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ABBREVIATIONS

UPVC pipe	- Unplasticized polyvinyl chloride pipe
PVC sheet	- Polyvinyl chloride
DC motor	- Direct current motor
RPM	- Revolutions per minute
F_b	- Buoyancy force

Chapter-1

INTRODUCTION

1.1 Introduction

Rivers are the lifelines of civilizations, providing water for drinking, agriculture, industry, and transportation. However, rapid urbanization, industrialization, and improper waste disposal have led to severe pollution in many major rivers across the globe. The Ganges River in India faces extreme contamination from industrial discharge, sewage, and religious offerings, with high levels of bacteria and heavy metals threatening aquatic ecosystems. The Yamuna River, one of its major tributaries, has turned into a “dead river” in many sections due to excessive foaming caused by chemical waste and untreated sewage. Similarly, the Citarum River in Indonesia remains one of the world’s most polluted rivers, with plastic waste and industrial pollutants making its water unfit for human use. In the Mississippi River (USA), agricultural runoff continues to cause excessive nutrient pollution, leading to harmful algal blooms and massive dead zones in the Gulf of Mexico. Even in Europe, the Danube River faces increased contamination from microplastics and pharmaceutical residues.

Figure 1.1 Water Pollution

This project focuses on the design and development of a river cleaning machine to efficiently remove floating waste and pollutants from water bodies. The proposed system incorporates a conveyor mechanism to identify and collect different types of waste, such as plastic, organic debris, and industrial pollutants. Additionally, integrating IoT-based real-time monitoring, will enhance the system's efficiency and sustainability.

1.2 Water Pollution and Its Effects

Water pollution occurs when harmful substances contaminate water bodies such as rivers, lakes, oceans, and groundwater. These pollutants may include plastic waste, industrial effluents, sewage, and agricultural runoff. When discharged into water without proper treatment, these substances degrade water quality and pose serious threats to both the environment and living organisms.

Effects of Water Pollution:

Harm to Aquatic Life: Toxic substances reduce oxygen levels and introduce hazardous chemicals into aquatic ecosystems, causing fish and other organisms to die or mutate.

Disruption of Ecosystems: Pollutants damage natural food chains and lead to the decline of species, upsetting the ecological balance.

Human Health Risks: Contaminated water can cause serious health issues such as cholera, dysentery, and other waterborne diseases.

Economic Impact: Polluted water bodies affect tourism, fishing industries, and increase the cost of water treatment.

1.3 Impurities in Water :

Pure water cannot be found in nature even rainwater which is pure at the instant of originating contains gases, dust and other substances as it passes through the atmosphere. The ultimate or primary source of water is water as it comes to the earth surface which is already impure rain passing through the atmosphere further picks up the organic and suspended matter as of surface runoff and portion of rainwater which percolates into the ground as groundwater dissolves several salts and minerals, organic and inorganic matter while infiltrating into subsurface strata. The water thus tapped from surface and ground source may contain undesirable and excess substances as termed as impurities which may be classified as follows.

Suspended impurities in water consist of visible particles such as soil, sand, and organic waste. These particles are typically larger than 1000 angstroms (Å) in size and contribute to the turbidity of water. Since they are relatively large, their removal can be effectively achieved through simple physical processes such as filtration, sedimentation, or settlement. These methods allow the heavier particles to either be strained out or settle at the bottom over time.

Colloidal impurities are much finer particles, ranging in size from 10 to 1000 Å, and may consist of both organic and inorganic matter. These impurities are responsible for making water appear cloudy or turbid, even though they are not easily visible to the naked eye. Due to their small size and stable suspension, colloidal particles cannot be removed by simple sedimentation. Instead, they are treated through a process of coagulation followed by sedimentation or filtration. Coagulants such as ferrous sulfate ($FeSO_4$), alum, sodium aluminate, and aluminum sulfate are commonly used to destabilize these particles and facilitate their removal.

Dissolved impurities include gases, inorganic salts, and various organic molecules that are completely dissolved in the water, making them invisible and difficult to remove through physical means alone. These impurities require chemical or thermal treatment for effective removal. Techniques such as mechanical deaeration, heating, and chemical treatment involving oxidation or biochemical oxidation are commonly employed to target and eliminate dissolved substances from water.

Biological impurities refer to living organisms present in the water, including bacteria, algae, fungi, and other small aquatic organisms. These contaminants can pose health risks and must be carefully eliminated. The treatment process usually begins with filtration to remove larger biological matter, followed by sterilization through chemical methods. Common chemical disinfectants include bleaching powder, sodium hypochlorite, chlorine, chloramines, and ozone. Additionally, physical methods such as ultraviolet (UV) light sterilization are also used to ensure complete disinfection of the water

1.31 Classification of impurities

Impurities in water refer to unwanted or harmful substances that are present in water, making it unsafe, unclean, or unsuitable for drinking, domestic use, agriculture, or industrial purposes. These impurities can come from natural sources (like soil, rocks, and decaying plants) or human activities (like sewage discharge, industrial waste, and agricultural runoff).

1.311 Based on Properties

Physical impurities - The presence of physical impurities in water affects physical characteristics such as colour, odour, taste and turbidity. Colour, odour and taste in water are due to the presence of organic matter, minerals, microorganisms etc. Turbidity in water is chiefly due to suspended matters whereas colloidal also liable for turbidity.

Chemical impurities - The presence of chemical impurities in water affects the chemical salts of minerals, characteristics of water such as PH, solids, hardness, alkalinity, chloride, nitrogen etc. The presence of chemical impurities may cause various types of diseases.

Bacteriological impurities - The presence of the bacteriological impurities affects the bacteriological characteristics of water such as pathogenic microorganisms. (Salmonella), non-pathogenic (E-coli) Bacteriological impurities present in water causes diseases in humans.

1.312 Based on State Of Presence

Suspended impurities - These impurities are a dispersion of solid particles resulting in turbidity in water. Suspended impurities include silt, clay, algae, fungi, organic and inorganic matters, mineral matter etc. These impurities remain in suspension due to the same specific gravity as that of water. Suspended impurities are macroscopic and cause turbidity in water. The concentration of suspended matter in water is measured by turbidity. Suspended impurities can be removed by settling or by filtration.

Dissolved impurities - Water is a very good solvent and can dissolve all that it comes in contact with the salts to The dissolved impurities may contain organic compounds, inorganic salts, gases etc. The amount of dissolved solids is normally expressed in and magnesium in water causes bad taste, hardness, alkalinity, alkaline PPm. Salt of calcium etc. Iron oxide and manganese when dissolved cause odour, taste, red or black or brown colour, produce stain's on cloth in laundries and plumbing fixtures in buildings. Gases like O_2 and CO_2 causes corrosiveness and H_2S causes the smell of rotten egg. Dissolved impurities is in a liquid having only one phase so such impurities can be removed only by phase change such as Precipitation, adsorption, distillation.

Colloidal impurities - These impurities are so small that they cannot be removed by an ordinary filter and are not visible to the naked eye. These are a dispersion of particles in water with electrically charged and remain in continuous motion and do not settle due to the same charge. These colloidal impurities are generally associated with organic matter containing bacteria and are the chief source of epidemics. Colour in water is normally due to colloidal impurities. Their quantity is determined by colour tests. Their quantity is determined by colour tests. The size of colloidal impurities is between 10-3 mm to 10-6 mm. Colloidal can be removed from water by coagulation and sedimentation than filtration.

1.4 Environmental Impact of River Pollution

River pollution has widespread and devastating effects on the environment, affecting not only aquatic ecosystems but also terrestrial life and atmospheric conditions. As rivers are interconnected with oceans, groundwater, and land systems, pollution in rivers can lead to a ripple effect across the entire ecosystem.

1.41 Damage to Aquatic Life

Toxic chemicals, plastics, and oil spills severely affect fish, amphibians, and other aquatic organisms. Oxygen levels decrease (a process called eutrophication), causing mass deaths of aquatic species. Microplastics are ingested by marine life, leading to illness or death, and eventually entering the food chain.

1.42 Destruction of Ecosystems

Polluted rivers disrupt the balance of natural ecosystems. Wetlands and riverbanks, which are breeding grounds for many species, become inhabitable. Plants and microorganisms crucial to ecosystem functioning are wiped out or weakened.

1.43 Contamination of Drinking Water

Polluted rivers, often sources of drinking water, can cause waterborne diseases like cholera, typhoid, and hepatitis in humans and animals. Heavy metals like lead and mercury accumulate in water and soil, leading to long-term contamination and health hazards.

