needed using Global Positioning System (GPS) andYOLOv5

Significance

Aiding search and monitoring

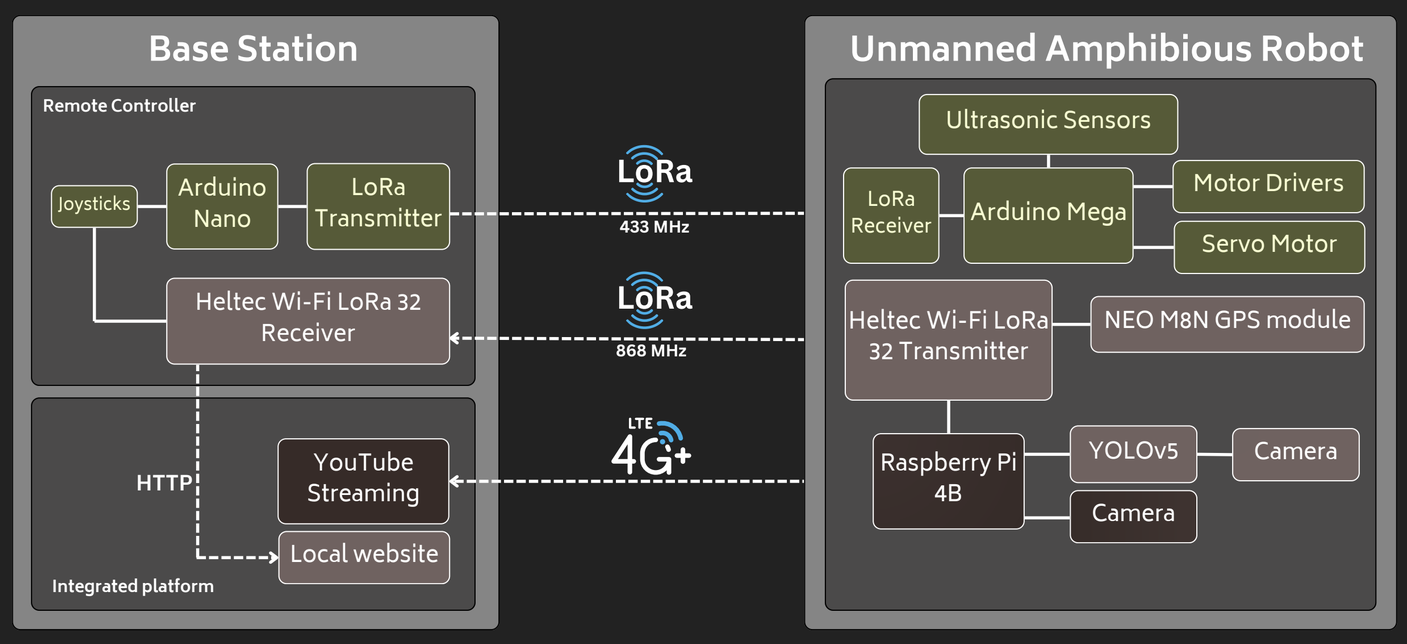
Ensuring rescuer safety

Contributing to innovation

METHODOLOGY

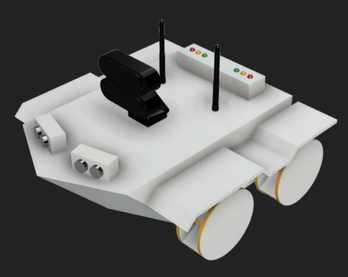
- **Research Design**
  Developmental design
  Experimental design
- **Research Development**
  Hardware structure construction
  Electronics and firmware integration
- **Data Collection**
  Residential area in Biwas, Tanza Cavite, involving 10 participants
- **Analysis and Interpretation**
  Hypothesis testing, correlation, descriptive statistics

System Architecture

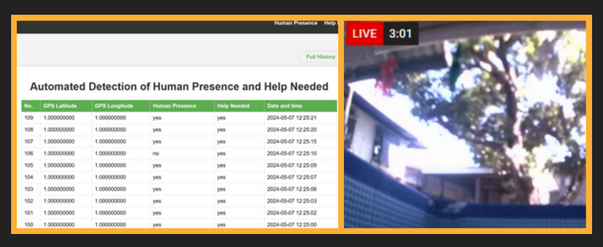


Research Development

- Unmanned Amphibious Robot



- Integrated Platform



RESULTS AND DISCUSSION

Land and Water Navigation

Land Navigation		Water Navigation	
Terrain Type	Speed	Randomly Generated Waves	0.2 m/s
Smooth Terrain	1.2 m/s		
Moderate Terrain	0.6 m/s		
Rough Terrain	0.45 m/s		
Ultrasonic Sensor Error			1.48%
UAR Collision Prevention Response			100%
UAR Collision Prevention Success Rate			73.33%
Maximum Effective LoRa-based Communication Distance			120m
Power Consumption Duration			56 minutes

Live Video Feed Quality

Network Connection	Final Rate Factor	Mean Q-parameter	Mean Bitrate (kbps)	Mean Encoding Speed	Mean Frames per second (fps)	Speed (Mbps)
4G LTE Network	25.28	17.47	1519.`04	1.01	30.01	15.1

Human Presence and Help Gesture Recognition

Difference with Google Maps	0.07 %
Overall Machine Learning Accuracy	91.67 %
Recognition Time	3.43 seconds
Local Website Display Capabilities	100 %

Locating Human Presence and Help Needed

Setting	Trials	Live Video Feed		UAR Navigation	Machine Learning Detection	Local Website Display Capability
		Quality	Delay			
Land	10	60%	11.66s	100%	60%	100%
Water	20	40%	13.81s	100%	60%	100%

The results indicate that the robot had a successful amphibious navigation, live feed provision, and automated detection. The individual processes show noteworthy performance. However, the system performance results show degradations in the live video feed and automated detection when simultaneous processes were done.

CONCLUSION

- Develop an unmanned amphibious robot (UAR) for post-typhoon heavy flooding response.
- Successfully navigates on land (smooth, moderate, rough terrains) and water.
- LoRa-based system with a maximum effective range of 120 meters.

  Effective obstacle detection and avoidance.
- Streams successfully using 4G LTE with positive video quality.
- Accurately detects human presence and help needs across varying distances.
- Processing machine learning and live video on Raspberry Pi 4B caused performance delay.
- UAR shows strong potential for use in post-typhoon heavy flooding response.

ASEC 2024 Conference

MDPI