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River Depth Monitoring Robot with Waste Collection Feature

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Abstract: Rivers are important to the balance of our environment and to human interests, including water, transportation, agriculture, and biodiversity, but they have increasing pressures from pollution, climate change, and rapid changes in depth that can affect swimmers, boaters, fishermen, and wildlife. The problem of floating waste including plastics, organic waste, and industrial run-off can cut down water quality, impact ecosystems, and cause devastation to the environment over the long-term. This project plans to address declining water quality using a River Depth Monitoring and Waste Collection Robot - which is an autonomous solution to improve the safety and cleanliness of rivers. The autonomous robot will use sonar-based sensors to monitor water levels continuously to identify rapid changes in depth, identify danger spots, and signal alerts to users or authorities. It will be equipped with a collection mechanism to pick up floating debris and halt contamination for the ecological and environmental health of the river. The updating data will be conveyed with GPS tracking using wireless transfer to the designated organisation, and is designed to function in a time-efficient manner. The robot leverages autonomous operation as scalable, cost-effective, and resilient, and can be operated with little to no personnel; benefitting municipalities, environmental groups, and emergency groups. By combining the elements of waste removal, depth levels and monitoring, this project can help to steward our rivers sustainably, assist in avoiding any danger to humans or wildlife, and enable environmental groups to attend to remediation efforts.

Keywords: River depth monitoring, autonomous robot, sonar sensors, waste collection, floating debris, water quality, pollution, GPS tracking, real-time data transmission, environmental safety, sustainable river management, aquatic ecosystem protection.

I. INTRODUCTION

The safety and cleanliness of rivers is becoming more and more difficult to maintain, due to both an increase in human activity, and industrial contamination. Potentially dangerous immediate changes in water depth, and increased floating debris, can all affect human life and the life of aquatic systems. With increasing number of water-related tourism activities, such as boating and rafting, it is imperative to start dealing with these problems.

The River Depth Measuring Robot is an autonomous solution to these issues, with real-time depth measurement and waste removal. The process begins with measuring how fast a change in depth occurs with sonar sensors, the robot proceeds to record depth with a GPS module the robot is equipped with at a specific location. The robot can also be controlled manually with a Bluetooth module, if required. The robot is equipped with a net on the back of the device that can collect floating debris. While the robot is navigating long the river collecting collect data on depth, it is also collecting floating debris. The robotic system is controllable with a mobile application, the mobile application displays real time data to assist in maintaining a safe river system with reduced manual effort and cleaner rivers.

II. PROBLEM STATEMENT AND OBJECTIVE

Problem statement:
Creating safety protocols is paramount in water tourism because boating, rafting, and swimming should all be done safely and consistently. An unanticipated change of water depth can indicate a tragic event that creates accidents that typically end in drowning. The underwater dangers of hidden rocks, depth drops, and currents certainly contribute risk perceptions to an adventure. Rainstorms, for instance, will change conditions dramatically in a very short amount of time making it confusing and unsafe to swim. Thus, without enough accurate depth information and navigation data that is updated in real-time, the possibility of accidents are high. Tourists are typically indifferent to unseen underwater dangers or raised the water level. It can also be slow in emergencies to get important and critical responses when there is little to no emergency response and trained emergency rescue team access.

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Objective:
The project will focus on designing and building an autonomous smart robot that can monitor river depth and collect floating rubbish in real-time. Rivers can be recreational, transporting, and touristic areas, however variable depths can pose safety risks and floating waste is also a problem as it can accumulate debris. The variable depth can cause boating accidents, but also accumulating floating debris in a target area poses risk to the local ecosystem and water quality of the river.

