International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 12 Issue 11 November 2023 || PP 37-42

Design and Fabrication of Water Weed and Garbage Cleaner

Rambabu Kantipudi, Sri Rama Murthy M, Saleem Shaik
Department of Mechanical Engineering,
Sir C R Reddy College of Engineering, Eluru, Andhra Pradesh, India.

Abstract: *This study presents the development and implementation of a remote-controlled water weed and garbage cleaning machine, a novel solution to combat water pollution in aquatic environments. The project addresses the pressing issue of waste accumulation in ponds, rivers, and lakes, which has led to the uncontrolled proliferation of aquatic plants and jeopardized the well-being of aquatic life. The machine, equipped with a battery-powered system and controlled via the BLYNK mobile application, employs an "ESP8266" microcontroller for efficient operation. It demonstrates exceptional effectiveness in the removal of waste materials from water bodies. The innovation showcased in this project not only provides an immediate and environmentally friendly remedy for water pollution but also promises to streamline the water-cleaning process. It serves as a beacon of hope for mitigating the adverse effects of water pollution on both the environment and human health, significantly reducing the risks associated with manual water cleaning operations. This research contributes to the ongoing efforts to preserve the integrity of aquatic ecosystems, presenting an innovative and sustainable approach to the protection of our natural water resources.*

Date of Submission: 18-11-2023 Date of Acceptance: 03-12-2023

I. Introduction:

Water, often regarded as the most vital resource for all living beings, plays a fundamental role in sustaining life on our planet. However, the cleanliness of water bodies, such as ponds, rivers, and lakes, is under constant threat due to human-induced pollution. The consequences of water pollution are alarming, with impurities posing a grave risk to human health and aquatic ecosystems. Pollution in water bodies, resulting from industrial discharge, agricultural runoff, sewage, and improper waste disposal, has reached critical levels. One of the most pressing concerns is the escalating accumulation of trash and water weed in oceans, rivers, and other water bodies, presenting a significant environmental challenge. Biodegradable materials like paper and food decompose naturally, while plastics and non-biodegradable objects persist, causing long-term pollution. Plastic waste, in particular, can endure for hundreds of years, leading to far-reaching environmental damage. Water pollution has far-reaching effects, impacting human health, ecosystems, and the economy. It endangers the safety of water sources, disrupting not only aquatic life but also industries such as fishing, tourism, and agriculture that depend on clean water. Mitigating water pollution is essential to safeguard both our environment and the well-being of individuals. The growth of water weeds, directly influenced by pollution, can further exacerbate the consequences. The introduction of nutrients, such as nitrogen and phosphorus, into water bodies via waste disposal can stimulate the proliferation of algae and aquatic plants, including water weeds. Excessive water weed growth can result in the formation of dense mats on the water's surface, altering water flow and harming aquatic life. Moreover, the overgrowth of water weeds can displace native plant species, leading to a decline in biodiversity and diminishing water quality. Traditional methods of water weed and trash removal, while effective, have limitations, including labor-intensity, ecological disruption, and cost implications. To address these issues, this project leverages the potential of the Internet of Things (IoT), a transformative technology that connects physical objects and devices through the internet. IoT offers real-time monitoring, remote operation, and data analytics for enhanced performance, making it a powerful tool to combat water pollution and streamline cleaning processes. By designing and implementing a remote-controlled water weed and garbage cleaning machine that integrates IoT, this project aims to revolutionize the way we tackle water pollution. This innovative approach promises not only efficient and eco-friendly cleaning but also a more secure and enjoyable environment for both people and wildlife. The project's objectives encompass improved water quality, economic advantages, and environmental benefits, setting the stage for a cleaner and more sustainable future. In the following sections, we delve deeper into the objectives, methodology, and results of this project, exploring how the integration of IoT technology can address water pollution challenges and enhance the efficiency of water cleaning processes.

II. Literature Review:

The history of river cleaning machines can be traced back to the early 20th century when urbanization along major waterways led to the increasing disposal of waste and pollution into rivers and other bodies of water. In response to this growing problem, early river cleaning machines were developed, primarily consisting of basic vessels equipped with nets and rudimentary tools for waste collection. As technology progressed, the design of river cleaning machines evolved as well. The 1960s and 1970s marked a significant turning point, with the introduction of new filtration systems and advanced technologies that enhanced the efficiency and effectiveness of waste removal from waterways. During this period, cities worldwide began investing in river cleaning machines as a means to combat the escalating issue of water pollution.

