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Study and Development of Aquabot

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Abstract:
Study aims to develop aAquabot that can efficiently collect and remove waste materials from water bodies. The project involves the design, construction, and testing of aAquabot that can navigate through different water conditions and collect different types of debris. In recent years, the increase in environmental pollution has raised concerns about the impact of waste materials on our water bodies. Traditional river cleaning methods are often labor-intensive, time-consuming, and can be dangerous for human workers. To address this issue, the development of Aquabot has emerged as a promising solution. This study aims to contribute to this area of research by developing aAquabot that is efficient, effective, and sustainable. The proposed prototype is designed to operate autonomously, making it suitable for use in remote or inaccessible areas. The Aquabot's system includes a water propulsion mechanism, a collection mechanism, and a sensor system. The collection mechanism uses a conveyor technology to capture the debris. The prototype's efficiency in collecting debris and navigating through different water conditions is evaluated through several tests. The results of the study demonstrate the potential of using Aquabot as a sustainable solution for cleaning water bodies and reducing environmental pollution.

Keywords **—aquabot, prototype**

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I. INTRODUCTION

The main objective of projects is to reduce the man power and time consumption for cleaning the river water. Despite the increasing problem of water pollution caused by human actions, a significant portion of society today seems to disregard it. Lakes and rivers continue to be defiled through the thoughtless disposal of rubbish and unnecessary items, posing a significant threat to aquatic life. Among the main contributors to this pollution are plastics, a material that is predominantly wasted, with only a small fraction being incinerated or successfully recycled.

Manual river cleaning processes face several challenges. They often have limited reach and coverage, resulting in incomplete cleaning of the river. Manual cleaning is time- consuming, labor-intensive, and may pose safety hazards for workers. Certain pollutants, such as fine sediments or chemical contaminants, are difficult to remove effectively using manual methods alone. Manual cleaning may struggle to address large-scale pollution incidents efficiently, requiring additional resources and alternative approaches. Additionally, it can unintentionally impact the river's ecosystem by disturbing the riverbed, vegetation, or wildlife habitats. Moreover, dependence on available manpower can lead to delays or inadequate response in polluted river environments. To overcome these limitations, the adoption of advanced technologies like aquatic cleaning robots, drones, or specialized river cleaning equipment is essential. These automated or mechanized solutions offer improved efficiency, widercoverage, and minimize the environmental impact while complementing manual cleaning efforts. By integrating advanced technologies with manual processes, more effective and sustainable river cleaning initiatives can be achieved.

II. LITERATURE REVIEW

Siddhanna et al. [1], presents the design and development of a water cleaning robot named "SwachhHasth". The robot is designed to remove waste materials and debris from water bodies, thus contributing to the prevention of water pollution. The robot is equipped with a suction-based debris collection mechanism, which helps to efficiently remove waste materials from water. The robot's propulsion system is based on a DC motor and a propeller, which provide the necessary thrust for its movement. The article highlights the importance of water cleaning robots in addressing the problem of water pollution. It also provides a review of the current state of the art in the field of water cleaning robots, including their design, technologies, and applications.

Siregar et al. [2], study presents the design and development of a garbage picker ship robot using Arduino Nano microcontroller. The robot is designed to collect garbage and debris from water bodies, thus contributing to the prevention of water pollution. The robot is equipped with a garbage picker system, which helps to efficiently collect waste materials from water. The robot's control system is based on the Arduino Nano microcontroller, which provides the necessary computing power for the robot's operation.

Phirke et al. [3], presents the design and development of an autonomous water cleaning robot, which is designed to address the problem of water pollution. The article provides a comprehensive review of the current state-of-the-art in water cleaning robots, highlighting the importance of autonomous robots in mitigating the effects of water pollution. The robot's design is based on a suction-based debris collection mechanism and a navigation system that includes a camera and a Raspberry Pi computer. The study also discusses the challenges and limitations of the robot's design, such as limited battery life and difficulty in maneuvering in rough water conditions. Finally, the authors suggest potential improvements for the robot's design, including the use of solar power and the implementation of obstacle avoidance algorithms. Overall, the study contributes to the growing body of literature on water cleaning robots and provides valuable insights into the design and development of autonomous robots for environmental applications.