The robot will use a sonar sensor to measure the depth of the water at regular intervals, and can recognize sudden depth fluctuations in the total depth reading. The sonar sensor can track limited depth areas of the river along with information from the GPS; also using this information in proposed instances of rapid rescue operation, whether this is in the case of an accident while boating, or rescue from a drowning victim in the river during swimming activity. There will also be a controlled operation of this robot, using Bluetooth via a mobile application, this will run autonomously while giving users the ability to control the robot remotely. In practical terms, the vessel will design and fabricate a net on the back of the robot that will deploy in water whenever it recognizes items of floating waste with the sonar sensor depth readings, while continuously taking sonar read-ins.

This integrated system will reduce the needs for conducting separate manual depth checks and debris collection as both will be delivered through a system that is automated, cost effective, and scalable. Therefore, the robot will provide a new way to monitor and manage water depth and artificial waste in shared waterways and it will enable cleaner aquatic environments and safer aquatic spaces and specifically water tourism zones.

III. SYSTEM DESIGN

A brand-new system of an autonomous robot is a system that will monitor river depth and collect floating garbage, keeping the water clean and safe, 24/7. All combined hardware and software components are designed to operate in an efficient manner in real time, using as little human monitoring of the system's operation as possible.

The robot has a floating platform that operates smoothly in the river under an extensive range of water conditions. The lightweight small-bodied design allows it to fold up to carry anywhere on the river without affecting the life in the water. A fluid collection net or conveyer collection system I designed would operate at the back of the floating platform, permitting the collection of all floating debris types including, plastics and organic waste. The floating platform provides all electronic components contractor-grade waterproof housing for many seasons of treatment and to prevent water damage.

The platform is outfitted with a sonar-based ultrasonic sensor capable of constantly measuring water depths beneath the floating platform, generating an ongoing sampling series that is associated with height from the base of the river. The underwater ultrasonic sensor emits sound waves from the platform, which propagate and return to the sensor from the riverbed; with a return time the depth is calculated. The continuous sampling of depth increments will provide an opportunity to observe instances where there are sudden disturbances of the river, which could reflect hazardous conditions for swimmers, boaters, and fishermen.

The GPS Module provides real-time locational information about the robot, which is necessary for mapping out hazardous zones of the river and to assist with emergency response. The GPS data, water depth, and waste collection status is transmitted via a Bluetooth or WIFI module, using wireless distance, back to a remote-control station or other supplied application. Continuous analysis will allow authorities and users to receive timely information about the condition of the river, along with the operating status of the robot.

The robot is outfitted with an Arduino UNO microcontroller, which takes input from peripherals, directs the movement of the robot, and holds a fixed array of floats (debris/shipping) with built-in programmed algorithms. Aside from roadblocks or floats of debris, the on-board system has a fixed navigation path it traverses along the river and can alter its navigation path based on detected hazards. The user also has the opportunity to take control from a mobile device utilizing Bluetooth connectivity to the robot.

The back of the robot features a motorized net that allows for debris collection while actively travelling. The collected waste is temporarily held on the platform and waste on the platform can be easily removed by the user when robot reaches the charging dock. This process helps to prevent pollution from being dispersed downstream, creates a more viable conservation effort, etc. The robot is powered by rechargeable batteries intended for long-operation hours. Solar panels could be installed as well, extending missions and creating sustainable options.

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The depth and debris data is captured and analyzed in real-time to provide alerts to authorities to address abrupt changes in depth or over accumulation of debris, to help improve safety and health in the river.

The ecosystem and design of this integrated robot provides a robust and economically scalable autonomous robot that can autonomously interact with a composite of river ecology and provides environmental managers and municipalities an effective way to monitor and assess river systems.

IV. METHODOLOGY

The River Depth Monitoring Robot with Waste Collection Feature is developed following a structured approach, through hardware selection, system integration, signal processing and testing.

1. Hardware Selection and Assembly:
The main hardware of the robot is the Arduino microcontroller, as it is in charge of all the sensors and motors. The propulsion of the robot is powered by 100 RPM DC motors and the LC298N motor driver is used to power the actuators. Two 3.7 V Li-ion batteries are used to power the robot for moving and sensors. A waterproof sonar depth sensor is used to measure the depth of water and the sonar readings are processed through the Arduino to classify the depth. A GPS module tracks the robot's location and it is also sent to the mobile app, along with the depth data. A Bluetooth module (HC-05) is used for the beauty of the mobile app to wirelessly communicate the robot's on/off state and the information from the developing sensors. A net was mounted to the rear of the robot that is used to capture waste, as the robot drifts in the water, the buggy collects floating debris and waste.