1.44 Soil and Agricultural Impact

Farmers using polluted river water for irrigation risk contaminating crops. This leads to reduced agricultural yield and soil infertility over time due to chemical buildup.

1.45 Negative Impact on Biodiversity

Many species go extinct or migrate due to toxic water conditions. Loss of biodiversity reduces nature's ability to recover from environmental stressors like climate change.

1.**46 Contribution to Climate Change** Decomposing waste in rivers releases greenhouse gases such as methane and carbon dioxide. This contributes to global warming and affects weather patterns, creating a dangerous environmental feedback loop.

1.5 River Cleaning Methods

Water pollution, especially in rivers, demands effective and sustainable cleaning methods. Over time, various techniques have been developed to clean and maintain water bodies. These methods can be broadly classified into manual, mechanical, and automated/innovative approaches:

Manual Cleaning Involves laborers physically removing waste using nets or boats. Effective for small-scale operations. This method limits as Time-consuming, risky in polluted or fast-flowing waters, not scalable for large areas.

Mechanical Cleaning Utilizes machines like trash skimmers, barges, or boats equipped with conveyor belts and robotic arms. Capable of collecting larger amounts of floating debris. Municipal river-cleaning boats, floating trash barriers are the examples of mechanical cleaning these method limits for high maintenance cost, may rely on fuel-based engines

Figure 1.2 Mechanical Cleaning

Aeration and Bioremediation – Aeration increases oxygen levels in water to help break down pollutants naturally where bioremediation introduces beneficial bacteria to degrade harmful substances. And these methods limitations are Mostly used for chemical/organic pollution—not effective for solid waste.

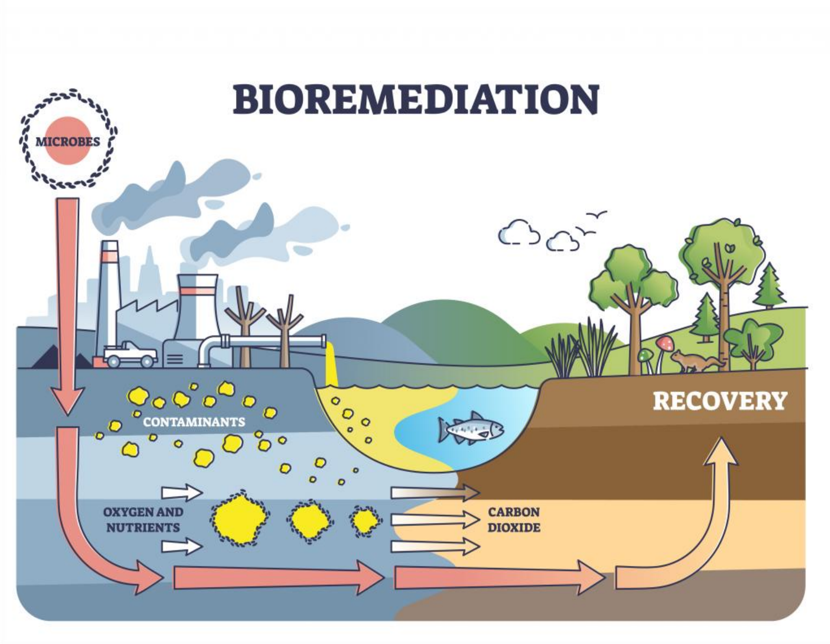

Figure 1.3 Bioremediation

Floating Barriers and Booms used to block and collect floating debris in one location for easier removal. Often paired with mechanical collection systems. This method limits only useful in static or slow-flowing areas.

The Interceptor by The Ocean Cleanup – A solar-powered autonomous boat designed to collect floating plastic waste from rivers before it reaches the oceans.

Trash Traps and Booms – Physical barriers installed in rivers to intercept and collect floating debris.

Figure 1.4 Drone-Based Water Monitoring

Drone-Based Water Monitoring – AI-powered drones that map polluted areas and guide cleaning machines for efficient waste removal.

The implimentation these modern approaches, we can significantly reduce pollution levels, restore water quality, and improve environmental sustainability. This project aligns with global efforts such as the United Nations' Sustainable Development Goals Water and seeks to contribute toward cleaner and healthier waterways for future generations.

1.6 Controlling Processes

The control system of a river cleaning machine ensures that all mechanical and electrical components function in a coordinated, efficient manner. The complexity of the control system can vary depending on whether the machine is manually operated, semi-automated, or fully automated.

1.61 Manual Control

In a basic prototype control is often done using a simple wired or wireless remote system:Power ON/OFF Switch – Starts or stops the system. Motor Control Switches – For operating the conveyor belt and wheels or paddles. Direction Control – Optional, if the prototype has mobility. Controlled by basic DC switches, relays, or toggle buttons.

1.62 Semi-Automated Control

Includes some automation features while still requiring manual operation:Arduino/8051 Microcontroller Based Control System. Controls conveyor motor speed and timing.Uses sensors (like IR or ultrasonic) to detect waste or water level. This can automate ON/OFF of conveyor belt or waste collector.

1. 7 Waste Water Collection

These are the most visible pollutants and include:

- Plastic Waste – Bottles, bags, food wrappers, microplastics
- Domestic Waste – Cloth, packaging materials, paper waste
- Industrial Waste – Factory scraps, synthetic materials, chemical containers
- Organic Waste – Leaves, branches, dead animals, food waste

Figure1.5 Impact of water pollution

1.8 Objective of the work

- To design an eco-friendly River cleaning machine for water purification process.
- SELECTION OF MATERIAL BASED ON THE DESIGN PARAMETERS.
- To Identify different componemts for fabrication of prototype model

1.9 Methodology

River cleaning machine is essential to purify the river water. Design of the various components were calculatecd by using numerical equations. Material selection was done based on the design constraints. Applying the mathematical equations for calculations of various parameters like buoyancy force , volume and collecting tank. The methodology has shown in the block diAgram

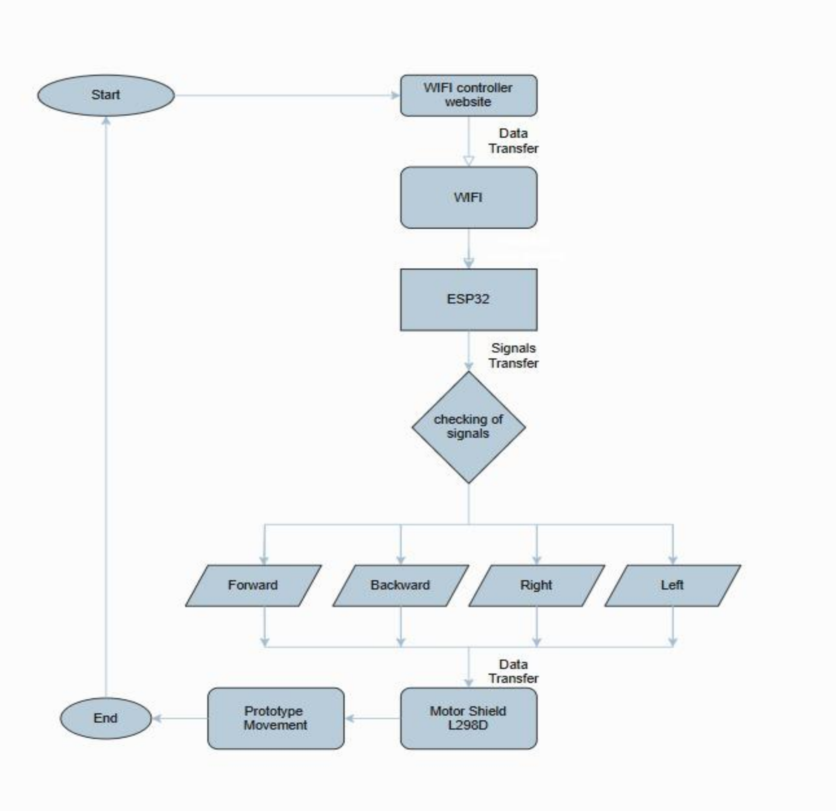

Figure 1.6 Block diagram

1.10 Layout of the Thesis

Chapter-1 describes the Introduction to water pollution and the necessity of river cleaning Machines, impurities present in water, waste water collection, control processes , Objectives and research methodology and layout of the thesis were discussed.

Chapter-2 deals with Literature on study of evolution in river cleaning mechanisms , Outcomes of the literature review and problem identification were discussed.

Chapter-3 describes principles that are adopted for the prototype, features of the river Cleaning machine, various components that are used for making the model and their specifications were discussed.

Chapter-4 deals with numerical design and required calculations to run the prototype, Complete Arduino code and division of the Arduino code was explained.