Prof. N.G. Jogi et.at. addressed the critical issue of Ganga River pollution and the need for efficient lake cleaning. Despite its revered status as India's national river, the Ganga is burdened with 29 crore liters of sewage and a significant load of pollutants. To contribute to water quality improvement, they are developing a pedal-operated boat equipped with a conveyor system. This innovative solution collects a range of waste materials, including floating garbage, polythene, food residues, and waste generated during religious festivals. Their project aligns with national efforts like the Ganga Abhiyan to restore and protect these vital water bodies. M Mohamed Idris et.al. introduced an innovative project aimed at automating the sewage cleaning process within drainage systems. The primary objective is to curb the spread of diseases to humans. By efficiently cleaning black water, this system plays a vital role in preventing pest infestations, as it reduces the residues that can attract and sustain pests. Additionally, the project contributes to extending the shelf life and sensory quality of food products. The system operates with remote control, eliminating the need for human intervention in sewage waste management, thereby avoiding the harmful impacts of sewage waste and its associated gases. The design incorporates a wiper motor and two power window motors connected to the wheels, facilitated by the remote-control setup. The process involves the collection of sewage waste using an arm mechanism, which subsequently disposes of the waste into a bin fixed at the bottom of the machine. The system can function effectively even in sewage areas with water, provided the water level remains within specified limits, ensuring that floating waste is also collected. Furthermore, the system is adept at removing garbage that obstructs drainage. By minimizing human involvement in the cleaning process, this innovative system significantly reduces the risk of disease transmission, ultimately contributing to improved public health and sanitation. Prof. N.G. Jogi et al. address the pressing issue of water pollution in India's sacred Ganga River, which is marred by the dumping of sewage and municipal solid waste. The polluted waters endanger aquatic life and human health, with aquatic animals consuming surface waste debris, sometimes leading to their demise. To mitigate water pollution, they propose the creation of a river cleanup machine powered by hydropower. This machine, operating in Nashik's Godavari River, extracts debris, plastics, and garbage, efficiently removing them from the water surface and promoting cleaner river ecosystems. Mr. P. M. Sirsat et al. focus on the design and fabrication of a river waste cleaning machine, acknowledging the severe pollution challenges in Indian rivers. With millions of liters of sewage and pollutants dumped into these water bodies, the need for innovative solutions is paramount. The remote-operated river cleaning machine they've developed overcomes the limitations of traditional cleaning methods. By utilizing DC motors, an RF transmitter and receiver, a propeller, PVC pipes, and a chain drive with a conveyor, the system collects waste, garbage, and plastic from water bodies, making it a more efficient and eco-friendly approach to river surface cleaning. Pankaj Singh Siroh et al. emphasize the importance of river water in agriculture, ecology, and human well-being. Their project seeks to address river pollution by using a turbine powered by the river's flow to drive two conveyor belts. The first belt collects solid waste from the river, while the second one transports the waste for proper disposal. By offering a cleaner river environment, the project contributes to enhanced environmental quality and public health. Ndubuisi C. Daniels introduces a Drainage System Cleaner, a machine designed to manage waste in drainage systems. By removing garbage from these systems, the project mitigates environmental hazards, prevents flooding, and minimizes the need for burning waste, which contributes to climate change. The machine operates through the motion generated by running water, eliminating the need for external power sources. Comprising a propeller, a cleaner, and a pan, the Drainage System Cleaner effectively tackles the problem of waste accumulation and plays a crucial role in environmental protection and waste management. Osiany Nurlansa et al.'s research focuses on the development of AGATOR (Automatic Garbage Collector), a rotor robot designed to efficiently collect waste from rivers, preventing blockages and related issues like flooding and pollution. The AGATOR's hardware and software components, mechanical systems, sensor technology, and actuators work in tandem to enable efficient garbage collection, with a maximum load capacity of 5 kg and an average speed of 0.26 m/s. Ankita B. Padwal explores the automation of drainage cleaning systems. In their project, they address issues related to the mobility and space constraints of traditional waste disposal methods in drainage systems. The proposed solution introduces autonomous vehicles to enhance mobility and control the disposal and filtration of waste materials efficiently. By reducing the need for manual labor and enhancing mobility, this approach offers a practical and sustainable solution for cleaning drainage systems.