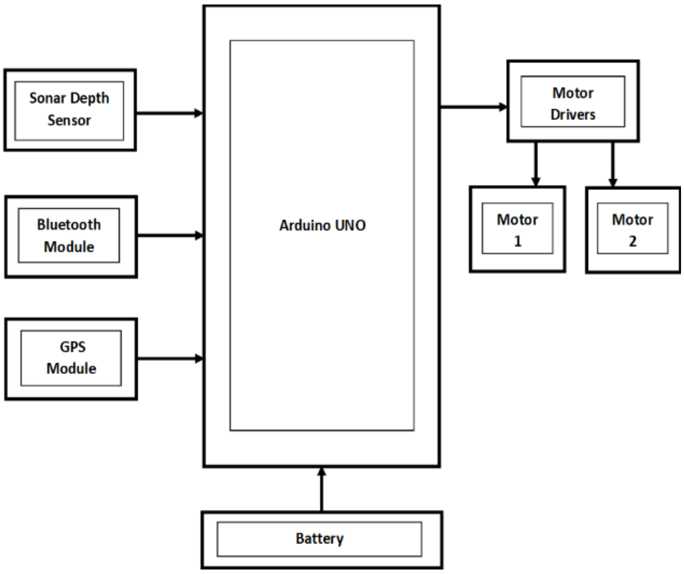

Fig 1 : Block Diagram

2. Signal Processing and Depth Classification:
The sonar depth sensor provides depth sensing, that is processed by the Arduino. The Arduino classifies the depth into Normal, Medium, or Dangerous, based on set ranges. If the robot identifies Dangerous depth (greater than 6 feet), then it also sends the warning to the Bluetooth mobile app, with the GPS coordinates of the depth. The app saves the area for later.

3. Waste Collection System:
The net at the rear-end of the robot is provided to collect floating waste as the robot progresses through the water. The net will be made from lightweight durable material, that will capture waste, and not slow down the speed or movement of the robot. As the robot moved and collects the waste in the net, the net can be removed or emptied once the robot is done with its monitoring route.

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4. Control System and Communication:
The Serial Bluetooth Terminal mobile app allows the user to control the movement of the robot, as well as receive a visible depth measurement reading. The app displays the depth classification found through the sonar monitoring system and can alert the user when a danger area is discovered. The app can also provide real-time GPS coordinates and can show the path the robot has traveled. This was built in for the purposes of marking danger areas that the robot discovers.

5. Testing and Calibration:
Trial testing is performed for the sonar depth sensor to confirm accurate reading, the empirical GPS module to establish reliable connections, and to perform overall calibration of the depth classification system to accurately classify, normal, medium, and dangerous depths. Tests performed for the waste collection system, on various water, ensured net collection varies debris and no loss of movement for the robot. Re-assurance testing in Bluetooth communication and graphically displaying on the app interface ensured stable connection and real-time monitoring of depth measurements.

6. Power Management:
The Li-ion batteries were selected to allow the utmost amount of working time for the robot as well as being tested for continuous powered movement. Power savings modes were built into the software for improving battery life and working time.

V. IMPLEMENTATION

The hardware component and the software component were developed with particular hardware components configured and designed so that the mapping of hardware and software functions could be automated. The type of hardware that was selected as the microcontroller for the system was the Arduino Uno, which was programmed to perform many of the system's functions based on sensor inputs and motor operations that were controlled by user commands.