Chapter-5 describes the fabrication of the entire prototype was explained detailed , includes Stages of activities during fabrication, and also includes advantages and Applications were discussed.

Chapter-6 deals with conclusions and future scope of the project were discussed.

1.11 Summary

This Chapter deals with brief introduction of river cleaning machine and also includes water pollution and its effects, water cleaning methods, controlling process that helps to operate the system remotely, and includes the impact of water pollution on environment . It also deals with the objectives of the work and methodology. And the next coming chapter it deals with literature review.

Chapter – 2

LITERATURE REVIEW

2.1 Introduction

Water pollution, especially in rivers and other freshwater bodies, has become a significant concern due to rapid urbanization, industrial growth, and improper waste disposal practices. The accumulation of solid waste in rivers not only affects water quality but also endangers aquatic life, public health, and the sustainability of natural ecosystems. To combat this, researchers and engineers around the world have explored various river cleaning technologies ranging from manual methods to sophisticated automated systems.

This literature review explores the existing studies, designs, and technologies related to water body cleaning mechanisms. It covers developments in mechanical and automated cleaning systems, the use of sensors and robotics in waste collection, energy-efficient solutions such as solar-powered mechanisms, and materials used for floating and waste conveyance. By analyzing previous work in this field, this section aims to identify the strengths, limitations, and research gaps that have informed the development of our prototype model.

2.2 Studies on design and fabrication of river cleaning machine

M. Mohamed Idhris et al. [1] described about the design and development a remote-controlled sewage cleaning machine that reduces human involvement in hazardous environments and helps prevent the spread of diseases caused by exposure to sewage waste and harmful gases. The proposed system successfully reduces human contact with sewage, limits the risk of disease transmission, and efficiently collects floating and solid waste. It improves hygiene in drainage systems by automating the cleaning process and preventing mosquito breeding and pest infestation, contributing to a cleaner and safer environment.

Rajendra Patil et al. [2] described a methodology to develop mechanical and efficient systems, such as skimmer boats, for collecting floating debris from water bodies, reducing reliance on inefficient and labor-intensive manual cleaning methods. Mechanized skimmer vessels offer a systematic and scalable approach to waste collection in aquatic environments. They improve cleanup efficiency, reduce manual labor, and allow for easy transfer of waste to secondary storage or disposal units. However, long-term success also depends on addressing pollution sources, not just removing visible waste.

Mr.Abhijeet et al. [3] discussed that India is a holy country with many festivals like Ganesh Visarjan, Navratri Durga Pooja & mainly Siahnsth Kumbhmela where there is lots of water pollution & then giving an idea of using River Clean Up machine to reduce water pollution. Implementing River Clean-Up Machines after such festivals can significantly reduce the pollution levels in rivers, protect aquatic life, and promote environmental sustainability while respecting cultural traditions.

Huang Cheng et al. [4] explained about the major pollution sources in the Liangtan River basin and determine the most effective projects and technologies for improving water quality in a rapidly urbanizing region using MIKE 11 water quality modeling. And found ways to clean water Upgrading municipal wastewater treatment to meet higher discharge standards. Investing in cleaner technology for major industrial enterprises. Adopting a combined cleaning approach that integrates mechanical and manual methods to achieve more effective and eco-friendly restoration. Requires multi-sectoral cooperation, which can be complex in urban areas with overlapping jurisdictions.Manual cleaning, while precise, is labor-intensive and time-consuming—less efficient for wide-scale application.

Ar. Sakshi Sandesh et al. [5] discussed the environmental impact—especially water and solid waste pollution—caused by mass religious gatherings like the Kumbh Mela, and to emphasize the need for sustainable waste and water management practices during such events to preserve the sanctity of sacred rivers and spaces. While the Kumbh Mela is a spiritually significant event, it inadvertently contributes to severe river and environmental pollution through ritual bathing and improper disposal of offerings and solid waste. Efficient waste management systems, public awareness, and eco-conscious rituals are essential to protect both the sacred value and ecological health of the rivers.There is a pressing need to balance tradition with environmental responsibility to preserve the purity and sustainability of sacred spaces.

Nurlansa et al. [6] discussed to develop an automatic garbage-collecting robot (AGATOR) that can effectively and efficiently reduce garbage accumulation in non-flowing river sections through autonomous operation.AGATOR successfully meets its design goals with tested electronic specifications and demonstrates potential as a low-power, automated solution for garbage collection in stagnant river areas.The system is designed primarily for non-flowing or stagnant water bodies, which limits its use in fast-flowing or deep rivers.The performance is dependent on the precision of its sensors and controllers, which may require regular calibration and maintenance.

Aditya Kulkarni et al. [7] A conveyor system is a common piece of mechanical Handling equipment that moves materials from one location to another. The main purpose of this project is to safely lift the load at the rate of 6m/min. This paper consist of, selection, the design of basic mechanical elements. This system is able to overcome the drawbacks of inclined belt conveyor, achieves desired height and occupies less floor space as the material is transformed in vertically upward direction. This Chain Conveyor utilizes a continuous chain arrangement, carrying a series of the single pallet for lifting the load. The chain arrangement is driven by a motor, and the material suspended on the pallets is conveyed to the next floor.

Dharmesh N. Kandare et al. [8] discussed to develop an eco-friendly, cost-effective, and time-efficient solution that reduces the reliance on manual labor and conventional methods such as boats, which are often risky and labor-intensive. The project integrates a conveyor-based mechanism with an innovative Air Tube Piping Guider system to enhance waste collection efficiency. By addressing the limitations of traditional cleaning techniques, the developed system successfully demonstrates improved operational control through motorized and R/C components, ultimately contributing to cleaner water bodies and supporting environmental sustainability goals.

Adarsh Dorlikar et al. [9] discussed to design and fabrication of the river waste cleaning machine. “River cleaning machine" a machine which involves the removing the waste debris from water surface and safely dispose from the water body. The work has done looking at the current situation of our national rivers which are dump with core liters of sewage and loaded with pollutants, toxic materials, debris etc. Due to increase in water pollution in the form to waste debris; it is hampering the life of aquatic animal and make their life in danger.

S. Abdul Mutalib et al. [10] discussed a methodology to design a propeller with isotropic material such as aluminum and composite materials to analyze its strength and deformation using ANSYS WORK BENCH software. To compare the effectiveness of aluminum metal and composite material such as CFRP and GFRP, static analysis and dynamic analysis are performed on these different materials. The solid model of marine propeller is developed using Solid works. This works approaches the substantial improvements in metal propellers. The stress, strain and the total deformation were found out both the aluminum and the composite marine propeller using ANSYS. The stresses obtained are well within the limit of elastic property of the materials. The results are compared with aluminum and Composite marine propeller for the maximum stress and maximum deformation.

K.P.M.Y.V. Dathu, et al[11]., 'Design of River Waste Collector Machine Using Arduino' discussed on design of the river waste collection. Trillions of pieces of plastic currently pollute the seas, rivers, lakes, ocean harming sea life, contaminating ecosystems and making a mess on beaches. Automation plays an important role in mass production. In this venture we have manufactured the remote worked waterway cleaning machine. Prime objective of our project is to collect all the wastes which are found floating on water bodies and to minimize labor work. These are done by using a hardware prototype and by using a Microcontroller for controlling all parts of a machine by using a smart phone by using Wi-Fi or Bluetooth.

Sreejith S Nair, et al.[12] addresses the pressing issue of water pollution by proposing the design and analysis of an autonomous river cleaning robot. With over two-thirds of Earth's surface covered in water and only a small percentage suitable for human use, controlling water pollution is critical. The robot is designed to perform tasks like collecting floating waste and underwater inspection, reducing the need for manual labor and its associated risks. Key components include a frame, cylindrical hull, thrusters, and wide arms for efficient waste removal. The study also includes hydrodynamic modeling using ANSYS Fluent, structural and buckling analysis, and prototype development.

Puneeth E Raikar, et al.[13] describes on the design and fabrication of a remote-operated river waste cleaning machine, developed in response to the growing pollution in Indian rivers caused by sewage, debris, and toxic materials. Inspired by large-scale initiatives like "Namami Gange" and "Narmada Bachao," the machine aims to automate the river cleaning process, reducing manpower and time consumption. It features a motor-driven, partially submerged cage mechanism controlled via RF transmitter and receiver. Emphasizing low-cost automation through robotics, the project showcases how automation can enhance environmental efforts and support cleaner water bodies efficiently.