Karthik et al. [4], proposes an autonomous river cleaning system that uses GPS technology for navigation and debris collection. The authors provide a literature review of related studies on river cleaning systems, highlighting the importance of addressing the problem of water pollution and the potential benefits of autonomous robots for this purpose. The proposed system is based on an autonomous boat that is equipped with a GPS module for navigation and a debris collection mechanism. The boat's path is planned using GPS coordinates and the collected debris is stored in a collection bin. The authors also discuss the challenges and limitations of the proposed system, such as the need for regular maintenance and the potential impact on aquatic life. Finally, the study concludes with potential future improvements for the system, such as the integration of advanced sensors and machine learning algorithms for improved navigation and debris collection. Overall, the study contributes to the growing body of literature on autonomous river cleaning systems and provides valuable insights into the potential applications of GPS technology in environmental monitoring and management.

III. METHODOLOGY

Project work starts with research on design of river clearing cleaning robot prototype designs are made using mechanical engineering software Solid Edge V20 and dimensions are finalised. This project used solar energy to charge the battery. Inverter used to convert the generated alternating current (AC) to direct current (DC). Figure 1 represents the block diagram of development of aquabot.

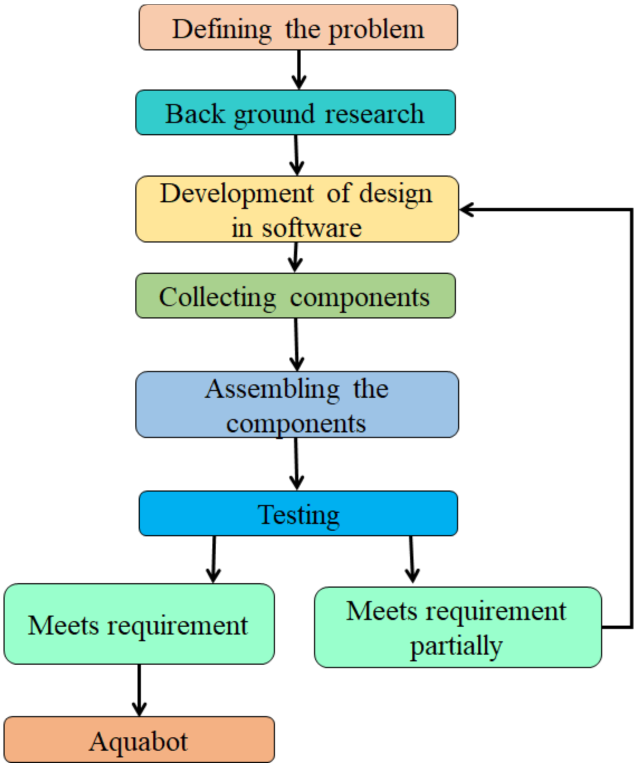

Fig 1Development of Project

DC motors with propellers attached will accomplish both of these goals. By turning on and off and reversing the polarity of the DC motors, the robot can turn left, right, backward, forward, left backward, right backward, left forward and right forward.

When the robot encounters garbage or is instructed to initiate the collection process, it engages in specific operations to effectively accomplish its task. To move forward and approach the garbage, both the right and left motors operate with positive polarity, causing them to rotate in the forward direction simultaneously. This allows the robot to smoothlyapproach and collect the garbage. When the robot needs to make a right turn while collecting garbage, the right motor is turned off while the left motor remains active, enabling the robot to pivot on its left side and execute the turn. Similarly, for a left turn, the right motor is turned off while the left motor continues operating, facilitating a leftward pivot. In situations where the robot needs to move backward while collecting garbage, both the right and left motors operate with positive polarity but with reversed electrical connections. This configuration provides a negative polarity to the motors, causing them to rotate in the opposite direction and facilitating backward movement. Through these well-coordinated operations, the garbage collecting system ensures efficient waste collection while enabling the robot to navigate and adapt to different scenarios encountered during the process.

