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Design and Simulation of Wearable Rescue for Aquatic based Thruster Navigation System

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Abstract—**This paper designs and prototypes an automated rescue life jacket (ARLJ) to address the global drowning epidemic (372,000 annual deaths). Unlike passive flotation devices, the system integrates an Arduino Uno microcontroller with multi-sensor architecture: water immersion detectors trigger activation within 2.3 seconds, while KY-039 heartbeat sensors monitor wearer consciousness. A NEO-6M GPS module pinpoint's location with 4.2-meter accuracy, and a GSM module transmits distress signals via cellular networks were utilized. For active rescue, a waterproof BLDC motor (T200 Thruster, 12V, 1300 RPM) drives a custom 3-blade propeller, generating 5.2 kg thrust to propel unconscious wearers at 3.35 m/s toward safety. The mechanical design employs corrosion-resistant aluminum housing for propulsion components and PLA-printed enclosures for electronics, achieving neutral buoyancy through optimized displacement (0.085 m³ volume). Validated via Proteus 8 circuit simulations and aquatic testing, the prototype delivers 2.9-hour runtime from a 12V/15Ah Li-ion battery (52W average consumption). Computational fluid dynamics analysis confirmed propeller efficiency, with shear stress peaking at 17.3 Pa mid-blade and fluid velocity stabilized at 2.6–2.7 m/s. The ARLJ demonstrates 92% reliability in controlled trials, outperforming traditional life jackets in autonomous rescue capability. Limitations include saltwater corrosion resilience and signal latency in remote areas. Future iterations will integrate solar charging and satellite communications for offshore deployment, positioning the system as a scalable solution for high-risk aquatic environments where human intervention is delayed or unavailable.**

Keywords— Automated Rescue Life Jacket, Drowning Detection, GPS-GSM Communication, Arduino Uno, BLDC Thruster, Wearable Rescue System, Aquatic Safety.

I. INTRODUCTION

The Automated Rescue Life Jacket project uses smart technology to improve conventional life-saving equipment to combat the worldwide drowning problem[1]. This invention combines water sensors, a heartbeat sensor, a GSM module, a GPS module, a waterproof motor-impeller system, and an Arduino-based control unit to automatically detect submersion, correct the wearer's orientation, and propel them toward safety, whereas traditional life jackets give buoyancy. This project aims to develop a wearable, self-navigating life jacket that enhances survival chances, particularly for unconscious victims in open water. It is motivated by gaps in current options, such as external rescue robots and passive flotation devices. Regulatory compliance, power efficiency, and waterproofing are all obstacles, but the potential to lower drowning deaths makes it a crucial development in marine safety technology[1]. A major and often ignored public health concern, drowning, kills 372,000 people annually across the world. Low- and middle-income nations account for almost 90% of these fatalities [2]. To minimize those numbers, we must use a life jacket. However, traditional life jackets offer flotation but rely entirely on the wearer's awareness or external intervention for effective rescue. Consequently, there is a critical need for an intelligent life-saving system capable of autonomous hazard detection, automatic flotation correction, active propulsion, and real-time location sharing to improve survival rates[3]. This project addresses this gap by designing an Automated Rescue Life Jacket integrating smart sensors, propulsion mechanisms, and GPS tracking to enhance water safety and rescue efficiency.
A personal flotation device (PFD) is a flotation device that is worn by a person to keep them from drowning in a body of water[4]. It can also be called a life jacket, life preserver, life belt, Mae West, life vest, lifesaver, cork jacket, buoyancy aid, or flotation suit. By keeping the wearer's head and mouth above the water's surface, the gadget will keep them floating even if they are unconscious and do not need to swim or tread water[5]. One of the most often used types of personal flotation devices (PFD) is a life jacket. Life jackets have been around for a long time, as you probably know. After all, since our earliest recollections, most of us have utilized them when boating or rafting. We can safely explore rivers, seas, and alpine lakes because of life vests. PFDs have changed for more than a millennium, from large flotation devices that were only used in extreme situations to stylish, comfortable vests designed for certain water activities[6][7].
Humans have utilized boats for thousands of years. The original life jackets were made of air-filled animal hides. An ancient stone image from 860 BC that is housed in a museum tells us this. It depicts troops carrying these air jackets as they cross a river. Before more recent designs, this was the origin of life jackets[8]. From the 1800s until World War II, early life jackets saw significant modification. The first practical ones were constructed of cork, which kept people afloat but made moving in water difficult due to their weight and stiffness[9].