Mohit Kharapkar, et al. [14] describes to design and development of a sludge collection machine to address severe river pollution caused by sewage and debris. Inspired by national river cleaning initiatives, the machine is remotely controlled and uses a motor with a belt drive system to automate waste collection. It aims to reduce manpower and cleaning time, promoting low-cost automation through basic electronics and robotics.

Raj Vaibhav Tiwari et al. [15] explains the design and fabrication of a remote-operated river waste cleaning machine, developed in response to the growing pollution in Indian rivers. Utilizing a motor and chain drive system controlled via RF transmitter and receiver, the machine aims to reduce manpower and cleaning time. It highlights the role of automation—particularly pneumatics—for achieving efficient, low-cost environmental solutions.

2.3 Outcome of the literature review

From the various literatures it has been observed the present and past existing methods for different kinds of water pollution and its impact it helped in understanding the purpose of the project and numerical calculations that are required and fabrication of the prototype of the river cleaning machine. As it is found that there is a limited literature available on auto control.

2.4 Problem Identification

The statement of the project is " Design and Fabrication of River Cleaning System" to remove the waste debris, plastic waste and garbage from river, This causes harm to acoustic and human life. To achieve clean water body for reduction of river pollution and to achieve the beauty of River by clean water bodies.

2.5 Summary

This chapter includes the literature reviews on studies of various river cleaning machines that are evolved according the problem raised. And also includes outcome of the literature review and the river watr cleaning machijne and its funtions were discussed. In the next coming chapter it deals with principles and functions of river cleaning machine.

Chapter – 3

RIVER CLEANING MACHINE

3.1 Introduction

The effective operation of any mechanical system relies heavily on its underlying principles and the specific functions it is engineered to perform. In the context of environmental restoration, particularly river surface cleaning, the design of a river cleaning machine must align with both mechanical and environmental engineering principles. This section provides a detailed insight into the working principles governing the functionality of the river cleaning prototype developed in this project. It outlines the core mechanical and electrical components, their coordinated actions, and the logic behind their integration. The aim is to ensure systematic waste collection, minimal manual intervention, and adaptability to varied water conditions.

3.2 Principle

Cleaning mechanism for collection and removing waste from water bodies using a belt drive mechanism. The conveyor belt that is worked by a battery continuously rotates in a backward direction by taking water debris into the collector tank. The river cleaning machine is used to clean the surface of the water level of different water bodies where it reduces the human intervention and work out will be more accurate. Various kinds of impurities can be removed very quick and well cleaned system.

The Four-Bar Linkage System is a fundamental mechanism used to move an arm or net in a controlled arc, such as lifting or lowering a collector. It comprises four links: the frame, crank, coupler, and follower. Typically, one link is powered by a motor, and the remaining links move in a coordinated loop due to their mechanical interconnection. The system includes metal or plastic rods for the links, hinges or pins for the joints, and a motor to drive one of the links. In a practical model, a net or scraper can be attached to the end of the linkage, enabling it to move up and down or forward and backward to collect floating waste as the motor actuates the system.

The Crank-Slider Mechanism, which may be considered optional or advanced, is designed to generate linear back-and-forth motion, ideal for scraping or dragging floating debris. It works by converting rotary motion from a crank into linear motion via a connecting rod and a slider. The primary components include a crank wheel (attached to a motor), a connecting rod, and a slider platform or arm. This mechanism can be effectively integrated into a river-cleaning model where a slider with a rake or net moves rhythmically to gather surface debris from the water.

The Conveyor Belt Mechanism serves the purpose of lifting floating waste—such as plastic bottles or leaves—from the water and depositing it into a collection container. It functions by using a DC motor to rotate two rollers, which in turn move a belt made of nylon mesh or rubber. This continuous movement scoops up waste and lifts it into the container, mimicking the operation of large-scale waste removal systems. Components include two rollers, a belt, a DC motor (typically 6V or 12V), and a supporting frame made of plastic, aluminum, or wood. In a scaled model, the conveyor system can be mounted on floating materials such as thermocol or PVC pipes, with the front section dipping into the water to collect waste.

The Belt Drive mechanism is used to transmit motion smoothly and quietly between two shafts using a belt looped over two pulleys—one on the motor and one on the driven shaft. The friction between the belt and pulleys enables the transmission of rotational motion from the motor to the output shaft. This is especially useful in conveyor belt systems or when the motor and driven components are not perfectly aligned. For example, with a pulley ratio of 1:2, a motor spinning at 120 RPM will drive the load at 60 RPM. Suitable materials for a model include rubber bands, timing belts, or O-rings for the belt, and plastic or 3D printed pulleys.

The Concept of Buoyancy Force is central to the functioning of any floating machine, such as a river cleaning system. Buoyancy is the upward force exerted by a fluid that opposes the weight of an object submerged in it. According to Archimedes' Principle: "Any object fully or partially submerged in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the object." For a river-cleaning machine, which often resembles a floating platform or barge, staying afloat while collecting surface waste is critical. The machine must displace enough water to create a buoyant force that supports its entire weight, including the collected waste.

When the machine is placed on water, it displaces a volume of water depending on its submerged shape. This displacement causes an upward force equal to the weight of the displaced water. If this force is equal to or greater than the total weight of the machine and its load, the machine will float. Otherwise, it will sink. In practical applications, the base of the river-cleaning model—made from floating materials such as plastic barrels, foam, or hollow PVC pipes—is designed to displace a sufficient amount of water to keep the system afloat. This includes not just the weight of the structure and components but also the weight of waste it collects.

For prototyping, simple materials such as plastic bottles, foam sheets, thermocol, hollow PVC pipes, and lightweight woods like balsa are effective for ensuring buoyancy. In designing the floating base or hull (e.g., pontoons or drums), it's essential to account for the full load, including machine weight, collected waste, and a safety margin. A recommended design tip is to include an extra buoyancy margin—typically 20–30%—to accommodate unexpected weight increases, water ingress, or environmental changes like waves.

Concept of load handling Load handling refers to the machine's ability to support, carry, and transfer the weight (load) of various components — including its own structure, operational parts, and the waste it collects — without failure.In your river cleaning machine, the load handling system ensures that the machine remains balanced, efficient, and safe, even when it's collecting and transporting heavy or uneven amounts of waste.

3.3 Functions

Collects Floating Waste - the primary function is to remove floating debris such as plastic bottles, bags, leaves, and other waste materials from the river surface. Conveys Waste to Collection Bin - A rotating or moving conveyor belt mechanism lifts the collected waste and transfers it to a bin or storage container mounted on the machine. Floats and Navigates on Water - the machine is designed to float stable on water, using buoyant materials , allowing it to operate in various river conditions. Reduces Human Effort and Risk - Automates the cleaning process, minimizing the need for manual labour in potentially hazardous conditions.Improves Water Quality - By removing surface waste, it helps improve water clarity and reduces pollutants that harm aquatic life.

3.4 Components

List of the components Were mentioned below that are used to fabricate the prototype model of river cleaning machine.

- UPVC pipes
- PVC sheet
- Centre shaft DC gear motor
- DC gear motor
- Groove bearing pulley wheel
- Sealed rechargeable battery
- Propeller
- Microcontroller
- Motor driver module

UPVC pipes

Table 3.1 Specifications of UPVC pipe

Parameters	**Dimensions used in mm**
Length	500
Diameter	50
Thickness	3

Figure 3.1 UPVC Pipe

UPVC, standing for Unplasticized Polyvinyl Chloride, is a widely used plastic pipe material known for its affordability, durability, and versatility. These pipes are made through a process of extrusion, where a combination of plastic and vinyl is heated and then forced through a die to form the pipe shape. These pipe is used for construction of base helps in floating the entire equipment.This manufacturing process ensures the pipes are strong and durable. UPVC pipes are most commonly used for cold water applications in plumbing, water supply, underground drainage, and sewage lines.
uPVC pipes, with their exceptional ability to withstand extreme movement and bending, are becoming a go-to choice in earthquake-prone areas. They can endure intense earth-shaking without sustaining any damage, making them a reliable solution in such regions.
The smooth surface of the pipe is not just resistant, but highly effective in preventing bacterial

contamination, such as E. Coli. Therefore, many water companies rely on uPVC pipes to ensure their systems are consistently free of contamination, providing a reassuring safety measure.

