SURVEY ON RESEARCH CHALLENGES AND APPLICATIONS OF UNMANNED MARINE ROBOT

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Abstract – The security at marine borders are important and crucial. It is very difficult to continuously monitor enemies at marine borders. Also, marine exploration is very important in understanding the global climate and environmental changes which helps in research areas for the purpose of various data collection, weather monitoring, pH sensing. Using these data disaster prevention like tsunami and earthquakes can be done. In the absence of garbage disposal facilities, the practice of dumping garbage into nearby water bodies has become quite common in recent years and has posed long-term negative impacts on the environment. Present technologies make use of batteries as the source of power. Once the battery dies, replacing them every time becomes difficult. The challenges of replacing the battery needs to be overcome. In this paper we present the literature survey on research challenges and applications of unmanned marine robot in order to overcome the drawbacks.

***Index terms* - WSN [wireless sensor node], ASV [autonomous surface vehicle], floating waste scooper robot, cloud based surveillance system, Arduino, Zigbee, Bluetooth module**

I. INTRODUCTION

Today, many military organizations take the help of military robots for risky jobs. The robots used in military are usually employed within integrated systems that include video screens, sensors, grippers, and cameras. Military robots also have different shapes and sizes according to their purposes, and they may be autonomous machines or remote-controlled devices. There is a belief that the future of modern warfare will be fought by automated weapons systems. Further the robots can also be employed for the applications of weather monitoring, water pH monitoring, cleaning of water bodies.

Military robots are usually associated with the following categories: ground, aerial, and marine. Most military robots are still pretty dumb, and almost all current unmanned systems involve humans in practically every aspect of their operations. It can also pave the real way to massive use of advanced mobile robotics in human societies, military systems including and particularly.

The paper involves how different methods can be combined to implement a marine robot with other applications like weather monitoring, water monitoring, cleaning of water bodies, etc.

II. LITERATURE SURVEY AND SUMMARY

Paper [1] describes the Rapid Environmental Picture (REP) studies which made use of multiple aerial unmanned vehicles (AUV), autonomous surface vessels (ASV), and unmanned aircraft systems (UAS), as well as manned ships. The goal of this study was to demonstrate communication and coordination among these systems. Maritime law enforcement was their second goal. To demonstrate communication between AUVs and ASVs using DTN was the third main goal of this study. The capability for human control of these systems when desired was demonstrated by using DTN technologies and adaptive sampling. DTN protocols enabled real-time communication between humans and the autonomous component data in near-real time. Adaptive sampling allowed the autonomous systems to perform maritime surveillance. The result of the study was that the AUVs could relay the Sonar data via acoustic modems at the rates of 1 Hz. The AUVs were also able to send back their side-scan sonar imagery (tool to detect debris and obstructions on the seafloor) to a remote operator who could transmit commands back to the AUVs.

In paper [2], development of Wireless Senor Network (WSN) for the purpose of weather monitoring is done. In order to monitor the weather conditions of a small area with higher accuracy, the data from the WSN nodes are sent to the base station which is attached to the embedded computer system. All these data sent can be accessed through a web-based monitoring application.

Paper [3] describes a radar system designed for deployment on an unmanned surface craft under development in the Autonomous Ocean Systems Laboratory of Memorial University. The radar system of the USC consists of a Long-Range Radar System (LRRS) and a Short-Range Radar System (SRRS). The LRRS detects the objects over the surface of the sea about very long distance in terms of few miles The SRRS not only detects the objects near it but also removes the blind spot of LRRS. The SRRS estimates sea state level through measuring wave height.

In paper [4], the requirement of a system to monitor the sea borders is fulfilled. A lot of research has been dedicated to monitor the ocean environment with relatively low cost. The main problem of power supply faced was solved with the development of an automated sailboat which was driven by wind power combined with a solar powering system. The photovoltaic cells which were present on the deck were used to generate electricity which was then stored in nautical batteries. Both short and long term missions could be performed by the proposed system without the requirement of refueling.

Paper [5] proposes the use of Wireless Sensor Node (WSN) to receive & transmit data in an ocean observation system which can have applications like oceanographic data collection, pollution monitoring, oceanic exploration, disaster prevention, navigation and surveillance. A sensor node in a network was able to perform different operations like gathering and processing information, communicating with other nodes of the network. Miniature sized terrestrial WSN with low power consumption paved way for the implementation of underwater WSN. RF communication which was used in terrestrial WSN could not be used in underwater WSN as RF wave transmission was of the order 5kb/s and 20kb/s which is limited. Hence, acoustic communication was found to be the best solution for underwater applications wherein the transmission rate of sound in water was found to be 1481 m/s. Though underwater communication using this technique was found to be most reliable, it faced many challenges such as high propagation delay, low bandwidth and dynamic nature of the work. This paper discusses various applications and challenges faced by underwater sensor networks.

