# Autonomous Surface Water Cleaning Robots

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***Abstract*—Water resources are indispensable for sustaining life on Earth, playing a crucial role in various ecosystems and supporting human civilization. However, the escalating levels of plastic and waste pollution in water bodies have become a pressing concern in recent years. This pollution not only disrupts aquatic ecosystems but also compromises water quality and obstructs sunlight penetration. Additionally, the advent of the coronavirus pandemic has exacerbated the problem, with the widespread usage of disposable masks, gloves, and other biomedical waste further contributing to water pollution.The improper disposal of waste, especially biomedical waste, poses significant challenges to both public health and environmental integrity. Inadequate management of such waste not only jeopardizes human well-being but also threatens the delicate balance of ecosystems. Consequently, addressing waste management has become an urgent imperative, with potentially dire consequences if left unaddressed.In response to this critical issue, our paper proposes the design of an innovative product: an autonomous water cleaning robot. This robot is engineered to efficiently tackle the problem of improper waste disposal in water bodies. Its design features a sturdy mechanical frame, complemented by advanced sensor fusion and computer vision technologies, enabling it to operate autonomously in cleaning water surfaces.The autonomous water cleaning robot serves as a proactive solution to combat water pollution effectively. Equipped with sensors and cameras, it navigates water bodies with precision, identifying and collecting floating garbage and waste materials. By harnessing the power of automation, the robot can operate continuously, covering large areas of water bodies and efficiently removing pollutants.One of the key strengths of our design is its adaptability to diverse environments and types of pollutants. The robot's sensor fusion capabilities allow it to distinguish between various types of waste, enabling targeted and efficient cleaning. Moreover, its autonomous operation reduces the need for manual intervention, minimizing human labor and associated costs.Furthermore, the design prioritizes sustainability by incorporating environmentally friendly materials and energy-efficient components. By utilizing renewable energy sources such as solar power, the robot minimizes its carbon footprint while maximizing operational efficiency. This approach aligns with global efforts to promote sustainable practices and mitigate the impacts of climate change.In conclusion, the autonomous water cleaning robot represents a promising solution to the escalating problem of water pollution caused by improper waste disposal. Through its innovative design and advanced technologies, it offers a proactive and sustainable approach to preserving water quality and safeguarding aquatic ecosystems. By addressing the root causes of pollution and promoting responsible waste management, our design contributes to the collective effort to ensure a healthier and more sustainable future for generations to come.***

***Keywords*—Autonomous Robot, surface water cleaning,raspberry pi, machine learning, obstacle avoidance***

## I. INTRODUCTION

Water is a vital resource for all life forms on Earth, yet it is increasingly threatened by pollution and degradation. Overexploitation and contamination of water sources, coupled with the accumulation of waste and debris, have led to a decline in water quality and ecosystem health. This problem is particularly pronounced in urban areas, where rapid urbanization and industrialization exacerbate water pollution.Despite the existence of numerous policies aimed at protecting water bodies, urban lakes and wetlands are in dire condition, with their numbers dwindling rapidly. For example, Bangalore, which once boasted 262 lakes in the 1960s, now has only a fraction of that number still holding water. Similarly, Ahmadabad has seen a significant reduction in its lake count over the years, with many being built over or degraded.

Urban rivers and streams suffer from pollution originating from various sources, including industrial waste, agricultural runoff, and human litter. This pollution not only harms aquatic ecosystems but also poses risks to human health, contaminating drinking water sources and reducing recreational opportunities. Moreover, water surfaces such as ponds and lakes often become repositories for trash and debris, creating unsightly and unsanitary conditions.Manual cleaning of water bodies is not only labor-intensive and time-consuming but also hazardous for workers, exposing them to infectious microorganisms present in sewage. Moreover, the sheer volume of waste, much of it plastic, poses significant challenges to effective cleaning efforts. Plastic waste, in particular, can clog waterways, disrupt the flow of water, and contribute to flooding, creating further environmental and public health hazards.