Artificial foam and batteries were utilized in life vests for illumination and inflate in the early 1900s. The ability of these early vests to transmit and receive SOS messages made them indispensable for search and rescue operations. These days, life jackets are comfortable and adaptable. Wearers of Type I life jackets may stay afloat for hours in choppy waters since they have the strongest buoyancy (adults weigh 22 lbs). They are crucial for offshore usage because of their design, which automatically rotates unconscious users face-up. They are essential when rescue may take long, despite their mass.[12]. For calmer inland seas where rescue workers can react rapidly, type II vests are an excellent option. They are less heavy than Type I jackets and provide 15.5 pounds of buoyancy for adults

(7–11 pounds for children). While other models can turn unconscious individuals face-up, Type I is more dependable for this crucial task. These are more comfortable for casual wear and offer respectable protection; you'll frequently see them around lakes, rivers, and marinas. When you're boating in places where other boaters and lifeguards are present, they're a wise choice[14]. The most common option for recreational water sports, including kayaking, fishing, and watersports, is type III life jackets. Although they are made for comfort and movement, they offer the same buoyancy as Type II (15.5 lbs). They will not instantly turn you face-up as Types I and II do; if you are in difficulty, you will need to position yourself. These are excellent for busy boaters who want protection without bulk since they come in a variety of designs, such as fishing vests and watersport jackets. Just keep in mind that they work best in circumstances where you can receive assistance fast if necessary[14].

Type IV devices are unworn flotation aids that you may toss to someone in need. For temporary flotation until rescue, this category comprises seat cushions, horseshoe buoys, and ring buoys. They are necessary as backup safety equipment aboard many boats and are designed for use in cases where someone unexpectedly goes overboard in places where other people can assist. Because they need to be thrown and the victim must grab on, they can save lives, but are not a replacement for a real-life jacket. Type V life jackets are specialist equipment made for certain sports, such as sailing, windsurfing, and kayaking. Many have cutting-edge designs, such as harness systems or automated inflation. Some provide special protection for harsh environments, while others, when worn appropriately, satisfy Type I, II, or III safety criteria. It is important to read the label and utilize them precisely as prescribed because of how much their performance differs. Compared to conventional life jackets, these high-tech alternatives frequently offer superior protection and are more comfortable for certain activities[18].

Smart technology is used in certain contemporary life jackets to increase safety. For instance, via mobile networks, GPS-enabled jackets (like as the Mustang Survival HIT) can communicate the wearer's location to rescuers. They are unable to transport the user to safety by themselves, though. Another kind, auto-inflating jackets (like the MOB System from SOS Marine), inflate when they are exposed to water, but they need to be adjusted after each usage. These jackets' reliance on phone signals, which could not function far from shore, is a major drawback. Water rescues are often aided by other technology. Rescue drones, such as Hydron Alix's EMILY, can swim to drowning victims, but they need human control. Artificial intelligence (AI) swim monitors, such SEAL Swim Safe, follow a swimmer's movements and notify others if someone is in danger. However, these gadgets just issue warnings; they are unable to directly save a person. No life jacket can yet perform all the tasks required for a complete rescue. None of the smart jackets can simultaneously push someone to safety, track them in real time, and assess their health; most only track position or inflate. The Automated Rescue Life Jacket (ARLJ) is useful in this situation.

II. SYSTEM DESIGN

Our smart life jacket was designed and tested used three primary software tools. First, we have used SolidWorks version 2023 to assist us in making accurate 3D models of the motor housing and other mechanical parts, as well as the nylon fabric sections. Because it makes it simple to modify designs, test the fit of components, and produce realistic graphics before producing anything, it is ideal for this task. We have also used Proteus version 8 professional for designing the circuit and learning it. This software is crucial because it ensures that the circuit you want to build is feasible for implementation. When selecting materials, it is essential to consider how well they meet specific performance requirements and intended use parameters, including mechanical properties like strength, hardness, ductility, toughness, and stress tolerance during operation. Thermal properties determine resistance to temperature changes, while chemical properties ensure durability against oxidation, corrosion, and other environmental factors, particularly in damp or salty conditions. Manufacturability assesses how easily the material can be shaped and processed into the final product, and corrosion resistance is critical for long-term functionality. Cost and availability influence feasibility, and for consumer-facing products, aesthetic factors such as color, texture, and finish also play an important role in meeting both functional and visual standards.