III. Methodology:

The project focuses on the development and implementation of an efficient water weed and garbage cleaner system designed to remove pollutants from water bodies. The methodology can be summarized in several key phases: The project began with extensive research and planning, involving a thorough review of existing literature and related works in the field of water trash collection. This research served as the foundation for the design and development of our system, ensuring it incorporated best practices while considering the benefits and downsides of previous studies. Subsequently, the system design phase was initiated, encompassing the layout and automation methods necessary for the cleaner's efficient operation. This included the detailed design and integration of components such as the collection unit, propulsion system, cutting unit, disposal unit, monitoring system, and maintenance and safety system. The project advanced to the implementation and prototyping phase, where a fully functional device was developed to work autonomously and robotically. This involved the construction of physical components, including the floating platform, conveyor belt, cutting blades, and propulsion mechanisms, along with the integration of control systems. The prototype underwent rigorous testing to assess its efficiency and effectiveness in removing water weeds and debris from water bodies. A comprehensive monitoring system, equipped with sensors and data loggers, was employed to record crucial performance metrics, such as pollutant collection, coverage area, and energy consumption. To ensure the longevity and safety of the system, we established a maintenance and safety system. This entailed the formulation of regular maintenance protocols and the incorporation of safety features, including automatic shut-off mechanisms, backup power sources, and emergency procedures. Furthermore, the project implemented a remote control and communication system, facilitating real-time adjustments to the device's operation. Throughout the project, our focus remained on environmental sustainability, with an emphasis on environmentally friendly disposal methods for collected materials. By incorporating these elements, our water weed and garbage cleaner system effectively and sustainably removes pollutants from water bodies, promoting environmental health and sustainability.

LIST OF COMPONENTS				
ESP8266 NODE MCU	DC motors	Jumper wire	Paddle Wheel	PVC Pipes
L298N motor driver	Relay module	Cutter blades	Steel bars	Plastic Gears
Battery	ESC	Conveyor mechanism	Ball bearings	Nuts and Bolts

1. Design and Fabrication:

a. Design Procedure :

The conceptual design for the water weed and garbage cleaner was meticulously crafted using Autodesk Fusion 360 CAD Modeling software. The design process adhered to a systematic step-by-step procedure, ensuring a comprehensive and effective approach. The design process commenced with the identification of the project's core problem and requirements. This initial step laid the groundwork for the entire design process, focusing on size, shape, and intended functionality. Using the versatile Sketch function within Fusion 360, the fundamental geometry of the cleaner was sketched. This involved selecting an appropriate plane or surface and employing various geometric shapes, lines, and circles to outline the essential design features. The Extrude function was then utilized to transform the 2D sketch into a fully three-dimensional object. This step added depth and dimension to the model, bringing it to life. Refinement of the design came next, accomplished by introducing intricate details. Features like Fillet, Chamfer, and Shell were employed to round off edges, add safety enhancements, and create hollow sections where needed. The completeness of the design required the integration of additional components, such as bearings, nuts, bolts, shafts, cutter blades, conveyor belts, and the trash bin. The Assemble function facilitated the assembly of these parts into the overall design.