To address these pressing challenges, innovative solutions are needed. One promising approach is the development of Autonomous Water Surface Cleaning Robots. These robots are designed to efficiently and effectively clean water surfaces, such as lakes, ponds, and reservoirs, without the need for constant human intervention. By harnessing technologies from fields such as robotics, artificial intelligence, and environmental engineering, these robots offer a scalable and sustainable solution to water pollution.The Autonomous Water Surface Cleaning Robot represents a significant advancement in the field of water surface cleaning robotics. Its autonomous nature enables it to tackle large-scale cleaning tasks with minimal human oversight, reducing the need for manual labor and associated risks to workers' health. Importantly, these robots are designed to be non-invasive to aquatic life, minimizing disruption to natural ecosystems during cleaning operations.

By deploying Autonomous Water Surface Cleaning Robots, we can take proactive steps towards restoring the health of our water bodies and ensuring a cleaner, healthier environment for future generations. This project not only addresses the immediate challenges posed by water pollution but also paves the way for further innovations in the field of water resource management and conservation. Ultimately, by fostering the development and adoption of such technologies, we can work towards a more sustainable future for our precious water resources.

## II. LITERATURE SURVEY

[1].This paper highlights the pressing issue of waterlogging caused by plastic, thermocole, and metal debris, which not only hampers development but also contributes to diseases like malaria and typhoid. Manual waste cleaning methods are deemed insufficient due to the vast areas involved and the risk of contracting diseases from sewage. To address this, a proposed garbage collection system is outlined, specifically designed to clean up debris from rivers, channels, and lakes. This system aims to effectively remove a variety of debris, including floating litter, trash, logs, and discarded tires. It incorporates IoT technology for monitoring and controlling the process. A specialized vessel has been developed to operate in various water environments beyond offshore areas, expanding the options for cleaning water pollution. This integrated approach offers a comprehensive solution to tackle the critical issue of water pollution caused by diverse forms of waste, emphasizing the importance of technological innovation in environmental conservation efforts.

[2]. The paper presents an innovative approach to combating river pollution with an autonomous cleaning robot named RoBoat.Its primary aim is to design a sophisticated robotic system capable of navigating rivers independently and efficiently removing pollutants. The paper elaborates on integrating various components and functionalities into RoBoat for this purpose.RoBoat boasts advanced computer vision algorithms for environmental sensing and obstacle detection, enabling safe navigation through river environments. These algorithms facilitate targeted cleanup operations by identifying and categorizing different types of debris and pollutants.Moreover, RoBoat features robust propulsion systems and maneuvering capabilities, allowing it to navigate river currents and reach remote areas effectively. The paper addresses the challenges of designing reliable propulsion systems suitable for river cleaning tasks.Additionally, RoBoat's autonomy is highlighted, achieved through intelligent control algorithms and onboard sensors. These algorithms enable real-time decision-making based on environmental conditions, optimizing cleaning efficiency and adaptability.Practical implementations of RoBoat in real-world river cleaning scenarios are discussed, showcasing its performance and effectiveness in reducing pollution levels. The results underscore the potential of autonomous river cleaning robots in addressing water pollution and preserving aquatic ecosystems.

[3]. The paper introduces a pioneering method for simultaneously monitoring water quality and conducting surface cleaning tasks utilizing an Unmanned Surface Vehicle (USV). Spearheaded by Chang HC et al., the study aims to develop an autonomous system proficient in efficiently assessing water quality parameters while executing surface cleaning operations. The research delineates the USV's design and deployment, underscoring its self-directed navigation and data gathering capabilities. Various sensors are integrated into the USV to gauge crucial water quality metrics such as pH, turbidity, and dissolved oxygen, furnishing real-time data for analysis. Moreover, the USV is outfitted with a cleaning mechanism tailored to eliminate surface debris and contaminants, thereby contributing to environmental upkeep and conservation. Key elements of the paper encompass the intricate technical specifications of the USV's hardware and software, the amalgamation of sensor technologies for water quality evaluation, and the efficacy of the cleaning apparatus. The study underscores the promising potential of autonomous systems in bolstering environmental monitoring and upkeep, offering valuable insights into their prospective applications in water resource management and pollution mitigation.

[4]. The paper details the development of a specialized robot designed specifically for cleaning water surfaces. The summary highlights key aspects: The research aims to tackle water surface pollution through the creation of an efficient cleaning robot. The paper delves into the process of crafting the cleaning robot, discussing aspects such as material choice, component integration, and mechanism design. The authors elucidate on the operational principles of the robot, focusing on its ability to autonomously navigate water surfaces and effectively remove pollutants. Anticipatedly, the paper contains an evaluation section, likely assessing the robot's cleaning efficiency, maneuverability, and durability under various conditions. The discussion may explore potential real-world applications of the cleaning robot and suggest avenues for further research and development.In summary, the paper contributes to the fields of robotics and environmental engineering by introducing an innovative solution for combating water surface pollution through autonomous cleaning technology.