- PVC sheet

Table 3.2 Specifications of PVC sheet

Parameters	**Dimensions used in mm**
Length	200
Breadth	250
Thickness	3

PVC (polyvinyl chloride) sheets are used in a wide variety of applications, including construction (cladding, windows, flooring), signage, healthcare (IV bags, medical tubing), and various industrial applications like piping, cable insulation, and more. PVC comes in rigid (sometimes abbreviated as RPVC) and flexible forms. Rigid PVC is used in construction for pipes, doors and windows. It is also used in making plastic bottles, packaging, and bank or membership cards. Adding plasticizers makes PVC softer and more flexible. It is used in plumbing, electrical cable insulation, flooring, signage, phonograph records, inflatable products, and in rubber substitutes. With cotton or linen, it is used in the production of canvas.

Figure:3.2 PVC Sheet

- Center Shaft DC Gear Motor

Table3.3 Specifications of center shaft DC gear motor

Parameters	value
Load (N)	50
Torque (N-m)	5
Power (W)	16
DC (RPM)	30

These motors are simple DC Motors featuring gears for the shaft for obtaining the optimal performance characteristics. They are known as Center Shaft DC Geared Motors because their shaft extends through the center of their gear box assembly. These standard size DC Motors are very easy to use. Also, you don't have to spend a lot of money to control motors with an Arduino or compatible board.

Figure 3.3 center shaft DC gear motor

- DC gear motor

Figure 3.4 DC gear motor

A DC motor is an electrical motor that uses direct current (DC) to produce mechanical force. The most common types rely on magnetic forces produced by currents in the coils. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motors to be widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

- Groove Bearing Pulley Wheel

Table 3.4 Specifications of grooved bearing pulley wheel

Parameters	**Dimensions used in mm**
Diameter	47
Thickness	18
Groove thickness	3

Figure 3.5 groove bearing pulley wheel

A pulley is a wheel on an axle or shaft enabling a taut cable or belt passing over the wheel to move and change direction, or transfer power between itself and a shaft. A sheave or pulley wheel is a pulley using an axle supported by a frame or shell (block) to guide a cable or exert force. A pulley may have a groove or grooves between flanges around its circumference to locate the cable or belt. The drive element of a pulley system can be a rope, cable, belt, or chain.

Types of pulley systems: Fixed: A fixed pulley has an axle mounted in bearings attached to a supporting structure. A fixed pulley changes the direction of the force on a rope or belt that moves along its circumference. Mechanical advantage is gained by combining a fixed pulley with a movable pulley or another fixed pulley of a different diameter.movable: A movable pulley has an axle in a movable block. A single movable pulley is supported by two parts of the same rope and has a mechanical advantage of two. Compound**:** A combination of fixed and movable pulleys forms a block and tackle. can have several pulleys mounted on the fixed and moving axles, further increasing the mechanical advantage.

- Sealed Rechargeable Battery

Table 3.5 Specifications of Sealed rechargeable battery

Model Name	Capacity	Cycle use	Initial current	Standby use
Amptek	12V , 1.3A	14.4V - 15.0V	less than 0.39A	13.5V – 13.8V

Fig:3.6 sealed rechargeable battery

A rechargeable battery, storage battery, or secondary cell (formally a type of energy accumulator), is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of electrode materials and electrolytes are used, including lead–acid, zinc–air, nickel–cadmium (NiCd), nickel–metal hydride (NiMH), lithium-ion (Li-ion)

- Propeller

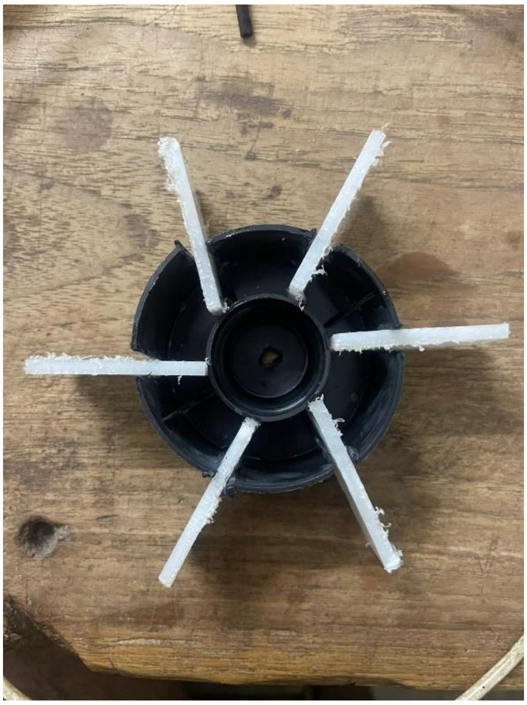

Fig : 3.7 propeller

This propeller is an innovative, self-designed component created to serve as the propulsion unit for a floating pond waste collection machine. The central hub of the propeller is ingeniously repurposed from a plastic bottle cap, while the blades—six in total—are carefully cut and shaped from lightweight PVC board.The blades are symmetrically arranged and securely attached to the cap, forming a simple yet effective radial design that ensures balanced thrust when rotated. When connected to a motor, this custom-built propeller efficiently drives the machine through water, enabling both movement and waste collection.

- Microcontroller

Figure : 3.8 Microcontroller

The ESP32-WROOM-32 is a versatile and powerful Wi-Fi + Bluetooth + Bluetooth LE module, designed to support a wide range of applications. It is equally suitable for low-power sensor networks as well as high-demand tasks like voice encoding, music streaming, and MP3 decoding. At the heart of the module is the ESP32-D0WDQ6 chip, engineered for scalability and adaptability. This chip features two CPU cores that can be independently controlled, with an adjustable clock frequency ranging from 80 MHz to 240 MHz. Additionally, it includes a low-power coprocessor, which is ideal for handling tasks that require minimal computing power—such as peripheral monitoring—while conserving energy.

- Connections

ESP32 D14 (GPIO14) ———→ L298N IN1
ESP32 D12 (GPIO12) ———→ L298N IN2
ESP32 D13 (GPIO13) ———→ L298N ENA

ESP32 D5 (GPIO5) ———→ L298N IN3
ESP32 D4 (GPIO4) ———→ L298N IN4
ESP32 D15 (GPIO15) ———→ L298N ENB

Motor A:
OUT1 ———→ Left Motor Wire 1
OUT2 ———→ Left Motor Wire 2

Motor B:
OUT3 ———→ Right Motor Wire 1
OUT4 ———→ Right Motor Wire 2

Power: Battery +ve ———→ L298N 12V
Battery -ve ———→ L298N GND
ESP32 GND ———→ L298N GND

- Motor driver module:

Table 3.6 Specifications of Motor driver module

details	**Value**
Driver Model	L298N 2A
Driver Chip: Double H Bridge	L298N
Motor Supply Voltage (Maximum)	46V
Motor Supply Current (Maximum)	2A
Logic Voltage	5V
Driver Voltage	5-35V
Driver Current	2A
Logical Current	0-36mA
Maximum Power (W)	25W

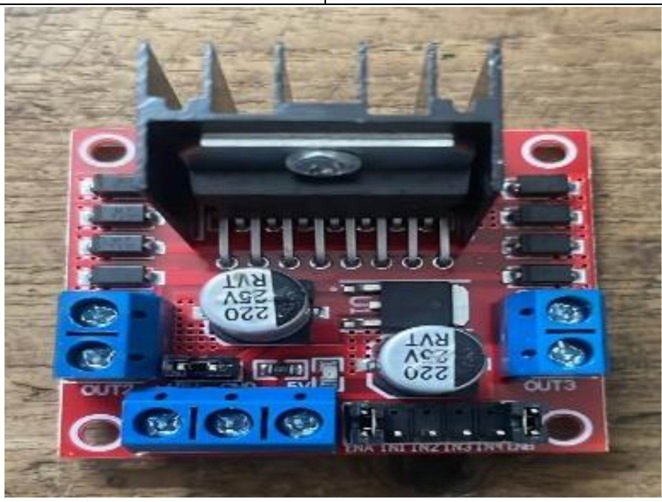

Figure3.9 Motor driver module

L298N module is a high voltage, high current dual full-bridge motor driver module for controlling DC motor and stepper motor. It can control both the speed and rotation direction of two DC motors. This module consists of an L298 dual-channel H-Bridge motor driver IC. This module uses two techniques for the control speed and rotation direction of the DC motors. These are PWM – For controlling the speed and H-Bridge – For controlling rotation direction. These modules can control two DC motor or one stepper motor at the same time.

The module has an on-board 78M05 5V Voltage regulator. This Voltage regulator will be performed only when the 5V Enable jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator, and the 5V pin can be used as an output pin to power the microcontroller or other circuitry (sensor). The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.

3.5 Summary

This chapter deals with on what principles the river cleaning machine is working and the main functions of the model and it also includes what are the various types of components are used to make the prototype of river cleaning machine. And the next coming chapter deals with design of river cleaning machine and it's related equations and calculations.