Paper [6] presents a cloud-based surveillance system for live video streaming. A low-cost local network-based surveillance system was implemented using local network such as Wi-Fi, cloud, Raspberry Pi 2 module and FFmpeg software based USB Camera(C170), stepper motor, ULN 2008 IC, DC Motor. Motion of system and the camera could be controlled with the control buttons that were provided on web page. The proposed system used a Service (IaaS) using Open Stack and Amazon Web Services (AWS). The USB camera (C170) feeds images to the network in real time. Captured images could be saved, stored or sent to remote locations. It could capture videos with resolution of 1024×768 pixels. The connection between Raspberry Pi2 and different component and internet connection were tested successfully.

The aim of paper [7] was to design a robot that replaces human dependency to collect floating waste from surface of water bodies and to investigate performance of the designed robot. Two types of mechanisms were used, one was a flight conveyor and the other was a scooping arm with a waste bin. Various tests were performed by varying the driving speed of the robot and the belt speed of the flight conveyor to clean a pond and the driving speed that gave maximum efficiency was 0.38 m/s. Two belt speeds selected as slow and fast were at 0.2 m/s and 0.5 m/s, respectively. The results show that more waste could be scooped with high driving speed. Activating both scoopers yielded higher efficiency. The side scooper had less capability than the front scooper. Capability of the designed waste scoopers was successfully evaluated.

In paper [8], we see the need for a technology to monitor the quality of water. Water is the basic need for any living organism. The amount of fresh water present on this planet is very less. Water in a few places may be contaminated and millions of people die every year due to the infections caused by kind of contaminated water. A technology for real time monitoring of water quality is developed by the application of Wireless Sensor Network (WSN). A number of sensors are programmed to the Arduino microcontroller along with the ZigBee module, in order to measure the different water quality parameter such as pH, temperature, etc. and the data collected is sent to the data center for further analysis. This kind of technology is deployed in overhead tanks and other water bodies to monitor the water quality. The complete system is powered by the solar power by means of solar panel.

The aim of paper [9] is to design and develop a smart robot for ocean exploration which helps in detection of metal underwater, provides video coverage of the ocean and can be controlled manually and automatically in case of emergency. The whole system is controlled by ARM-LPC2148 controller which has Low power real-time clock with independent power and dedicated 32 kHz clock input and the peripherals like DTMF, LCD, GPS, GSM, LCD, DC motors, Motor drivers, Wireless camera and Sensors are connected to it. The position of the robot is located using GPS. Wireless camera captures a video and sends it to the projector through RF communication. Short and long range obstacle is detected using IR and ultrasonic sensor respectively. If an obstacle is present, then the message is sent to mobile phone through GSM and is also displayed in the LCD. DC motors are used for the robot movement.

Paper [10] discusses about weather forecasting and home automation with the help of various sensors. Using various quantitative data collected about the present state of a certain area, the weather can be predicted. Using the output of the weather monitoring system, the controls for an home automation system is done using microcontrollers.

III. ADVANTAGES AND APPLICATIONS

In paper [1], the systems could provide surveillance and adaptive response capacity to disasters, natural or man-made, cost-effectively compared manned aircraft or ships.

In paper [2], the proposed cloud based system had more data collecting capacity and also allowed the user to access the data online, sitting in a remote area. Live health status of the wireless network sent to the administrator helped to monitor the wireless network and troubleshoot the system remotely.

In paper [3], a 24GHz short-range FMCW radar transceiver for detecting sea-surface targets and estimating sea state information to enhance the navigational safety of a USC is designed.

In paper [4], the developed automated sailboat is self-powered, having photovoltaic cells located on the deck of the sailboat which is capable of generating electricity. The system need not be brought back to the land for refueling. Also the electromechanical and electronic parts can be controlled from a central place.

In paper [5], wireless sensor nodes proved to be advantageous because of their unmanned operation, easy deployment, real time monitoring and relatively lower cost. The underwater cables which were deployed for undersea exploration made it easy for installing oil/gas pipelines and fiber optic cables. Underwater WSNs provides assistive navigation and can be used to perform collaborative monitoring tasks in ocean environment. Autonomous Underwater vehicles that use acoustic and optical sensors can be used to detect objects and can monitor rapid environmental variations in the ocean.

In paper [6], a person with basic knowledge of computer could easily operate the system. Controlling of camera movement and navigation of whole module from web page is not only possible with a PC, but also possible with an Android based mobile phone. The system is potable inexpensive. Also, the system could not cover multiple areas at a time.

In paper [7], the robot was proven to be capable to replace labor for water surface cleaning as the waste has small drag force and water surface tension causes surface wave, the waste usually flows away when reaching by ship or boat. The typical waste collecting by human is often done by using scoop net with long handle. However, the operation is a simple and cost-effective approach.