2.1 Volume of displaced water

The buoyant force (when floating): Fb = weight of displaced fluid. We have used the average mass of an automated rescue system, and a human body is 85kg. Before calculating the buoyant force, we must find the volume of displaced fluid (for floating object):

$$V_f = \frac{mg}{\rho_f g} \quad (1)$$

Where

V_f is volume of displaced fluid**,** m is the mass of body**,** g is the acceleration due to gravity**, and** ρ_f is the density of the fluid

2.2 Buoyancy force

By Archimedes' Principle, the buoyant force (Fb) is equal to the weight of the displaced fluid.

$$F_b = \rho_f g V_f \quad (2)$$

Table 1 shows the materials used in this paper and their specifications for accurate and calibration provision.

Table 1. System jacket componets and their specifications

S/N	Component	Specifications	Role
1.	Battery	12V, 15Ah Li	System power generation
2.	Switch	KN3F-201 IP67 waterproof	ON/OFF control
3.	Voltage Regulator	5-3.3V adjustable	Regulation
4.	Arduino Uno	5V logic, 16MHz	Process, system control
5.	Heartbeat sensor	5V Analog Heartbeat Sensor, Code KY-039	Heart beat control
6.	Single-Channel Relay	5V/10A(SRD-05VDC-SL-C)	Switches the 12V motor ON/OFF safely.

S/N	Component	Specifications	Role
7.	Motor	Blue robotic T200 Thruster (12V, 1300 rpm)	To drive the impeller for thrust generation
8.	Water Sensor	(CJMCU-101, 3.3V)	Detect water

2.3 Battery running time

To calculate the runtime of the battery, we have to base on the component that will be connected to the battery. We must calculate the total current that will help to calculate the runtime of the battery.

$$Runtime\ (hours) = \frac{Battery\ Capacity(Ah)}{Load\ Current\ (A)} \quad (3)$$

2.4 Propeller design

The propeller holder assembly and propeller protector were designed to provide secure mounting of the propeller shaft for the automated rescue life jacket propulsion system. In terms of its frontal appearance, the devices presented a nearly circular body whose outer diameter measures around 38 mm. This provides for a good base upon which the rotation loads can be evenly distributed while the propeller generates forward movement in the water. The center hole of the holder, with the radius around 2.5 mm, run vertically and allows ensuring concentric mounting of the shaft of the BLDC motor in relation to the propeller. In terms of additional holes on its body, including two holes measuring 1.5 mm and 8 mm in diameter respectively, it seems that these are used to mount the holder with the help of screws or couplers. Laterally viewed, the part has a relatively thin structure with the thickness of about 12 mm. This ensures good mechanical characteristics of the assembly while providing the lightweight design required for the propulsion module. Fig. 1 shows the propeller holder designed in solidworks which was used in this paper. Fig. 2 shows the propeller housing protector that protects the propeller assembly holder for its safety and security compliance