It could perform its sensing functions by the use of a JSN-SR04T waterproof sonar sensor. The JSN-SR04T is able to determine the depth of the water based on confident measurements of the depth of the water when the sonar pulse makes contact with the longitudinal structure of the riverbed. Subsequent echo-return pulses are used by the Arduino system to compute the speed of sound in undisturbed water. The depth will be categorized by the Arduino to indicate whether the depth is Normal (0-3 ft), Medium (3-5 ft), or Dangerous (greater than 6 feet). The command center of the application invoked an alert message process at Dangerous depth levels.

The robot's geographical location is managed by the NEO-6M GPS module, as it has real-time location capabilities and produces latitude and longitude coordinates. These coordinates are vital to mapping hazardous zones along the river.

The depth and geographical data are wirelessly transferred to a mobile application with the use of an HC-05 Bluetooth module, which allows for monitoring and controlling the robot from miles away as it sends depth readings, alerts, and allows the user to follow the robot's distance in real-time.

It is operated via two 100 RPM dc motors with an L298N motor driver. The Arduino processes the movement commands from the mobile app for example, forward, backward, left, right, and stop, resulting in the ability to move anywhere in the water.

The motors are attached to a beam frame made of PVC pipe, providing buoyancy and protecting the other components from exposure to water. It is equipped with a net for collecting floating debris as a method of pollution reduction. The net is mounted on the back of the robot and moves with the robot, allowing waste to collected and taken out of the water, while monitoring depth as another benefit.

Implemented in software are libraries like SoftwareSerial for Bluetooth communication and TinyGPS++ for decoding GPS signal communications. The initialization routines setup the sensor pins and communication structures. In the main while loop, the code will continuously read the sensor data, process commands (described above), and update the mobile app with the depths and locations. Data will be transmitted at intervals such as 100 milliseconds. This is so that we are continuously responsive.

The power supply is a 3.7 V Li-ion battery. The battery has energy efficient properties and will allow for sustained operation without human intervention. The systems power management routines and built-in safety features such as an emergency stop to ensure that the robotic structures are reliable and safe to operate in dynamically and unpredictable environments such as river systems.

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The integrated hardware-software system is a scalable, autonomous, real-time river depth monitoring and waste collection operation that can aid the overall safety and conservation of the environment.

VI. ALGORITHM

1.After powering on all the necessary components (Arduino, sensors, motors, and communication modules), the sonar depth sensor, GPS module, and Bluetooth module initialize. After initiating component status checks and the new power-up self-check, the battery status needs to be read; if the battery is low, a prompt for charging will appear. After the components are read and activity checks are completed, it is time to enter the first operational status.

The fig 2 is the flowchart that represents the order of operations of the river depth monitoring and waste collection robot. It starts with the system power on, activates the sensors, results in measuring the depth using every sensor, tags the GPS location when the depth has been recorded, identifies trash debris, collects trash and effectively transmits all readings to the software. Each step continues to serve in developing continuous monitoring and effective cleanup of the environment.