In paper [8], the presented real time water monitoring system which is based on the wireless sensor network, uses low power and is highly efficient. The issue of critical power was solved here by the usage of solar panel and due to different modes of the sensor node. As the model is interfaced with the internet, all the data measured is sent to the base station. From the base station, the users can login and collect the data showing the quality of the water.

In paper [9], the Smart robotic vehicle is found to be advantageous because of their low cost, unmanned operation and relatively small in size. Collision avoidance is the main advantage as it a challenging task to maintain a sailboat in unstable environment.

In paper [10], an effective, secure and a low-cost weather monitoring system and smart home automation system was implemented.

IV. GAPS FOUND IN THE LITERATURE

In paper [1], it was found that autonomous system data streams such as HD videos, high frequency acoustic sensors, multi-beam seafloor maps, UAS (unmanned aerial system), Lidar and other sensor data have high bandwidth transmission requirements. The ship computer and bridge control systems are not currently prepared to receive, display, archive and integrate data from AUVs, ASVs, and particularly from UAS into their command and control systems. Dealing with autonomous system data streams and integrating them into usable data displays for human users in near-real time are challenges for the near future.

In paper [2], the proposed system could only monitor the data required for sensing the environmental conditions of a small area. The same system could not be used to measure the weather conditions of a larger area. Many such systems had to be deployed and the total data collected from many such systems was required to measure the environmental condition of a larger area.

In paper [3], the spectrograms of the received signals can demonstrate the velocity variation of water particles, and the wave height can be calculated based on the relationship of wave height and water particle velocity. The wave height estimated in the wave tank is close to the known value.

In paper [4], the developed system must go into hibernation state during night or cloudy skies. This disadvantage can be avoided by the usage of back-up batteries.

In paper [5], solar energy cannot be exploited in underwater for recharging batteries. Hence, battery power is limited. Propagation delay in underwater sensor networks was found to be higher when compared to terrestrial sensor networks. The available bandwidth is very limited. Bit error rates are high. There can be temporary losses of connectivity. Underwater sensors are prone to failure due to corrosion. Due to multipath fading, the underwater channel can be severely damaged.

In paper [6], the internet connection can be slow if the signal strength is poor in certain areas. There can be problems in establishing a connection with the server and uploading videos to cloud.

In paper [7], the robot must only be used in still water and hence cannot be used in oceans and seas as is difficult to clean seas and oceans due to waves. Driving the robot faster cannot always increase amount of collected waste.

In paper [9], it was found that the smart robotic vehicle cannot travel faster due to wind opposition and other external factors. The power backup is also a disadvantage. Better camera can be used with high resolution and pixels. The long-lasting battery or solar power can be used instead of using power supplies.

In paper [10], the weather monitoring was done for a confined space and not for a larger area.

V. CONCLUSION

The continuous naval border security is very crucial, and the garbage disposal needs to be taken care. In this survey paper, we have come across various techniques given by various researchers for solving the issues mentioned above. To make the marine robot multifunctional and reliable, an efficient and continuous power system needs to be implemented.

REFERENCES

[1] P. McGillivary, K. Rajan, et al, "Integrating Autonomous Underwater Vessels, Surface Vessels and Aircraft as Persistent Surveillance Components of Ocean Observing Studies", Conference: Autonomous Underwater Vehicles, IEEE, 2012

[2] E. Kanagaraj, et al, "Cloud-based Remote Environment Monitoring System with Distributed WSN Weather Stations", IEEE, 2015

[3] Jian Cui, et al, "Wave Height Measurement Using Short-range FMCW Radar for Unmanned Surface Craft", MTS, 2015

[4] Vilas Boas, Silva Junior, et al, "Towards the electromechanical design of an autonomous robotic sailboat", Latin American Robotics symposium, Brazilian Robotics Symposium, 2016

[5] Sahana Salagare, P N Sudha, Kartik P, "A Survey on Applications and Challenges of Underwater Wireless Sensor Node", IJETT, 2016

[6] Neel Oza, N.B.Gohil, "Implementation of Cloud Based Live Streaming for Surveillance", ICCSP, 2016

[7] Niramon Ruangpayoongsak, et al, "A Floating Waste Scooper Robot on Water surface", ICCAS, 2017

[8] Sowmya, Dr. C.D Naidu, et al, "Implementation of Wireless Sensor Network for Real Time Overhead Tank Water Quality Monitoring," IEEE 7th International Advance Computing Conference, 2017

[9] Nagarjun J, et al, "A Smart Robotic Vehicle to Survey the Ocean", IJERECE, 2017

[10] Indrasom Majumdar, et al, "Design of Weather Monitoring System and Smart Home Automation", ICSCA, 2018