ICIUS-2010-0149

Bukit Merah Lake Contour Mapping using Swarm of mini ASVs

Zulkifli Zainal Abidin, Khairul Izman Abdul Rahim, Mohd Rizal Arshad, Umi Kalthum Ngah
Underwater Robotics Research Group (URRG), School of Electrical and Electronic Engineering, Universiti Sains Malaysia, 14300, Pulau Pinang Malaysia
zzulkifli@iiu.edu.my, khairulizman@yahoo.com, rizal@usm.edu.my and eeumi@eng.usm.my

Key Words Autonomous Surface Vehicle (ASV), Drosobots, Drosophila.

Abstract- A new concept of an Autonomous Surface Vehicle (ASV) is proposed, mimicking the predictable biological balancing nature of the Drosophila or the fruit fly. The idea of mini ASVs known as Drosobots is proposed in tandem with swarming concepts. Here, ASV may be deployed to overcome factors of complexity in instrument deployment, expensive tools for marine applications, data collections inhibited by time and resources. Factors influencing the conceptual model, the choice of shape, parameters influencing control in design, the practicalities encountered in navigational issues and mechanisms of communication amongst a group of the Drosobots based upon their optimal swarming movements are also investigated.

I. INTRODUCTION

In general, ASV is a robot that can maneuver itself on the earth surface. In this project, the ASV is designed for oceanographic application and so it is set to maneuver itself on the surface of fluid. ASVs are getting less attention if comparing to autonomous underwater vehicle (AUV) [1]. This is because underwater environment is dangerous and thus demand for unmanned vehicle to complete its task is especially higher than the one at the water level.

However, this factor does not impede the research of ASV. At the initial stage, ASV is known as unmanned surface vehicle. Almost all the ASV projects are funded by navy section of defense department of various countries. Unmanned surface vehicles were expected to be applied in ship design so unmanned boats and unmanned ship can be built. Such a desire proved to be too ambitious since the environmental forces cannot be predicted even in the presence of the specialists. Recently, development of ASVs tends to go to another extreme. Other than, the sizes of ASVs are reduced, now the ASVs are produced in swarms in order to perform surveillance tasks and topography investigations [2].

Thus, the main scenario of this project is to produce ASV prototypes that can maneuver to the desired points which are either assigned manually or assigned by automatic path planning system in order to cover a larger area in limited period of time.

Hence, the primary objective of this project is to develop a control system that will enable the ASV to maneuver on the surface of water in swarms.

The significance of this project is to catalyze the integration of swarm robotics and ASV researches. Swarm robotics is a relatively new branch of robotics. Most of the swarm robotics application is still limited to the land robots. Hence, the realization of swarm robotics

ISBN 978-979-16955-1-0

application using ASV is still relatively fresh in robotic realm [3].

II. BACKGROUND

Drosobots is the prototype in this project. Drosobots is named after a species of fruit fly with the scientific name, Drosophila Melanogaster. The motivation behind the Drosobots project is to create a swarm of agent which imitates the fly behavior. Thus, Drosobots is a swarm robotic application on the surface of water. Since Drosobots is designed for surveillance purpose and topology investigation, an AI path planning system will be designed in order to imitate the searching behavior and motion of the Drosophila.

In this work, ASVs is a good decision make to apply the concept behavior of drosophila and brought this project toward the names of DrosoBOTs. This DrosoBOTs has been built using small size rounded tray aluminum as a base and acrylic as a cap. It was easy to get these component at any hardware shop and available in different sizes and shapes depend on our needed. This component allows fast prototyping and flexibility in the vehicle structure. To present an alternative solution of propelling methods used in autonomous vehicles, slim line water pumps have been used to propel the DrosoBOTs. To achieve the objectives in design of navigation and surveillance purpose, depth and temperature transducer were used.