Chapter – 4

DESIGN OF RIVER CLEANING MACHINE

4.1 Introduction

The River Cleaning Machine is designed to remove floating waste such as plastic and organic debris from water bodies. It operates using a conveyor mechanism driven by DC motors, collecting waste into a bin as it moves across the water. The system is controlled by an Arduino Uno, which manages motor movement and obstacle avoidance using ultrasonic sensors.

4.2 Numerical Design

In the development of the river cleaning machine prototype, several key parameters were calculated to ensure optimal functionality and structural stability. These included specifications for the piping system, motor requirements, and buoyancy force. The motor, operating at a speed of 30 RPM, was selected based on torque and power needs derived from the anticipated load and mechanical configuration. The pipe dimensions were determined to provide sufficient structural support while maintaining lightweight characteristics essential for flotation. One of the most critical aspects considered was the buoyancy force, which plays a pivotal role in maintaining the machine's stability on water. Buoyancy ensures that the entire structure remains afloat while counterbalancing the weight of the components such as the motor, pipes, and collection mechanisms. To achieve effective floatation, the design incorporated materials and geometries with appropriate density and volume to displace enough water, generating an upward force greater than the system's weight. The calculated buoyancy not only facilitates the smooth operation of the device on varying water levels but also contributes significantly to its maneuverability and safety. Overall, integrating flotation and mechanical efficiency was essential to the success of the prototype. ARDUINO IDE.exe app to construct the entire model into remotely operated by using any kind of Bluetooth or other wireless connections. Which allows the machine to move towards the entire area that was considered. Propeller is designed and model is evaluated for it's open water characteristics and cavity performance. The design of a vertical chain conveyor helps to move the system backward.

4.3 Calculations

Table 4.1 Model Data

S.no.	parameters	values
1.	Pipe material Outer diameter (mm) Pipe lengths (mm)	PVC 50 500mm --- 2pipes 280mm ---- 2pipes
2.	Wall thickness(mm)	3mm
3.	Density of PVC(kg/m^3)	1400kg/m^3
4.	Density of water(kg/m^3)	1000kg/m^3
5.	Acceleration due to gravity (m/s^2)	9.81

- Volume Of The Pipes **:**

  Outer volume of the pipe (including enclosed air)

  $V_{outer} = \pi \text{ x } (D_{outer}/2)^2 \text{ x } L$

Table 4.2 Outer volume of the pipe

S.no.	Pipe length (mm)	V_{outer} (m^3)
1.	500	$9.8174 \text{ x } 10^{-4}$
2.	280	$5.498 \text{ x } 10^{-4}$

- Inner volume (hollow portion)

  $D_{inner} = D_{outer} - 2t$

  $= 0.05 - 2(0.003) = 0.044\text{m}$

$V_{inner} = \pi \times (D_{inner}/2)^2 \times L$

Table 4.3 Inner volume of the pipe

S.no	Pipe length (mm)	$V_{outer} (m^3)$
1.	500	7.606×10^{-4}
2.	280	4.2574×10^{-4}

- Solid PVC volume

$V_{pvc} = V_{outer} - V_{inner}$

Table 4.4 Solid PVC volume

S.no	Pipe length (mm)	$V_{outer} (m^3)$
1.	500	2.2148×10^{-4}
2.	280	1.2406×10^{-4}

- Weight Of The Pipe :

$W_{pipe} = \boldsymbol{\rho}_{pvc} \times V_{pvc} \times g$

Table 4.5 Weight of the pipe

S.no	Pipe length (mm)	W_{pipe} (N)
1.	500	3.0418
2.	280	1.70

- Buoyan force calculations – Buoyant force is calculated for different pipes against the water surface .

$Fb = \rho water \times Vsubmerged \times g$

Assuming various submergence levels:

500 mm Pipe:

Table 4.6 submergence level of 500mm

S.no	Submergence	Volume Submerged (m^3)	FbF_bFb (N)	Max Load (g)
1.	50%	4.91×10^{-4}	~4.81	181 g
2.	60%	5.89×10^{-4}	~5.77	359 g
3.	70%	6.87×10^{-4}	~6.73	533 g
4.	80%	7.85×10^{-4}	~7.68	476 g

280 mm Pipe:

Table 4.7 Submergence level of 280mm

S.no.	Submergence	Volume Submerged (m^3)	FbF_bFb (N)	Max Load (g)
1.	50%	2.75×10^{-4}	~2.69	101
2.	60%	3.30×10^{-4}	~3.23	188
3.	70%	3.85×10^{-4}	~3.78	266
4.	80%	4.40×10^{-4}	~4.32	266

- TOTAL STRUCTURE **(2 × 500 mm + 2 × 280 mm) –** The total structure is calculated for 2 pipes of 500mm and 2 pipes of 280mm from the buoyant force calculations.

Table 4.8 Total structure

S.no.	Submergence	2 x 500 mm (g)	2 x 280 mm (g)	Total Supportable Load (g)
1.	50%	362	203	565
2.	60%	559	313	872
3.	70%	755	422	1177
4.	80%	952	533	1485

- Natural Submergence (No Extra Load)

To find when pipe just floats (weight = buoyancy):

Wpipe=Fb⇒X=1.831000×9.81×5.89×10−4≈31.6%

The sealed PVC pipe naturally submerges ~31.6% in water without extra weight.

- Complete submergence (includes thermocoal)

  Dimensions: 20 cm × 20 cm × 5 cm = 0.2 m × 0.2 m × 0.05 m

  Volume of thermocol, $V = 0.2 \times 0.2 \times 0.05 = 0.002\ m^3$

  Buoyant Force (equals the weight needed):

  $F_b = \rho \times V \times g = 1000 \times 0.002 \times 9.81 = 19.62$ N

  Convert to mass (weight required):

  $m = F_b / g = 19.62 / 9.81 = 2$ kg

- Volume Of The Collecting Bin:

  VOLUME = AREA x LENGTH

  AREA = Area of square + area of triangle

  $= (150 \times 150) mm^2 + (0.5 \times 150 \times 50)\ mm^2$

  $= 26250\ mm^2$

  Length = 185mm

  Volume = 26250x185

  $= 4856250 mm^3$

  $= 0.004856 m^3$

- CONCLUSION

  Without extra weight, sealed pipe floats at ~31.6% submersion. Max additional load (per submergence level):

Table 4.9 Max additional load

S.no	Submergence level	Load (g)
1.	50%	2565
2.	60%	2872
3.	70%	3177
4.	80%	3485

4-pipe system along with thermo coal can float up to 3.48 kg (at 80% submersion)