[5]. The paper tackles the pressing need for efficient cleaning methods in aquatic settings, especially relevant in industries like marine maintenance, aquaculture, and underwater infrastructure upkeep.Their proposed solution revolves around a specialized robot tailored for cleaning submerged surfaces. Leveraging state-of-the-art mechatronics and automation technologies, the robot aims to optimize cleaning operations, reducing human involvement and environmental impact.Highlighted

features of the robot include its underwater navigation capabilities, precise targeting of cleaning areas, and adaptability to diverse surface conditions. It's expected that the authors delve into design intricacies, technical specifications, and potential real-world applications of the robot, underscoring its importance in overcoming challenges associated with underwater maintenance tasks.In summary, the paper presents an inventive approach to underwater surface cleaning, offering significant strides in the realm of aquatic robotics and automation.

[6]. The paper focuses on the crucial task of maintaining pond hygiene, essential for preserving ecological balance and water quality.Their proposed solution entails the development of a specialized robot tailored specifically for pond cleaning duties. By incorporating cutting-edge engineering and technology, the robot aims to enhance the efficiency and efficacy of pond cleaning endeavors, thereby reducing manual labor and fostering environmental sustainability.Expected features of the robot likely encompass its capability to maneuver through aquatic environments, identify and eliminate debris, and potentially even monitor water quality indicators. The authors are anticipated to explore the design methodology, technical specifications, and possible applications of the pond cleaning robot, highlighting its significance in safeguarding the health of pond ecosystems.In essence, the paper offers an inventive remedy to the challenge of pond maintenance, presenting promising advancements in the realm of aquatic robotics and environmental conservation.

[7]. The paper tackles the urgent need for effective technologies to combat water pollution and uphold water quality standards.Their proposed remedy, "Swachh Hasth," entails a specialized robot engineered to operate in aquatic environments. By integrating cutting-edge engineering and technology, the robot aims to optimize water cleaning procedures, minimizing manual labor and fostering environmental sustainability.Anticipated features of the Swachh Hasth-A Water Cleaning Robot include its adeptness in navigating water bodies, identifying and eliminating pollutants, and possibly assessing water quality indicators. The authors likely explore the underlying design principles, technical specifications, and prospective applications of the robot, underscoring its relevance in mitigating water pollution challenges. the paper offers a pioneering approach to water cleaning, heralding promising advancements in the realms of robotics and environmental engineering.

[8]. The paper introduces the SMURF (Surface-cleaning Maritime Robot for Unmanned Fouling) robot, designed to autonomously clean water surfaces.At the heart of this innovation is a unique coverage path planning method utilized by SMURF, enabling it to efficiently navigate and clean expansive water surfaces without human intervention. This strategy not only boosts cleaning efficiency but also minimizes operational costs.SMURF is likely equipped with autonomous navigation capabilities, adaptable cleaning mechanisms, and real-time monitoring systems. The authors probably delve into technical aspects of the robot's design, operation, and performance assessment, emphasizing its relevance in combating water surface pollution and fouling.the paper represents a groundbreaking advancement in marine robotics, providing a fully autonomous solution for water surface cleaning with potential applications in marine conservation, pollution control, and preserving aquatic ecosystems.

## III. OVERVIEW

Autonomous surface water cleaning robots introduce an innovative approach to combatting water pollution and preserving the delicate balance of aquatic ecosystems. These robots are equipped with advanced technology, enabling them to autonomously operate on various water bodies like lakes, rivers, ponds, and reservoirs. Let's delve into an overview of these robots:

1. Objective: The primary goal of autonomous surface water cleaning robots is to enhance water quality and safeguard aquatic habitats by removing pollutants, debris, and contaminants from water bodies. They're specifically designed to navigate water surfaces independently, executing a range of cleaning and monitoring tasks without human intervention.

2. Components: Typically, these robots come equipped with a variety of components, including propulsion

systems for movement on water (such as electric motors or thrusters), sensors to detect pollutants and monitor water quality parameters, cameras for navigation and visual inspection, and cleaning mechanisms like skimmers, filters, or scoops for removing debris and pollutants from the water surface.