III. SYSTEM DESIGN

The ASV agent was designed to be in rounded shape, so that it can move in omni directional, based on the motion behavior of the Drosophila. Dimension of each agent is 40cm in diameter and 7cm in height. Compared to a conventional ship with dimensions in meters, motion of an ASV can be greatly influenced by the environmental forces. Moreover, the DrosoBot is round in shape and so the ship model parameters cannot be taken.

A Drosobot agent has two thrusters with equal power. Two thrusters are designed to be parallel with each other. Since two thrusters in the same orientation, no significant rotation will be derived. Servo motor is used to control the rudder angle. Hence, the control system must be able to handle these actuators and the power must be consistently supplied. The power source is set to be lithium-ion batteries which will last for 3 hours. The hardware of the control system is a Basic Stamp microcontroller development kit which is small in sizing.

Since Drosobots is a swarm robotic application, eight ASVs had been built in order to demonstrate the practical benefits of the swarm intelligence. Thus, communication problem is one of the extra challenges in this project. This is because when two agents request for transmission in same time, the data might be lost. The topology investigation tasks aspired the implementation of a communication system with 900Mhz RF transceiver as its core. This system is able to communicate among themselves and also central station via distributed control architecture system with a maximum distance of 36km (Fig. 2). The depth sensor also installed in order to meet the demand of topology investigation tasks. Magnetic compass and GPS are also available in the sensory system. All the sensors are linked to the NMEA combiner that relieves the microcontroller system from serial communication traffic. The sensory system enables the implementation of the maneuvering control system of the ASV.

Magnetic compass and GPS are also available in the sensory system. All the sensors are linked to the NMEA combiner that relieves the microcontroller system from serial communication traffic. The sensory system enables the implementation of the maneuvering control system of the ASV.

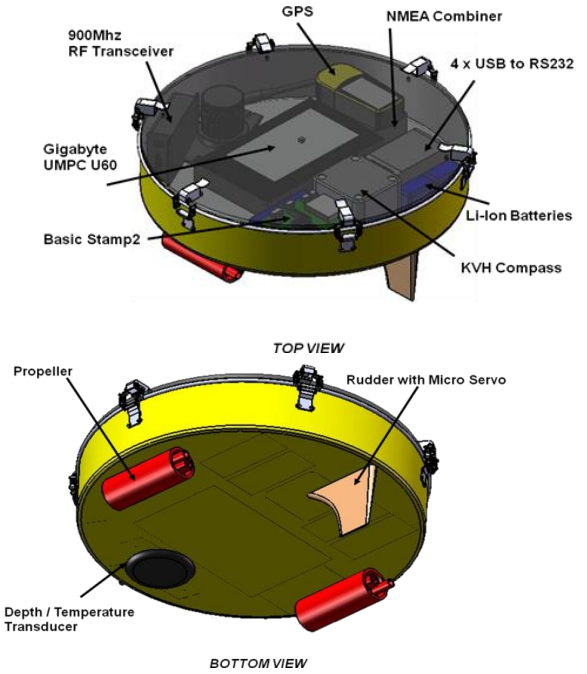

Fig. 1: The Drosobots design by Solidworks

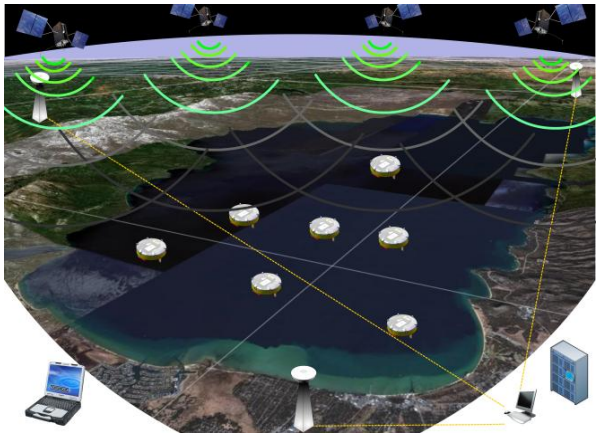

Fig 2: Overview of Drosobots Project.