4.4 COMPLETE ARDUINO CODE FOR REMOTE OPERATED

```
#include <WiFi.h>
#include <WebServer.h>

// Wi-Fi Credentials
const char *ssid = "BoatController";
const char *password = "12345678";

WebServer server(80);

// Motor Pins
#define IN1 14 // Left motor forward
#define IN2 12 // Left motor backward
#define ENA 13 // Left motor enable (PWM)

#define IN3 5 // Right motor forward
#define IN4 4 // Right motor backward
#define ENB 0 // Right motor enable (PWM)

// PWM Channels
#define LEFT_MOTOR_CHANNEL 0
#define RIGHT_MOTOR_CHANNEL 1

// Speed (0–255)
int motorSpeed = 200;

void setup() {
  Serial.begin(115200);

  pinMode(IN1, OUTPUT);
```

```
  pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);

  // Setup PWM for motor enable pins
  ledcSetup(LEFT_MOTOR_CHANNEL, 1000, 8); // 1 kHz, 8-bit
  ledcAttachPin(ENA, LEFT_MOTOR_CHANNEL);

  ledcSetup(RIGHT_MOTOR_CHANNEL, 1000, 8);
  ledcAttachPin(ENB, RIGHT_MOTOR_CHANNEL);

  stopMotors();

  // Start Wi-Fi AP
  WiFi.softAP(ssid, password);
  Serial.println("WiFi Started. Connect to 'BoatController' and open 192.168.4.1");


// Web Server Routes
  server.on("/", handleRoot);
  server.on("/forward", forward);
  server.on("/backward", backward);
  server.on("/left", turnLeft);
  server.on("/right", turnRight);
  server.on("/stop", stopMotors);

  server.begin();
  Serial.println("Web server started.");
}

void loop() {
  server.handleClient();
```

```
}

void handleRoot() {
  server.send(200, "text/html", R"rawliteral(
    <!DOCTYPE html>
    <html>
    <head>
      <title>Boat Controller</title>
      <style>
        body { text-align: center; font-family: Arial; }
        button { font-size: 20px; padding: 15px; margin: 10px; }
      </style>
    </head>
    <body>
      <h2>ESP32 Boat Controller</h2>
      <button onclick="sendCommand('forward')">Forward</button><br>
      <button onclick="sendCommand('left')">Left</button>
      <button onclick="sendCommand('right')">Right</button><br>
      <button onclick="sendCommand('backward')">Backward</button><br>
      <button onclick="sendCommand('stop')">Stop</button>
      <p id="status"></p>
      <script>
        function sendCommand(cmd) {
          var xhttp = new XMLHttpRequest();
          xhttp.onreadystatechange = function() {
            if (this.readyState == 4 && this.status == 200) {
              document.getElementById("status").innerText = this.responseText;
            }
          };
          xhttp.open("GET", "/" + cmd, true);
          xhttp.send();
        }
```

```
    </script>
  </body>
  </html>
 )rawliteral");
}

void forward() {
 digitalWrite(IN1, HIGH);
 digitalWrite(IN2, LOW);
 digitalWrite(IN3, HIGH);
 digitalWrite(IN4, LOW);

 ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
 ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);

 server.send(200, "text/plain", "Moving Forward");
}

void backward() {
 digitalWrite(IN1, LOW);
 digitalWrite(IN2, HIGH);
 digitalWrite(IN3, LOW);
 digitalWrite(IN4, HIGH);

 ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
 ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);

 server.send(200, "text/plain", "Moving Backward");
}

void turnRight() {
 digitalWrite(IN1, HIGH);
```

```
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, HIGH);

  ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
  ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);

  server.send(200, "text/plain", "Turning Right");
}

void turnLeft() {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, HIGH);
  digitalWrite(IN3, HIGH);
  digitalWrite(IN4, LOW);

  ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
  ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);

  server.send(200, "text/plain", "Turning Left");
}

void stopMotors() {
  // Stop by writing 0 PWM
  ledcWrite(LEFT_MOTOR_CHANNEL, 0);
  ledcWrite(RIGHT_MOTOR_CHANNEL, 0);

  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW);
  digitalWrite(IN4, LOW);
```

```
  server.send(200, "text/plain", "Stopped");
}
```

**** End of Code ****

4.5 Division of the code

ESP32 Boat Controller code divided into clear sections so it's easier to understand

- Include Libraries & Define WIFI

```
#include <WiFi.h>
#include <WebServer.h>

// Wi-Fi Credentials
const char* ssid = "BoatController";
const char* password = "12345678";

WebServer server(80);
```

- Define Motor Pins & Settings

```
#define IN1 14
#define IN2 12
#define ENA 13

#define IN3 5
#define IN4 4
#define ENB 0

#define LEFT_MOTOR_CHANNEL 0
#define RIGHT_MOTOR_CHANNEL 1

int motorSpeed = 200;
```

- Setup Function (runs once)

```
void setup() {
  Serial.begin(115200);

  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT);
  pinMode(IN4, OUTPUT);

  ledcSetup(LEFT_MOTOR_CHANNEL, 1000, 8);
  ledcAttachPin(ENA, LEFT_MOTOR_CHANNEL);

  ledcSetup(RIGHT_MOTOR_CHANNEL, 1000, 8);
  ledcAttachPin(ENB, RIGHT_MOTOR_CHANNEL);

  stopMotors();

  WiFi.softAP(ssid, password);
  Serial.println("WiFi Started. Connect to 'BoatController' and open 192.168.4.1");

  server.on("/", handleRoot);
  server.on("/forward", forward);
  server.on("/backward", backward);
  server.on("/left", turnLeft);
  server.on("/right", turnRight);
  server.on("/stop", stopMotors);

  server.begin();
  Serial.println("Web server started.");
}
```

- Loop Function (runs continuously)

```
void loop() {
  server.handleClient();
}
```

- Web Interface (HTML + JavaScript)

```
void handleRoot() {
  server.send(200, "text/html", R"rawliteral(
    <!DOCTYPE html>
    <html>
    <head>
        <title>Boat Controller</title>
        <style>
            body { text-align: center; font-family: Arial; }
            button { font-size: 20px; padding: 15px; margin: 10px; }
        </style>
    </head>
    <body>
        <h2>ESP32 Boat Controller</h2>
        <button onclick="sendCommand('forward')">Forward</button><br>
        <button onclick="sendCommand('left')">Left</button>
        <button onclick="sendCommand('right')">Right</button><br>
        <button onclick="sendCommand('backward')">Backward</button><br>
        <button onclick="sendCommand('stop')">Stop</button>
        <p id="status"></p>
        <script>
            function sendCommand(cmd) {
                var xhttp = new XMLHttpRequest();
                xhttp.onreadystatechange = function() {
                    if (this.readyState == 4 && this.status == 200) {
                        document.getElementById("status").innerText = this.responseText;
                    }
                };
                xhttp.open("GET", "/" + cmd, true);
                xhttp.send();
            }
        </script>
    </body>
    </html>
  )rawliteral");
}
```

- Motor Control Handlers

Forward:

```
void forward() {
  digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
  digitalWrite(IN3, HIGH); digitalWrite(IN4, LOW);
  ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
  ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);
  server.send(200, "text/plain", "Moving Forward");
}
```

Backward:

```
void backward() {
  digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH);
  digitalWrite(IN3, LOW); digitalWrite(IN4, HIGH);
  ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
  ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);
  server.send(200, "text/plain", "Moving Backward");
}
```

Turn Left:

```
void turnLeft() {
  digitalWrite(IN1, LOW); digitalWrite(IN2,
HIGH); digitalWrite(IN3, HIGH); digitalWrite(IN4,
LOW); ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
  ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);
  server.send(200, "text/plain", "Turning Left");
}
```

Turn Right:

```
void turnRight() {
  digitalWrite(IN1, HIGH); digitalWrite(IN2,
LOW); digitalWrite(IN3, LOW); digitalWrite(IN4,
HIGH); ledcWrite(LEFT_MOTOR_CHANNEL, motorSpeed);
  ledcWrite(RIGHT_MOTOR_CHANNEL, motorSpeed);
  server.send(200, "text/plain", "Turning Right");
}
```

Stop:

```
void stopMotors() {
  ledcWrite(LEFT_MOTOR_CHANNEL, 0);
  ledcWrite(RIGHT_MOTOR_CHANNEL, 0);
  digitalWrite(IN1, LOW); digitalWrite(IN2,
LOW); digitalWrite(IN3, LOW); digitalWrite(IN4,
LOW); server.send(200, "text/plain", "Stopped");
}
```

4.6 summary

This chapter described about the working of the entire prototype Of river cleaning machine , includes all the required calculations and also mentions about the arduino code and it's division is also explained in the next coming chapter it deals with fabrication and performance.

Chapter - 5

FABRICATION OF PROTOTYPE MODEL

5.1 Introduction

The machine is built on a floating platform with a moving belt (conveyor) at the front to collect waste from the water surface. The collected waste is dropped into a storage bin on the machine. It runs using small motors and is controlled by an Arduino board, which acts like the brain of the system. The whole structure is made using light and rust-free materials so it can float and move easily on water.

5.2 Fabrication

In this project the main aim of this machine is to lift the waste debris from the water surface and dispose them in the tray. Fabricating the remote operated river cleaning machine. The construction of the river cleaning machine model was guided by principles of structural stability, ease of assembly, and operational functionality. The following materials and construction procedures were followed during the preparation of the model

Base and Collecting Tank Construction Two UPVC pipes were used as the primary floatation base due to their lightweight, buoyant, and corrosion-resistant properties. And also three small pipes used for balancing at the chassis. A PVC sheet was mounted above the pipes to form the collecting tank platform, providing a stable and waterproof surface for waste collection. The base was carefully balanced to ensure the machine floats evenly on water and supports the mounted components effectively.

Drive Mechanism for Waste Collection Two center shaft geared motors were installed to drive a rubber conveyor belt, which functions as the primary waste collection system. Groove bearing pulley wheels were used on either end of the belt system to support and guide the movement of the belt, ensuring smooth and continuous rotation. The conveyor mechanism was tested for alignment and tension to prevent belt slippage and ensure consistent performance.

Propulsion System Two additional geared motors were used to operate propellers fixed at the rear of the model, enabling controlled movement and navigation across the water surface. The propellers were mounted securely and aligned for optimal thrust and directional control. Structural Support Plywood sheets were used to mount and support the motors and the rubber belt assembly. The plywood provided a firm and vibration-resistant base for the mechanical components and allowed easy drilling and mounting of parts. All components were attached using screws, nuts, and waterproof adhesives to maintain structural integrity during water testing. Along the plywood two ends are fixed with grooved rollers where the belt is aligned along the entire length of the belt polymer mesh is attached by using adhesive material.