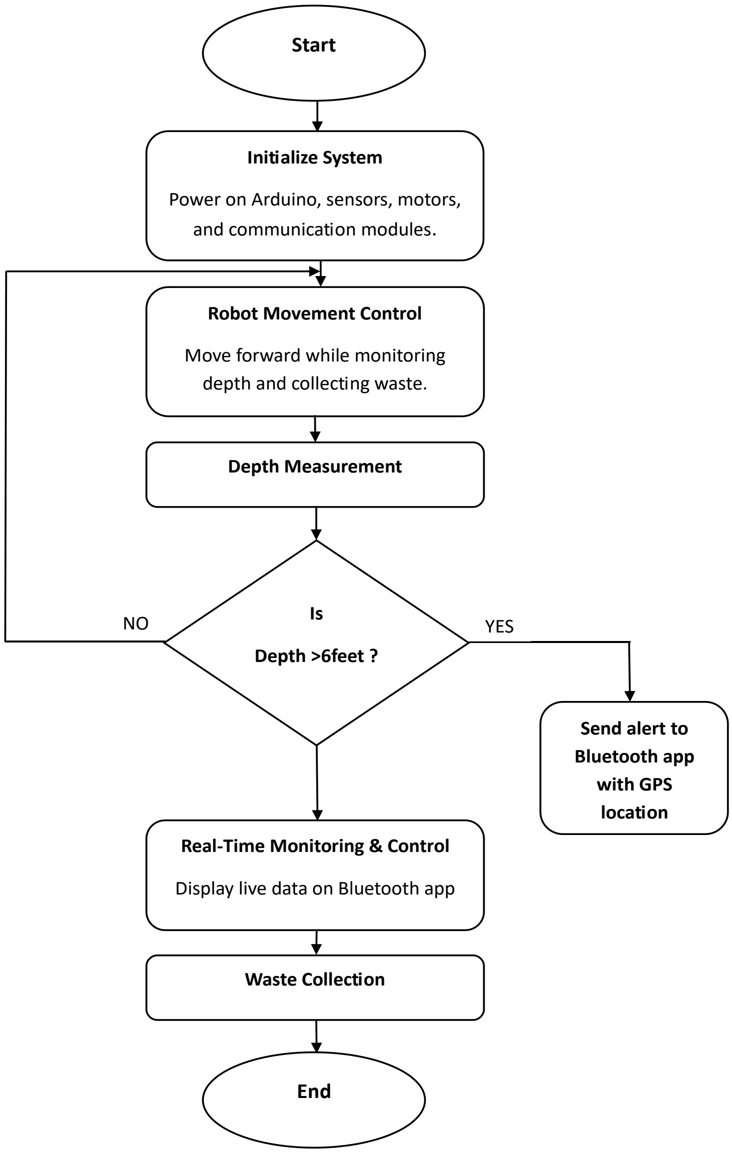

Fig 2: Flow Chart

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2. The robot drives forward, while the sonar depth sensor measures water depth creating depth specifications. Another operational aspect is that the waste collection net is being deployed as a trigger to pick up floating debris while the robot is driving through the water pulling the debris from its path. The robot can either drive along a program lead line or it can be operated by a manual drive via Bluetooth app.

3. Continuous reads from the sonar sensor will classify depth data as normal (≤3 feet), medium (≥ 3 feet but ≤ 6 feet), or dangerous (greater than 6 feet). These classifications allow for more detailed analysis of safe or risky zones in a water body.

4. When depth is set to Dangerous, the GPS is acquired, and an alert is sent to the Bluetooth app along with depth information. The app saves this location for future notification, so the alert allows someone to proactively do something if it is appropriate or warranted. If the depth is Normal or Medium, the robot operates normally without alerting the user.

5. Depth and location data is collected by the sensor and Bluetooth transmission to the mobile app to monitor the results in real-time. The data are displayed in the mobile interface. Also, if needed the user could provide manual control to the robotic unit. The app also keeps track of the previous depth and location data for analysis, which is useful for a long-term perspective in the consideration of the environment.

6. The waste collection net continues to collect floating debris. If net is full, user gets notification via Bluetooth. The robot returns to the base station to dispose of waste in the event that it is required.

7. When the monitoring and waste collection task is completed, the robot can be collected in order to clean and analyze the data. The waste collected is taken from the net, and the appropriate cleaning process is review so that we can increase the chances of smooth operations, and performance in the future. Any parts that were not working are checked and replaced as need be.

8. The information collected from many operations is analysis (analysis) of the depth of water change and accumulation of waste. This information assists with informed planning of waste management and identifying high-risk areas of the water body.

9. If you choose, the system can be turned back on for additional monitoring. Continuous environmental monitoring can provide a significant value for the future. Regularly updating mobile applications, or firmware updates can provide better functionality and improve efficiencies making the system useful for future improvements.

VII. RESULTS

Hardware Model of River Depth Monitoring and Waste Collection Robot.