IV. DESIGN

The 3D model of the river cleaning robot is shown in Figure 2. It consists of PVC pipes, PVC fittings, a conveyor, a propeller, a solar panel, a waste collecting bin, and other components. Two 4-inch diameter pipes are connected by a T-junction at a distance of 40 cm. The conveyor is positioned at the front of the robot. A Raspberry Pi, which is used to detect debris, is placed at the front and connected to an Arduino UNO for monitoring its operation. The waste collecting bin is positioned strategically to allow debris to fall directly into it from the conveyor. The battery serves as the power supply for the propeller motors and conveyor motor, while it is charged by the solar panel

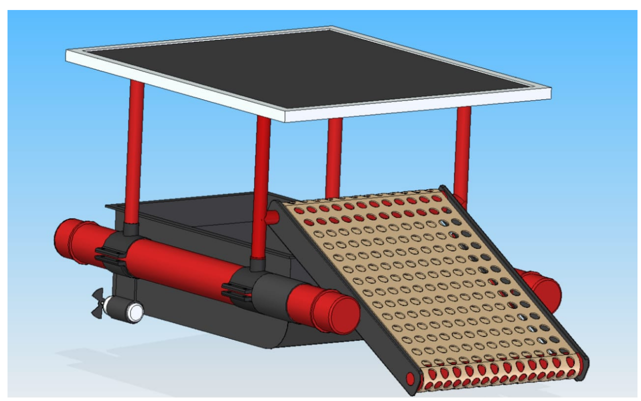

Fig. 2 System Design

The load consumption is 100 watt/hours. So, the panel poer estimation can be calculated based on the equation below [5].

Panel's power estimation:

Load consumption/ Hours of sunlight = 100 $(watt/\ hours)$/ 3 hours= 33 $Watt$

Equation represents the relationship between the load consumption and the available hours of sunlight. The load consumption is specified as 100 watt/hours, indicating the amount of power consumed by the load over a certain period. On the other hand, the equation states that there are 3 hours of sunlight available for harnessing solar energy. By dividing the load consumption by the hours of sunlight, the result is calculated to be 33.33 watts, which represents the average power output that can be obtained during the given sunlightduration. This equation provides valuable insights into the power sustainability and sizing of solar systems, aiding in the assessment and optimization of load requirements in relation to available sunlight. As a result, a 40W solar panel is employed as a design safety margin.

V. WORKING PRINCIPLE

The Aquabot developed in this study incorporates several key components and operates based on a well-defined working principle. The structural framework of the robot is constructed using pipes and fittings, providing stability and support to the various components. A bearing is employed to facilitate smooth rotation of the moving parts, reducing friction and ensuring efficient movement in water. The DC motor serves as the primary driving force of the robot, converting electrical energy from the battery into mechanical energy to propel the robot through the water. To enable effective debris collection, a wiper motor is utilized to operate cleaning mechanisms. These are responsible for gathering and removing pollutants and waste from the river.

Controlling the robot's functions and actions is the Arduino UNO microcontroller board, which acts as the central processing unit. It receives input from sensors, such as Raspberry Pi, to detect obstacles and avoid collisions during navigation. Additionally, the Arduino UNO controls the motors and other electrical components, ensuring coordinated movements and efficient operation. Incorporating sustainable energy sources, a solar panel is integrated to harness solar energy and convert it into electrical energy. This energy is stored in the battery, providing a renewable power supply for prolonged robot operation without relying solely on external power sources.

The waste collecting bin serves as a designated container for storing the collected debris and pollutants securely. This allows for proper disposal and management of the waste after the cleaning process. To propel the robot through the water, a propeller driven by the DC motor generates thrust, enabling forward and backward movement. This ensures the robot's ability to navigate the river and reach targeted cleaning areas effectively.

VI. OBSERVATION AND RESULTS

The boat system works well with the movements and speed corresponding to the collecting process of floating solids. For the conveyor system, it was found that that the rotational power is capable to hold a maximum capacity. It is limited due to the strength of wire mesh attached to the conveyor. Nevertheless, the speed controller and the relay of the conveyor system is working efficiently

A. Distance travelled by the Aquabot

The Figure 3 illustrates the relationship between time and the distance traveled by the Aquabot. The time intervals, measured in seconds, range from 10 to 60 seconds, increasing in increments of 10 seconds. Corresponding to each time interval, the distance traveled by the Aquabot, measured in milimeter, is recorded. Table 8.1 and Figure 8.1 shows the distance travelled by the Aquabot

From the Figure, it is evident that the Aquabot's distance traveled increases consistently as time progresses. Starting at 1000 mm in the initial 10 seconds, the Aquabot covers a distance of 1950 mm in 20 seconds, 2800 mm in 30 seconds, 4100 mm in 40 seconds,

4950 mm in 50 seconds, and finally reaches 6050 mm in 60 seconds. Aquabot exhibits a linear relationship between time and distance. As time increases, the distance traveled by the Aquabot also increases proportionally. This suggests that the Aquabot maintains a consistent speed or rate of travel throughout the observed time intervals.