Installing a remote control processor During construction, we need to assemble the microcontroller and motor driver module. By using a proper coding device or any app like ARDUINO IDE.exe through the availability we need to install a code in the microcontroller which can be operated by the Bluetooth through the connected mobile. Before installing need to run and check the code that need to be installed.

Safety and Assembly Measures During construction, all rotating and electrical parts were tested separately before integration into the main frame. Insulated wiring was used for electrical connections, and components were positioned to avoid direct water exposure. Basic safety protocols were followed during cutting, soldering, and motor testing processes.

Testing and Adjustments Once assembled, the model underwent dry testing on land to ensure proper motor operation and conveyor belt movement. It was then tested in a controlled water body to evaluate its floating capability, propeller-driven movement, and waste collection efficiency. Minor adjustments were made to the belt tension and motor alignment based on test results.

5.3 Stages of activities during fabrication

Construction of base frame and chassis along with the collecting tank

Figure 5.1 Base frame and collecting tank

Installation of belt with the support of grooved wheels

Figure 5.2 Installation of belt drive

Complete prototype in different views

Top view

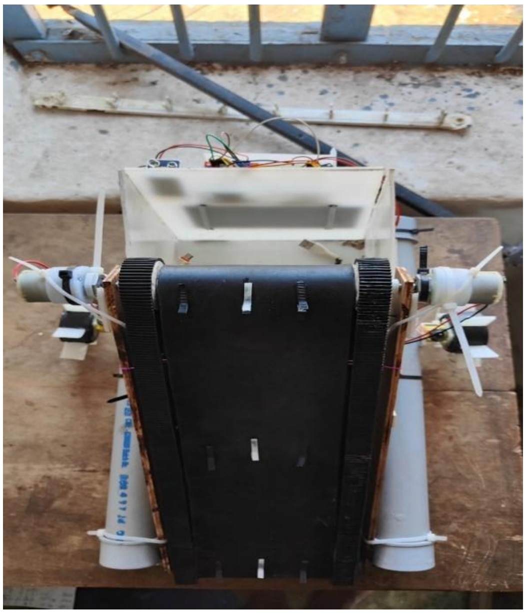

Figure 5.3 Top view

side view

Figure 5.4 Side view

Back view

Figure 5.5 Back view

Isometric view

Figure 5.6 Isometric view

5.4 Advantages of model

- Environment-Friendly helps reduce water pollution and protect aquatic life by removing harmful waste from rivers and lakes.
- Reduces Manual Labor Minimizes the need for workers to physically enter the water, making the process safer and less tiring.
- Cost-Effective Uses low-cost components like Arduino and DC motors, making it affordable compared to heavy machinery.
- Portable and Lightweight Easy to transport and deploy in different water bodies due to its compact and floating design.
- Simple to Operate Requires minimal training, with easy-to-use controls and basic automation features.

5.5Applications of model

- River and Lake Cleaning Ideal for cleaning floating waste from small rivers, lakes, and ponds.
- Water Treatment Facilities Helps in removing surface waste before water enters treatment plants.
- Industrial Zones Can be deployed near factories or industrial areas to manage water pollution.
- Educational Demonstrations Serves as a practical model for environmental science and robotics-related projects.

5.6 Summary

These chapter explained about the entire fabrication method includes testing and finalising and also dealt with different stages during fabricating and also included with applications and advatanges. The next coming chapter gives information about conclusion and future scope.

Chapter – 6

CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusions

The **Design and Fabrication of a River Cleaning Machine** marks a significant step toward sustainable and practical solutions for water pollution. In this project, a functional prototype was successfully developed to collect floating waste such as plastic, leaves, and debris from the surface of rivers and lakes. The machine operates on a simple conveyor mechanism powered by DC motors and controlled through an Arduino microcontroller, demonstrating that effective environmental tools can be created using accessible and low-cost technology.

The project not only highlights the importance of engineering in solving real-world problems but also encourages innovation in eco-friendly practices. The machine is lightweight, easy to operate, and requires minimal maintenance, making it a viable option for both urban and rural water bodies. Its modular design allows for future improvements, and its effectiveness in collecting floating waste helps reduce manual labor and health risks for workers. Overall, this project brings attention to the need for proactive environmental management and shows how engineering students and professionals alike can contribute to a cleaner and healthier ecosystem. By combining creativity, basic electronics, and environmental awareness, the River Cleaning Machine stands as a promising prototype for future development and real-world application.

6.2 Future scope

Solar power intergration this machine can be upgraded with solar panels to make it more sustainable and capable of operating without external electricity.Smart waste detection incorporating cameras or sensors with AI can help in identifying and sorting different types of waste more efficiently.Data collection features Sensors can be added to measure water quality parameters like pH, temperature, or turbidity during operation.

REFERENCES:

1. M. Mohamed Idhris, M. Elamparthi, C. Manoj Kumar Dr.N. Nithyavathy, Mr. K. Suganeswaran, Mr. S. Arun kumar, Design And Fabrication Of Remote Controlled Sewage Cleaning Machine[1] ; Journal from IJSART ; volume no: 03, 2017

2. Rajendra Patil , Rahul Itnare , Sagar Ahirrao , Amol Jadhav , Ajay Dhumal Study Of River Harvesting & Trash Cleaning Machine [2] ; International journal of innovative and research in science and engineering ; volume no : 02 ; 2016

3. Mr.Abhijeet & Team. Design & Fabrication of River Cleaning System [3] ; www.ijisrt.com ; volume no: 03 ; 2018

4. Huang Cheng, Zhang Zhi Identification of the Most Efficient Methods for Improving Water Quality in Rapid Urbanized Area Using the MIKE Modelling System [4] ; seventeenth international conference on measuring technology and mechatronics automation ; 2015

5. Ar. Sakshi Sandesh , Ar. Jasmine kohli and team Impact Of Kumb Mela On Environment [5] ; international journal of engineering research and technology ; volume no – 13 ; 2024

6. AGATOR (Automatic Garbage Collector) as Automatic Garbage Collector Robot Model [6] Nurlansa, Dewi Anisa Istiqomah, and Mahendra Astu Osiany Sanggh a Pawitra, Member, IACSIT ; international journal of engineering research and technology ; volume no – 09 ; 2021

7. Design of continuous loading vertical chain conveyor, Aditya Kulkarni, Tanmay Kulkarni,PES Modern college of Engineering, Pune, Maharshtra, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181http://www.ijert.orgwww.ijert.org Vol. 9 Issue 04, 2021

8. Dharmesh N. Kandare, Aniket N. Kalel, Aniket S. Jamdade, Gitesh P. Jawale , R.K. Khanpate Professor [8] Design and construction of river cleaning mechanism; IJCRT | Volume 9, 2021

9. Saif Ali Sayyad, Adarsh Dorlikar, Sneha Ratanparkhi, Tanvi Bhagat, RCERT, Chandrapur, India MH.[9] Design and fabrication of River Cleaning Machine, International Journal of Engineering Research & Technology (IJERT)
Vol. 9 Issue 04, 2020

10. Design and Analysis of Composite Marine Propeller using ANSYS WORK BENCH,[10] S. Abdul Mutalib, S. Suresh, S.Jaya Kishore, Department of Mechanical Engineering, Siddarth institute of Engineering and Technology, Puttur, A.P, India.[10] International Journal of Engineering Research & Technology (IJERT)
Vol. 9 Issue 04, 2020

11. Design of river cleaning machine [11] Tanmay Sharma , Swapnil Sharma , Prakhar Sharma , Saransh Jain, Ashwini Joshi, IJRAR, Vol.6, 2019.

12. Sreejith S Nair 'Design and Fabrication of River Cleaning Robot', AIR 2019: Proceedings of the Advances in Robotics 2019, [12] Article no. 53, 2019.

13. Puneeth E Raikar, 'Lake Health Monitoring and Waste Collecting Aquabot', International Journal of Advance Research in Science and Engineering[13], Vol.8, Issue-5, 2019.

14. Mohit Kharapkar, 'Design & Development of Sludge Collection Machine', International Journal for Research in Applied Science & Engineering Technology (IJRASET)[14], Vol.7, Issue-III, 2019.

15. Raj Vaibhav Tiwari, 'Design and Fabrication of Project on Water Bodies Cleaning Robot', International Journal of Engineering and Management Research,[15] Vol.8, Issue-3, 2018.