Fig 3: Hardware Model

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Real-time data collection using Serial Bluetooth Terminal application

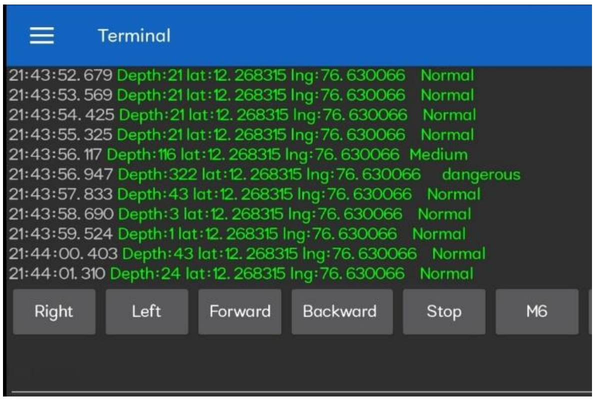

Fig 4: Data Collection

Geo-Location Monitoring

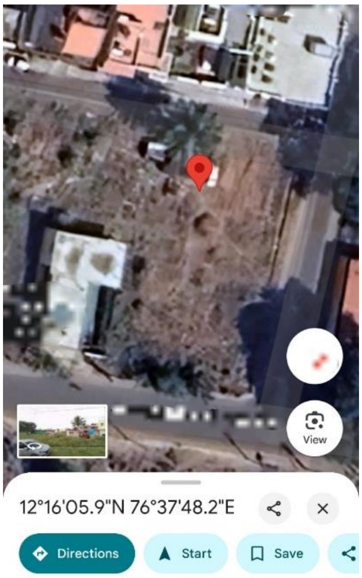

Fig 5: Location Monitoring

VIII. FUTURE ENHANCEMENTS

To improve functionality and improve the River Depth Monitoring and Waste Collection Robot in future iterations, there are various amendments that can be made to improve the robot's effectiveness and ease of use. A machine learning algorithm could be applied to enable the robot to predict depth-related hazards based on historical data, adjusting its navigation strategy. Due to the robots nature of working outdoors, we can add solar panels to provide some continuous power to increase the longevity of time before the robot needs to be charged. The addition of various water quality sensors (pH, turbidity, temperature/etc.) would allow for comprehensive environmental monitoring; measuring more than just depth and debris. Another way to develop the capabilities of the robot would be to add a camera module to function as real time visual feedback and assist with object detection to further improve and enhance the robot's litter collection. Currently the robot relies on short-range Bluetooth to send and receive data. We could enhance this area with wireless modules such as GSM or Wi-Fi to allow the robots to communicate over long-range distances, eliminating reliance on the short-range Bluetooth. Finally, one of the biggest changes would be to design a centralized cloud platform where users could store data and analyse information. This would give authorities the opportunity to monitor multiple robots, see patterns of pollution in rivers, and plan more effective interventions. These improvements would improve the robot's efficiency, intelligence, and contribution to the river conservation initiative.

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IX. CONCLUSION

The River Depth Monitoring and Waste Collection Robot provides a smart and effective way to solve critical issues with water environments, directed at sudden water depth changes or floating waste pollution. With the integration of sonar-based depth changes, GPS tracking of the waterway, Bluetooth communication, and an automated waste collection system, the system ensures both safety and cleanliness of rivers. The autonomous operations reduce the manual labor on the people monitoring the waterway, making the process more efficient and less time consuming. The robot's ability to relay live data for monitoring increases the monitoring process and allows someone to react to potential dangers in a timely manner. The simple design, scalable structure, and inexpensive components would allow this to be utilized in many rivers and river systems. This project establishes a greater environmental protection impact for rivers, promotes safer water tourism, and increases sustainable waterway management. As issues with water pollution and safety concerns increase, it is imperative that like-minded innovations become part of everyday activities which operationally protect ecological balancing while maintaining public safety around waterway resources.