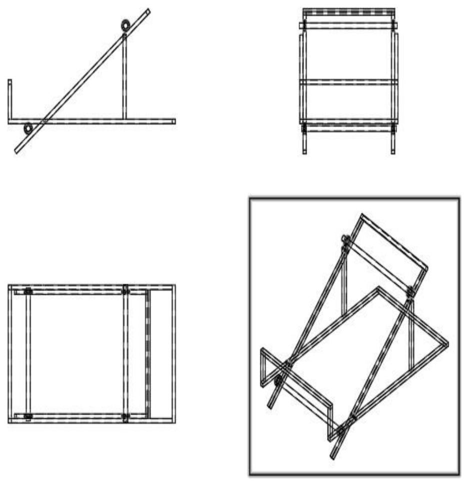

Fig.4.1. Orthographic and Isometric view

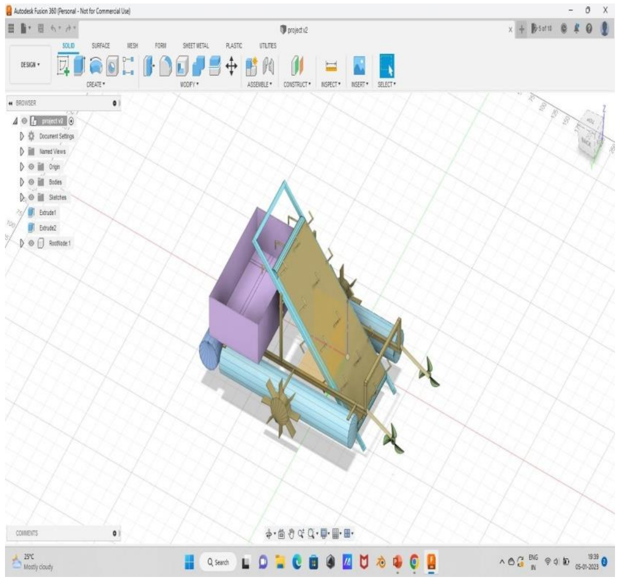

Fig.4.2. Design in fusion 360 workbench

b. Static Structural Analysis

The analysis process in ANSYS began with the import of the structure's geometry to ensure its cleanliness and freedom from errors. Once the geometry was in place, the next step involved the generation of a mesh. This mesh had to be sufficiently refined to capture intricate details while remaining error-free, ensuring the accuracy of the subsequent analysis. The accuracy of the analysis was highly dependent on the definition of material properties. Parameters such as Young's modulus, Poisson's ratio, and density were carefully specified based on either material testing data or well-established published references. These material properties played a critical role in accurately simulating the behavior of the structure. To replicate real-world conditions, boundary conditions were diligently applied. This step involved defining fixed constraints, as well as specifying the loads and external forces that would interact with the structure during the analysis. The precise setup of these boundary conditions was crucial for the realistic modeling of the structure's behavior. The analysis process continued with the configuration of the analysis settings. Decisions were made regarding the type of analysis to be conducted, whether linear or nonlinear, and other relevant parameters, including the convergence criteria. These settings were tailored to ensure an accurate representation of the structure's behavior under various conditions. With all the preparatory work complete, the ANSYS software was employed to conduct the analysis. It systematically solved for key parameters such as deformation, stress, and strain within the structure. The results were generated in multiple formats, including contour plots, graphs, and data sets, enabling a comprehensive examination of the structure's response. The analysis results were subjected to a rigorous evaluation. This evaluation encompassed a meticulous review to detect any signs of excessive deformation, stress, or strain. Additionally, the stability and structural integrity of the structure were verified to ensure that the design criteria were met. Where necessary, the analysis results were used to optimize the design of the structure. This optimization process involved making adjustments to material properties, modifying the geometry, or altering boundary conditions to enhance the structure's performance. Finally, a comprehensive report was compiled to communicate the findings effectively. This report summarized the analysis methodology, input parameters, and the outcomes obtained from the analysis, providing a clear and detailed account of the analysis process and its results.