3. Navigation and Control: Autonomous surface water cleaning robots rely on navigation systems and control algorithms to autonomously navigate water surfaces, evade obstacles, and adhere to predefined paths or mission objectives. Utilizing GPS, inertial navigation systems (INS), sonar, lidar, or computer vision techniques, they perceive their environment in real-time and make navigation decisions accordingly.
4. Sensing and Monitoring: Equipped with sensors capable of monitoring various water quality parameters like pH, dissolved oxygen, turbidity, temperature, and pollutant concentrations, these robots provide real-time data to assess water quality, pinpoint pollution sources, and prioritize cleaning efforts.
5. Pollutant Removal: These robots employ diverse methods for removing pollutants and debris from the water surface, including skimming mechanisms for collecting floating trash, absorbent materials for addressing oil spills, and filtration systems for capturing suspended solids and pollutants. Some models may even feature robotic arms or manipulators for precise cleaning tasks.
6. Remote Operation and Communication: Enabling remote operation through wireless communication technologies like Wi-Fi, cellular networks, or satellite communication, autonomous surface water cleaning robots allow operators to monitor performance, adjust mission parameters, and receive real-time data and alerts from onboard sensors.
7. Advantages: Offering increased efficiency and effectiveness in pollutant removal, reduced dependence on manual labor and chemical treatments, minimal environmental impact, and the capability to operate in remote or hazardous environments, autonomous surface water cleaning robots provide valuable data for environmental research and management.

In essence, autonomous surface water cleaning robots embody cutting-edge technology with vast potential to address water pollution challenges and foster sustainable water resource management. With continual advancements in robotics, sensing, and communication technologies, these robots are poised to play a pivotal role in global environmental conservation efforts.

Fig 1 water cleaning robot

## IV. METHODOLOGY

### A. Existing systems

Currently, the process of cleaning water bodies like lakes and ponds relies heavily on manual labor, where workers are often underpaid and subjected to hazardous conditions. These individuals labor tirelessly along the shores or in small boats, using rudimentary tools like rakes or nets on sticks to remove floating debris. This work is not only physically demanding but also dangerous, particularly in hot weather conditions. Moreover, manual cleaning methods are inefficient and time-consuming, failing to address the problem adequately.In some regions, alternative methods such as skimming are employed. Skimming involves the use of specialized machinery or boats equipped with long arms fitted with scoops or nets. These devices traverse the water's surface, collecting floating waste such as leaves, litter, and algae. Additionally, chemical treatments like iron salts or alum are sometimes utilized to enhance water quality. For example, alum can help control algae growth by reducing phosphorus levels in the water.

However, each of these approaches comes with its own set of drawbacks. Chemical treatments may disrupt the delicate balance of the lake's ecosystem, leading to a decline in aquatic biodiversity. This, in turn, can adversely affect communities reliant on fishing for their livelihoods. Meanwhile, employing machinery or boats for cleaning purposes incurs significant costs, including fuel expenses and the wages of operators. Furthermore, the use of petroleum-based fuels contributes to pollution, exacerbating environmental concerns.Efforts to improve water body cleaning methods must prioritize sustainability and effectiveness while mitigating adverse impacts on both the environment and human communities. Alternative solutions that minimize reliance on manual labor and harmful chemicals are essential. These might include the development of innovative technologies that automate cleaning processes with minimal environmental footprint, such as solar-powered or electrically driven devices. Additionally, promoting community engagement and education on waste management and conservation practices can help foster a collective responsibility for preserving water resources.

Ultimately, addressing the challenges associated with cleaning water bodies requires a multifaceted approach that integrates technological innovation, environmental stewardship, and social equity. By prioritizing sustainable solutions and collaborative efforts, we can work towards ensuring the health and vitality of our

aquatic ecosystems for generations to come.