IV. FIELDWORK TRIAL

Bukit Merah is famous due to Bukit Merah Laketown Resort which is surrounding by lush greenery and fronting one of Malaysia's largest lakes at 7000 arces in size. Only 3 hours of driving is needed to reach there, via Bukit Merah toll exit off the North-South Expressway. Water Park is the main extraction as well as Orang Utan Island which is located at the middle of the lake.

In our test, all eight of Drosobots had been deploy to map the underwater contours of the lake as shown in Fig. 3. The GUI of the software that been used to plot the real time data that consist of depth, longitudinal and latitude. In the post processing work, all of the point had been converted to build up a 3-D image. Fig. 4 show the scattered plot of all Drosobots consist data of longitudinal and latitude of the lake.

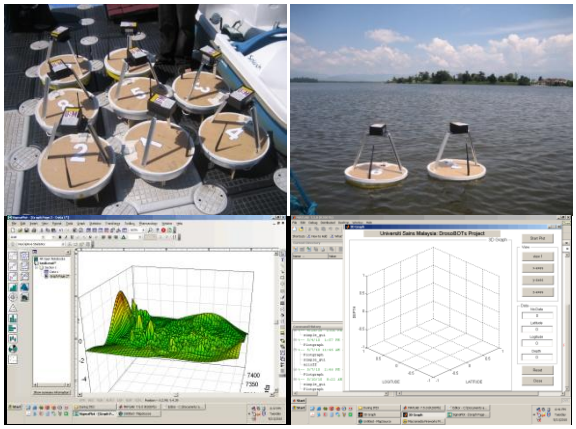

Fig. 3: Bukit Merah trial photos (Top left: Drosobot ready to deploy. Top right: View of the lake. Bottom left: Contour image. Bottom right: Real-time GUI)

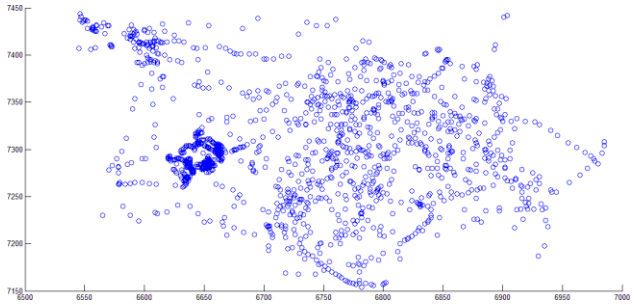

Fig. 4: Scattered plots of Drosobots

I. CONCLUSION

The study of animal behavior in their natural habitat has led to Animal-Inspired Metaheuristic Algorithms which may be implemented in the development of ASVs Despite the fact that accuracy of GPS is 3 meters, compass sensor ±0.5° and transducer depth is only ±15cm, promising trial results are obtained. There is future potential for ASVs in real applications as multi-agents in sea-bed mapping, mine-sweeping, environmental and oceanographic

ISBN 978-979-16955-1-0

measurements, port security, oil spill tracking, and search and rescue mission.

II. ACKNOWLEDGEMENT

This research was sponsored by the National Oceanography Department, Malaysia, under grants NOD-USM 6050124 and USM Research University, under grants 1001/PELECT/814059

III. REFERENCES

[1] Committee on Autonomous Vehicles in Support of Naval Operations, 2008, *Autonomous Vehicles in Support of Naval Operations*, U.S. National Research Council.

[2] Frey, C., Zarzhitsky, D., Spears, W.M., Spears, D.F., Karlsson, C., Ramos 2008, A Physiomimetics Control Framework for Swarms of Autonomous Surface Vehicles, *OCEAN 2008*, IEEE.

[3] Siciliano, B. & Khatib O. 2008, Springer Handbook of Robotics, Springer, Heidenberg.