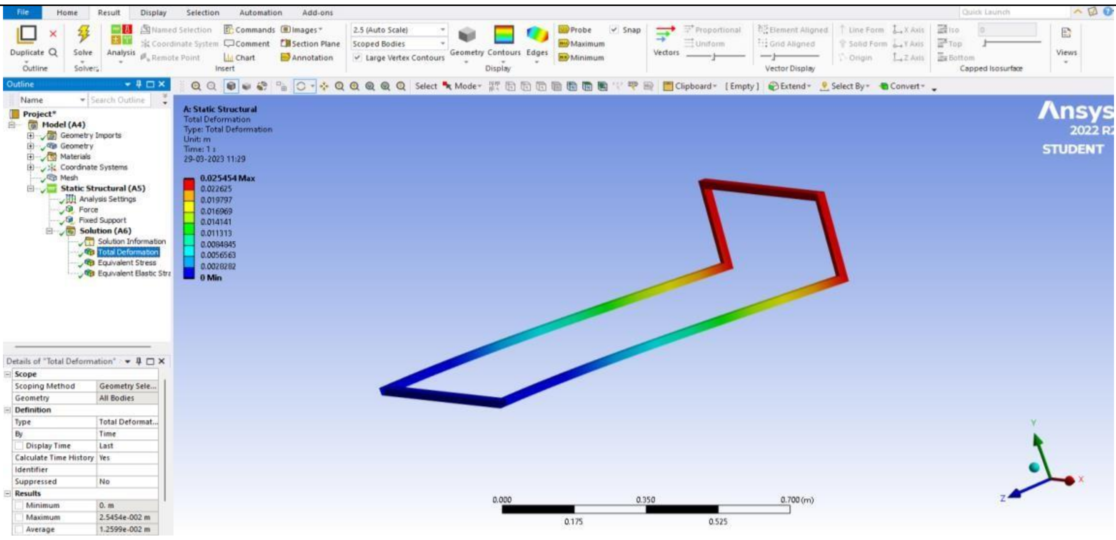

Fig.4.3. Total deformation

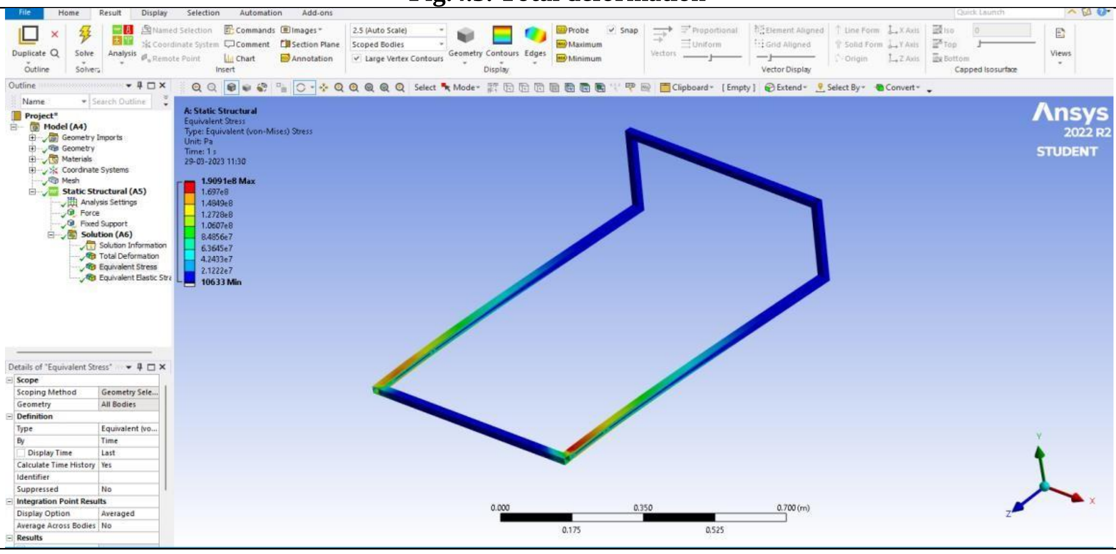

Fig.4.4. Equivalent(von-mises)stress

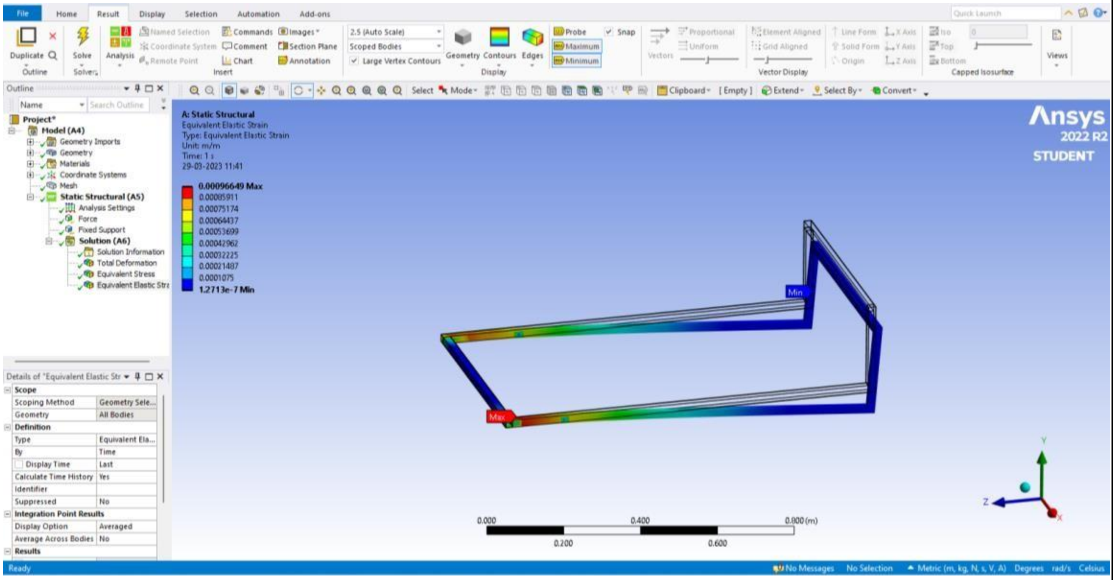

Fig.4.4. Equivalent elastic Strain

c. Fabrication

The project initiation involved preparing the chassis by cutting iron rods to specified lengths and welding them together to form the frame. The welded joints were then smoothed, and additional components like bearings were attached. Next, PVC pipes were cut, cleaned, and assembled into a float, connected to the chassis using GI wire. The conveyor mechanism was prepared by selecting an appropriate conveyor belt, cutting and installing it onto the frame, and integrating a belt drive mechanism powered by a stepper motor. Motors and pedal wheels were assembled by preparing a wooden shaft, drilling a hole, and fixing the motor and pedal wheel to it. The stepper motor was connected to the conveyor belt using a gear drive system. Circuit connections were established by coding an ESP8266 in Arduino IDE, uploading the code, and connecting various components such as DC motors, stepper motor, L298N motor driver, relay module, ESP8266, and battery. Cutter blades were prepared by attaching them to a flag-like structure with a BLDC motor. Finally, the overall structure was assembled by connecting the conveyor belt to the main frame, attaching a trash collection bin, placing the battery, and completing the circuit, followed by thorough testing to ensure safety and functionality.

Fig.4.4. Final Structure of Assembly

IV. Conclusions

The designed water weed and garbage cleaner project stands out for its economic feasibility, user-friendly operation, and its efficacy in water weed and garbage removal. It holds potential for modification to enhance cleaning capacity and overall efficiency. Through extensive research and experimentation, it is evident that the project offers a viable solution to combat water pollution stemming from the overgrowth of aquatic weeds and the accumulation of garbage in water bodies. The project's design