Fig 2 Manual cleaning

**B.PROPOSED SYSTEM**

To address the limitations of current water cleaning methods, a novel solution has been devised: the remote-controlled water cleaning machine. This innovative device offers efficient and environmentally friendly cleaning of water surfaces. It comprises key components including an Arduino Uno, DC motors, servo motors, rechargeable batteries, an ultrasonic sensor, a GPS module, a Raspberry Pi 4, and a Raspberry Pi Camera. This comprehensive setup enables the robot to effectively collect waste from water surfaces while analyzing the type of debris present.Central to the design is the utilization of renewable energy sources, particularly rechargeable batteries, which power the boat. This sustainable approach not only reduces reliance on fossil fuels but also minimizes the environmental footprint of the cleaning process. The integration of Arduino Uno and Raspberry Pi technology facilitates seamless control and coordination of the robot's movements and waste analysis functions. While the Arduino Uno governs locomotion and collision avoidance, the Raspberry Pi handles image processing and object classification tasks.

Through advanced object classification capabilities, the robot can accurately identify and categorize various types of waste encountered in water bodies. This information is then stored in a container onboard the robot for later disposal or recycling. Equipped with an onboard GPS module, the robot operates autonomously, navigating to specified locations and efficiently cleaning targeted areas. Additionally, an ultrasonic sensor serves to detect the boundaries of the water body, preventing the robot from straying out of bounds and ensuring its safety from collisions or damage.One of the key advantages of this solution is its versatility in weather conditions, as the robot is designed to operate effectively even in adverse conditions such as rain and wind. Moreover, the system is cost-effective to implement and maintain, offering a sustainable and long-term solution to water body cleaning. Importantly, the proposed system prioritizes environmental safety, ensuring minimal disruption to aquatic ecosystems and posing no harm to humans, aquatic life, or other animals.

Furthermore, the robot is engineered to adapt to diverse water environments, making it suitable for deployment in various settings. Its autonomous functionality enables continuous operation without the need for frequent human intervention, enhancing efficiency and reducing labor requirements. Crucially, stringent safety measures are incorporated into the design to ensure the robot operates safely and responsibly in proximity to humans and wildlife.In summary, the remote-controlled water cleaning machine represents a significant advancement in water body cleaning technology, offering a sustainable, efficient, and environmentally friendly solution to the challenges associated with manual labor and chemical treatments.

**C.Prototype Design of Unmanned Surface Vehicle (USV)**

The envisioned design for the unmanned surface vehicle (USV) aimed at autonomous cleaning operations prioritizes compactness and efficiency .this USV is engineered to gather debris and waste from aquatic environments, contributing to their preservation and cleanliness.The USV's structure comprises two pontoon structures crafted from EPS foam, providing buoyancy and stability essential for its operations. These pontoons ensure the USV maintains balance and remains afloat during cleaning tasks. Situated between the pontoons, a salvage net is supported by an acrylic frame, guaranteeing stability and optimal positioning for efficient debris collection.Embedded within each pontoon are motors connected to propellers via shafts, meticulously designed to prevent water ingress. These propellers, boasting a diameter of 47 mm, generate the required thrust and agility for the USV to maneuver adeptly through water bodies, enabling it to access targeted areas for debris collection.

To safeguard the delicate electronic components from water-related damage, a sealed and watertight enclosure is situated above the acrylic frame. This protective casing ensures the electronics remain operational and secure, even in damp and challenging conditions, thereby ensuring the USV's dependable performance.