REFERENCES

[1] D. Willems, “Irrawaddy River Dolphins,” WWF-Myanmar, p. 2, 2019.
[2] M. N. Azwad, “Threats to River,” WWF-Malaysia, p. 1, 2017.
[3] A. Sinha, P. Bhardwaj, B. Vaibhav, and N. Mohammad, “Research and Development of Ro-Boat – An Autonomous River Cleaning Robot,” in Intelligent Robots and Computer Vision XXXI: Algorithms and Techniques, 2014, vol. 9025, pp. 1–8.
[4] S. S. Rafique and A. Langde, “Design And Fabrication Of River Cleaning Machine,” Int. J. Sci. Res. Dev., vol. 3, no. 11, pp. 8–18, 2017.
[5] Ganesh U L and Vinod V Rampur” Semi-Automatic Drain For Sewage Water Treatment Of Floating Materials” International Journal of Research in Engineering and Technology, 2016, vol.5,7, pp.1-4.
[6] M. Mohamed Idhris, M.Elamparthi,C. Manoj Kumar, Dr.N.Nithyavathy, Mr. K. Suganeswaran, Mr. S. Arunkumar, “Design and fabrication of remote controlled sewage cleaning Machine”, IJETT – Volume-45 Number2 -March 2017.
[7] Mr. P. M. Sirsat, Dr. I. A. Khan, Mr. P. V. Jadhav, Mr. P. T. Date, “Design and fabrication of River Waste Cleaning Machine”, IJCMES 2017 Special Issue-1 ISSN: 2455-5304.
[8] T. Thomas, S. Lukose, J. George, and A. B. Thundathil, “River Cleaning Robot,” J. Adv. Electr. Devices, vol. 3, no. 2, pp. 1–3, 2018.
[9] S. L. Fong, D. Wui Yung Chin, R. A. Abbas, A. Jamal and F. Y. H. Ahmed, "Smart City Bus Application With QR Code: A Review," 2019 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS), Selangor, Malaysia, 2019, pp. 34-39.
[10] Sim Liew Fong, David Chin Wui Yung, Falah YH Ahmed, Arshad Jamal, Smart City Bus Application with Quick Response (QR) Code Payment, ICSCA '19 Proceedings of the 2019 8th International Conference on Software and Computer Applications, Pages 248-252, Penang, Malaysia — February 19 - 21, 2019
[11] M. N. Mohammed, Heayma Raj Hamid, S. Al-Zubaidi, Nur Shazwany Zamani, Muhammad Irsyad Abdullah, A New Design of Batik Production Machine Using IOT Technology, 2019 IEEE 7th Conference on Systems, Process and Control (ICSPC), 13–14 December 2019, Melaka, Malaysia
[12] Zainuddin, N.F., Mohammed, M.N., Al-Zubaidi, S., Khogali, S.I., Design and Development of Smart Self-Cleaning Solar Panel System, 2019 IEEE International Conference on Automatic Control and Intelligent Systems, I2CACIS 2019 – Proceedings 8825056, pp. 40-43
[13] A. Jamal, D. D. AL Narayanasamy, N. Q. Mohd Zaki and R. A. Abbas Helmi, "Large Hall Temperature Monitoring Portal," *2019 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS)*, Selangor, Malaysia, 2019, pp. 62-67.
[14] M. N. Mohammed; S. Al-Zubaidi; Siti Humairah Kamarul Bahrain; M. Zaenudin; Muhammad Irsyad Abdullah “Design and Development of River Cleaning Robot Using IoT Technology”,2020
[15] Soumya, H.M. Preeti, Baswaraj Gadgay “Pond cleaning robot”,2018
[16] R. Bajaj; S.L. Ranaweera; D.P. Agrawal “ GPS: location-tracking technology”,2020
[17] Anil K Dwivedi “Researches in water pollution: a review”,2017
[18] Jongsun Ahn; Ha Yeong Song; Sangkyung Sung; Jin-bok Kim; Young Jae Lee “An efficient GPS parameter prediction method using GPS ephemeris patterns for Self-Assisted GPS”,2010