effectively captures and contains floating debris and weeds, preventing further contamination of the water. The collection and disposal process is not only efficient but also environmentally conscious. Implementation of the project has the potential to positively impact the aquatic ecosystem by preserving a healthy nutrient balance and reducing the risk of harmful algal blooms. In summary, the water weed and garbage collector project represents a practical and sustainable approach to addressing water pollution, contributing to the preservation of aquatic life and the promotion of a healthier environment. The utilization of ESP8266 for comprehensive control via an Android mobile device using Wi-Fi, particularly through the BLYNK app, enhances the overall functionality and accessibility of the system.

V. Future Scope

The future scope of the water weed and garbage collector project holds significant promise for further advancements. Integration of advanced sensors and artificial intelligence algorithms could enhance the system's autonomous capabilities, enabling it to adapt to changing environmental conditions and optimize cleaning efficiency. Additionally, incorporating sustainable energy sources, such as solar or wind power, could contribute to the project's environmental friendliness. The development of a real-time monitoring system, accessible remotely, would provide valuable insights into the water body's health and allow for prompt intervention. Collaboration with local environmental agencies and municipalities could facilitate widespread adoption, contributing to broader initiatives for water body conservation. Lastly, ongoing research and development to explore bio-inspired designs and materials may lead to innovative solutions for more effective and eco-friendly water weed and garbage removal.

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Rambabu Kantipudi. "Design and Fabrication of Water Weed and Garbage Cleaner." *International Journal of Engineering Science Invention (IJESI)*, Vol. 12(11), 2023, PP 37-42. Journal DOI- 10.35629/6734