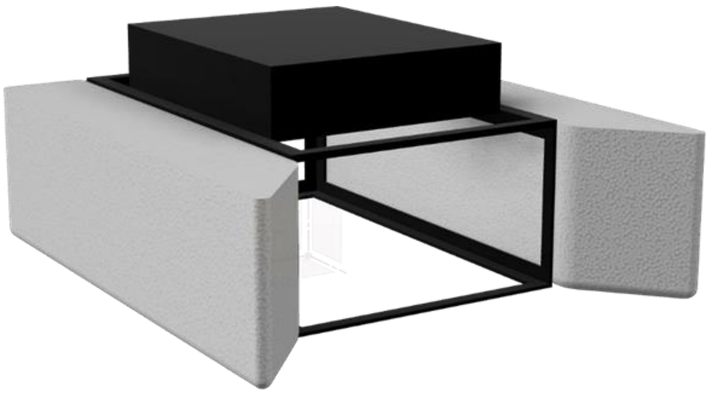

Fig 3 Model of water cleaning robot

**D. Obstacle Avoidance**

The obstacle avoidance logic implemented in this project utilizes an ultrasonic sensor (HC- SR04) and a servo motor (SG90). The ultrasonic sensor emits pulses and measures the time it takes for the pulses to bounce back, providing distance measurements between the robot and nearby obstacles. When an obstacle is detected within a specified range, the robot initiates the obstacle avoidance routine. It halts its forward motion to prevent collisions and employs the servo motor to scan the surroundings. By rotating the servo motor, the robot scans the right and left sides, measuring distances using the ultrasonic sensor. Based on the comparison of these distances, the robot determines the direction with more clearance. It turns either right or left, depending on which side offers more space. In cases where both sides have equal clearance, it prefers turning left. After turning, the robot briefly pauses to align itself and avoid immediate obstacles. If the robot encounters multiple consecutive obstacles, it enters a recovery mode, reversing its direction for a specified duration to create additional space and prevent getting stuck. If no obstacles are detected within the maximum range, the robot resumes moving forward while periodically scanning the surroundings to ensure a clear path. This obstacle avoidance logic enables the robot to autonomously navigate around obstacles, ensuring safe and efficient operation during its cleaning task.

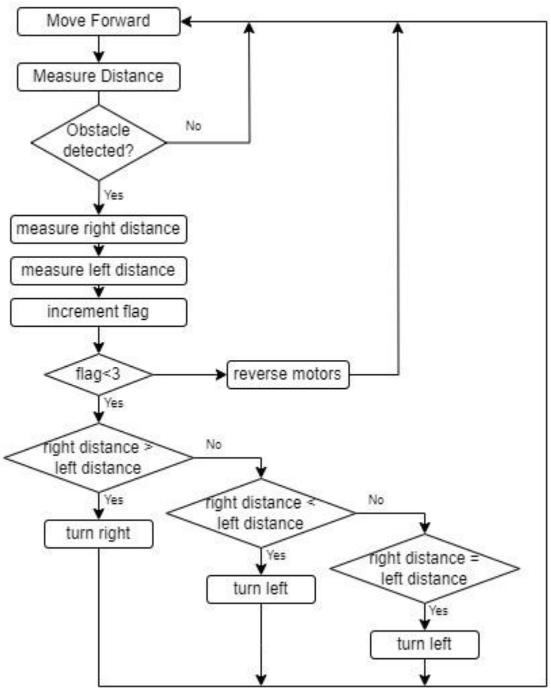

Fig 4 obstacle avoidance flowchart

## E.Machine Learning

### *1. Google Teachable Machine*

Individuals utilize an application called Teachable Machine, developed by Google, to train the trash dataset. This tool simplifies the process of training AI models with minimal coding requirements. With just a small set of training examples, Teachable Machine can differentiate between objects, even considering variations in orientation, distance, and lighting conditions. It employs transfer learning, a widely used method in deep learning, for this purpose. Teachable Machine offers three pre-trained models:

1. MobileNet: Optimized for mobile and embedded devices, MobileNet is a lightweight convolutional neural network architecture. It balances accuracy and computational efficiency effectively.
2. ResNet: Known for its exceptional performance in image classification tasks, ResNet (Residual Network) consistently achieves top-tier results in various computer vision competitions.
3. Inception: Another popular convolutional neural network architecture, Inception is adept at capturing intricate details within images. Its ability to discern fine-grained features has contributed to its popularity.

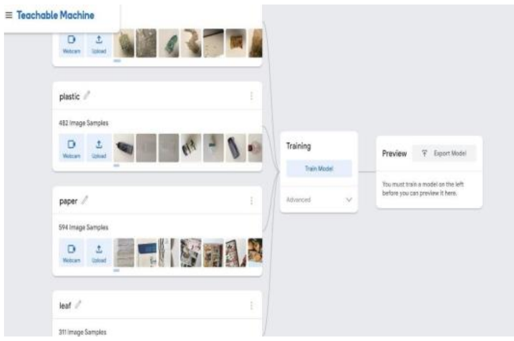

Fig 5 Teachable Machine

### *2.Transfer learning*

Teachable Machine relies on transfer learning, a widely used deep learning technique. It involves taking a pre-trained model like MobileNet, ResNet, or Inception, which has been trained on a large dataset like ImageNet, and fine-tuning it on a smaller, specific dataset, such as one containing images of different types of trash. Users can gather or curate their own dataset of trash images and use Teachable Machine to train a custom image classification model tailored to their specific trash categories.With Teachable Machine, users can provide examples of different types of trash images along with their corresponding labels. The tool then employs transfer learning methods to adjust a pre-trained model to classify the trash items according to the user's specific needs.In the case of neural network models, Teachable Machine utilizes a base model proficient at general tasks, such as classifying various images into numerous classes. It removes only the last classifier layer, replaces it with a custom classification layer, and trains this layer with new images. This way, the base model essentially operates as a 'fixed feature extractor,' generating a representation of an image that captures relevant features in general.