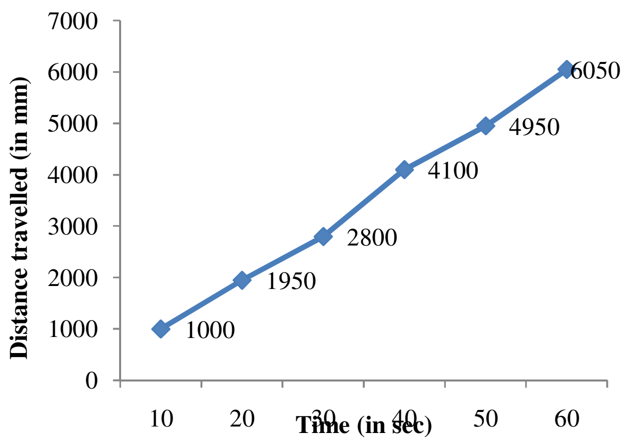

Fig 3 DistanceTravelledbythe Aquabot

B. Garbage collected in pool

Table 1 shows the time taken to complete garbage collection in a pool. The average time for the water garbage collector to collect garbage in pool area was 8.24 seconds. Quantity of garbage collection was different each time because at times, the garbage was far away from the water garbage collector and the user experience difficulties in collecting it when the garbage is near the edge of the pool. As for the battery voltage before and after each operation, there was a slightly drop between every trial.

TABLE I
GARBAGE COLLECTED IN POOL

Parameters	**Operation in pool area (3 m x 1.5 m)**		
	Trail 1	**Trail 2**	**Trail 3**
Weight of garbage collected (g)	134	180	192
Battery voltage before operation (V)	12.05	11.98	11.97
Battery voltage after operation (V)	11.98	11.97	11.95
Time taken to complete garbage collection (Sec)	6.14	6.02	12.56

VII. CONCLUSION

The Aquabot that has been developed can operate successfully and is able to suck up garbage floating on the water surface. It is environmentally friendly and does not affect aquatic life. This product uses solar panels to charge batteries and uses the concept of a suction process to collect debris floating in the water.

- The study and development of the Aquabot have shown promising results in addressing river pollution and improving environmental health.
- The integration of components such as pipes and fittings, bearing, DC motor, wiper motor, Arduino UNO, solar panel, battery, Raspberry Pi, waste collecting bin, and propeller has created a functional and efficient robot system.
- The robot prototype demonstrated enhanced efficiency and effectiveness compared to manual cleaning methods, operating autonomously and covering larger areas for faster debris removal.
- The robot's working principle, including navigation, debris collection, and cleaning actions, showcased its potential for effectively addressing river pollution.
- The Aquabot positively impacted the environment by restoring river ecosystems, improving water quality, and preserving aquatic life and biodiversity.
- The prototype's adaptability to small rivers and ponds expands its potential applications in various water bodies.
- The cost-effectiveness and sustainability aspects of the robot prototype were highlighted through the integration of a solar panel and battery system, reducing dependence on external power sources.
- Further research, advancements, and field implementation of river cleaning robots hold promise for effectively tackling river pollution and ensuring the health and sustainability of water ecosystems.

REFERENCES

[1] P. M. JSiddhannaJanai , H N Supreetha , Bhoomika S , Yogithashree R P, “SwachhHasth-A Water Cleaning Robot,” *Int. J. Eng. Res. Technol.*, vol. 9, no. 7, pp. 687-692.

[2] I. MarethaSiregar, M. Yunus, V. Marudut, and M. Siregar, “A Prototype of Garbage Picker Ship Robot Using Arduino Nano Microcontroller,” *Internet Things Artif. Intell. J.*, vol. 2, no. 3, pp. 150–168.

[3] S. Phirke, A. Patel, and J. Jani, “Design of an autonomous water cleaning bot,” *Mater. Today Proc.*, vol. 46, pp. 8742–8747

[4] K. S. R. and I. B. M. Karthik, C. Manikanta, V. Vamsi, “Autonomous River Cleaning SystemusingGPSTechnology,”*2023Int.Conf.Sustain.Comput.DataCommun.Syst.*,pp. 1000–1003

[5] M.S.S.Basyoni,M.S.S.Basyoni,andK.Al-Dhlan,"Design,sizingandimplementation of a PV system for powering a living room," *Computer*, vol. 90, no. 8, pp. 12, 2017.