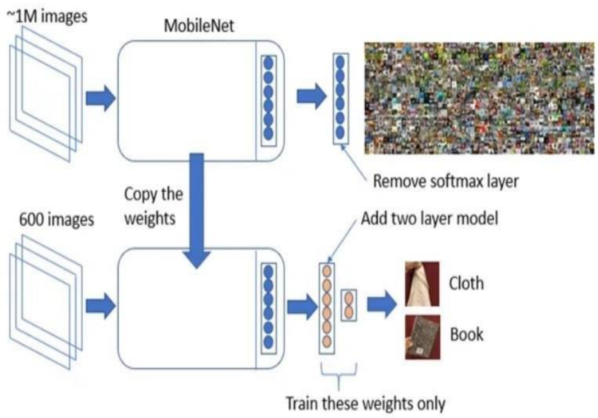


Fig 6 Transfer learning

Teachable Machine utilizes a transfer learning approach as follows:

1. It starts by using the pre-trained MobileNet model, a 28-layer CNN designed for image classification.

2. The softmax layer of MobileNet is removed, and the output before this layer serves as the representation of the image.

3. A new model is constructed with only two layers: a Dense layer (typically with 100 units) and a final softmax layer with the number of units matching the desired classes.

4. Images are collected and converted into tensors using MobileNet's transformations. These transformed tensors are then used for training the model.

5. The two-layer model is trained using the collected data for a certain number of epochs.

6. After training, MobileNet and the two-layer model are combined to create a joint model.

7. This joint model can then be utilized to make predictions on new images.

### *3.TensorFlow Lite*

For deployment on resource-constrained devices like the Raspberry Pi, TensorFlow Lite is employed. TensorFlow Lite is a lightweight version of TensorFlow tailored for such devices, allowing for efficient inference of machine learning models without relying on cloud-based services. By converting the Teachable Machine model to TensorFlow Lite format and installing the TensorFlow Lite runtime on the Raspberry Pi 4, users can achieve fast and optimized inference performance directly on the device.

### *4.Using Teachable Machine to train the model*

A waste classification system was developed using Teachable Machine and TensorFlow Lite. The objective was to create a model capable of accurately categorizing different types of waste, including trash, plastic, paper, and leaf. Teachable Machine was used on the laptop and then the model was deployed on the Pi. The dataset for plastic, trash and paper were taken from Kaggle , the dataset for leaves were taken from Kaggle and the some pictures were taken from the webcam of the laptop and it was uploaded in the Teachable Machine. The trash dataset consists of 137 sample images, Plastic has 482 image samples, Paper has 594 image samples and Leaf consists of 311 image samples.
Once the training process was complete, the trained model was exported in the TensorFlow Lite floating-point format. This format is saved in the name **model.tflite** This format ensures compatibility with the TensorFlow Lite runtime, which allows for efficient deployment on resource-constrained devices such as the Raspberry Pi 4. The TensorFlow Lite floating-point model represents a compressed and optimized version of the original Teachable Machine model, designed specifically for efficient on-device inference. This conversion process involved utilizing the TensorFlow Lite Converter tool to transform the model into a format suitable for deployment on the Raspberry Pi 4. The. tflite

model is then transferred to the Raspberry Pi using VNC viewer.

### F. Raspberry Pi Technology

Raspberry Pi technology can be utilized in autonomous surface water cleaning robots in several ways:

1. Control System: Raspberry Pi can serve as the central control unit of the robot. It can manage various components such as motors, sensors, cameras, and other peripherals necessary for navigation, obstacle avoidance, and water cleaning operations.
2. Sensor Integration: Raspberry Pi can interface with a variety of sensors, including ultrasonic sensors, infrared sensors, GPS modules, and environmental sensors (such as those for detecting water quality parameters like pH, turbidity, or pollutant levels). These sensors provide crucial data for navigation, obstacle detection, and monitoring water conditions.
3. Image Processing and Computer Vision: Raspberry Pi can process images captured by onboard cameras to perform tasks such as object recognition, identifying debris or pollutants in the water, and detecting obstacles or navigational landmarks.
4. Data Logging and Analysis: Raspberry Pi can log sensor data and images for further analysis. This data can be used to assess the effectiveness of the cleaning operations, track changes in water quality over time, and optimize the robot's behavior.
5. Communication: Raspberry Pi can enable communication capabilities, allowing the robot to transmit data, receive commands remotely, or even collaborate with other robots in a coordinated manner.
6. Autonomous Navigation: Using Raspberry Pi along with appropriate algorithms, the robot can autonomously navigate its environment, avoiding obstacles and following predefined paths or instructions.

By leveraging Raspberry Pi technology, developers can create cost-effective and customizable solutions for autonomous surface water cleaning robots that are capable of efficiently cleaning water bodies while adapting to different environmental conditions.

## V.APPLICATIONS

Autonomous surface water cleaning robots represent a promising solution for combating the diverse environmental issues stemming from water pollution in lakes, rivers, ponds, and similar water bodies. These robots are equipped with advanced technology enabling them to autonomously navigate across water surfaces, identify and eliminate pollutants, and continually monitor water quality. Their applications extend across various domains, each contributing to the enhancement of water ecosystems and human well-being. Here are several primary applications of autonomous surface water cleaning robots:

1. Environmental Conservation:

Autonomous water cleaning robots play a pivotal role in conserving the environment by efficiently removing pollutants and debris from water bodies. By preventing the accumulation of harmful substances like plastics, chemicals, and organic waste, these robots aid in restoring the ecological balance of aquatic ecosystems. Their actions contribute significantly to preserving aquatic habitats and safeguarding vulnerable species.

2. Water Quality Monitoring:

Equipped with sophisticated sensors capable of real-time monitoring, these robots continuously assess various water quality parameters such as pH, dissolved oxygen, turbidity, temperature, and nutrient levels. This data is invaluable for environmental researchers and policymakers in evaluating water body health, pinpointing pollution sources, and implementing targeted remediation strategies.

3. Algae Bloom Management:

Autonomous surface water cleaning robots are adept at managing and mitigating harmful algal blooms (HABs), which pose significant threats to aquatic life and human health. By detecting and removing algae from the water surface, these robots effectively curb the spread of toxins associated with algal blooms, thereby minimizing their adverse ecological and economic impacts.

4. Oil Spill Response:

In the event of an oil spill, autonomous water cleaning robots can be swiftly deployed to contain and remove oil from the water surface. With specialized skimmers and absorbent materials, these robots efficiently collect oil, preventing its further spread and reducing environmental damage to aquatic ecosystems and coastal areas. Their autonomous operation ensures prompt and effective cleanup, thereby mitigating long-term ecological repercussions and cleanup costs.

## VI.CONCLUSION AND FUTURE SCOPE

In conclusion, the development of an autonomous river cleaning robot has significant potential for addressing the pressing issue of water pollution and improving the overall health and cleanliness of water bodies. The project's objectives, including effective debris collection, obstacle avoidance, and trash analysis, have been successfully achieved through the implementation of a robust hardware and software system. The robot's compact design and intelligent algorithms enable it to navigate through water bodies, detect and classify different types of trash using deep learning algorithms, and effectively collect the debris. By leveraging the power of deep learning, the project offers an innovative approach to trash analysis, allowing for accurate identification and categorization of waste materials present in the water. The integration of obstacle avoidance mechanisms ensures the safe and obstacle-free movement of the robot. With its autonomous functionality and efficient cleaning capabilities, this project offers a promising solution to the challenges associated with manual river cleaning operations. This technology holds great promise for streamlining and improving the efficiency of cleaning operations in lakes, rivers and other water bodies, contributing to the preservation of aquatic ecosystems and the mitigation of water pollution.

In the future, the scope of the project extends to testing the USV in more challenging field environments to enhance its performance and reliability. This includes refining the methodology for water surface cleaning and obstacle avoidance to make them more robust and stable. Additional sensors and advanced algorithms will be integrated into the USV to further enhance its capabilities, allowing for more accurate obstacle detection and avoidance, as well as improved efficiency in cleaning operations. These advancements will contribute to the continued development and optimization of autonomous river cleaning robots, paving the way for their widespread use in addressing water pollution and maintaining the cleanliness of water bodies.

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