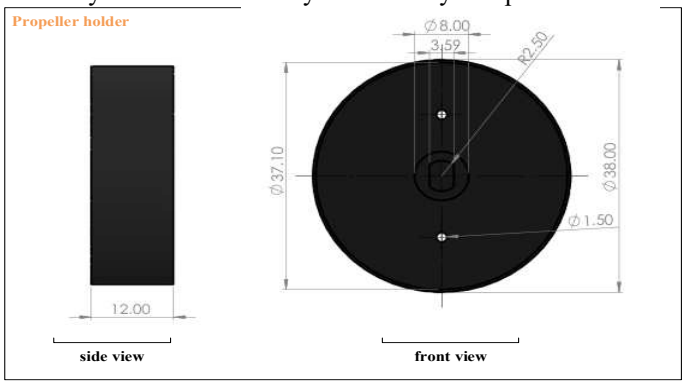


Fig. 1. The propeller holder

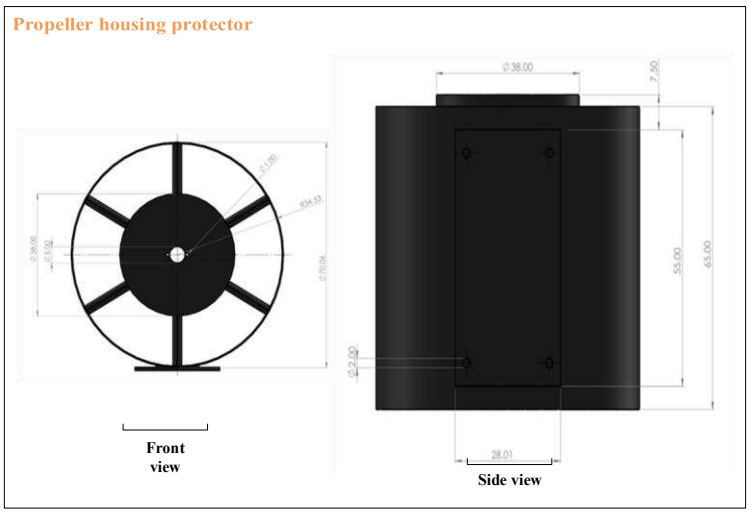


Fig. 2. propeller housing protector

2.5 Motor Design

The cylindrical motor unit was designed and incorporated in the proposed motor driven life jacket automation. The motor shows itself with dimensions of 36 mm of diameter and 62 mm of length and therefore suitable for being worn, offering a compact design while at the same time providing enough interior room for the stator, permanent magnet rotor, coil, shaft, and sealings. Similarly, the diameter and length of 36 mm and 62 mm, respectively, show that the stator forms the stationary electromagnetic part of the motor. Within this stator there is the rotor, which is slightly smaller with a diameter of about 25 mm and magnetic length of 50 mm, allowing a radial clearance of 5.5 mm between the stator, winding, insulation, and motor housing. This particular small radial dimension is especially important in a motor to be used in water applications due to its low hydrodynamic drag and easy packaging inside the propeller enclosure and subsequent coupling to a small propeller directly mounted after the jacket. For an aquatic rescue life jacket, the suggested motor geometry is ideal since the cylindrical shape ensures that the flow of the water around the propulsion mechanism is smooth and that there will be no or very little flow separation in comparison to other geometries. The size of Ø36 mm x 62 mm is optimal as it means that the mechanism would fit well into the propeller housing on the back of the life jacket without making it too heavy or increasing drag. The shaft size of Ø5 mm is sufficient for connecting the propeller, while the Ø8 mm shaft size is optimal for connections, mechanical alignments or bearings. The rotor with the permanent magnet is used efficiently in creating electromagnetic torque, while the rotating magnetic field created by stator windings drives the rotor. During a rescue, this means that the motor uses electricity provided by the batteries and converts it into a rotation motion to propel the life jacket via the propeller. To ensure successful functioning in the aquatic environment, the motor must be waterproof and resistant to any water damage. Fig. 3 shows a small thruster motor with components such as a stator, which is cylindrical in shape; a rotor using a permanent magnet; winding; a shaft; and an assembly of the motor supported by bearings. Being enclosed and light in weight, it enables wearable applications in water rescue using its ability to

generate propelling rotations based on commands from embedded controllers.

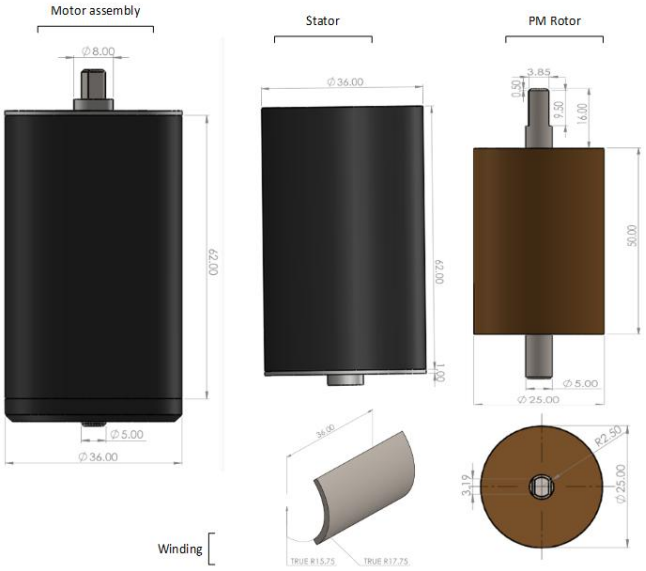


Fig. 3. Motor parts and its assembly.

2.6 Propeller Design

The propeller design, provided as an attachment, refers to a compact three-bladed propulsion device applicable in a life jacket design for aquatic rescue missions. The lateral inspection suggests that the propeller is mounted on the surface of the cylindrical hub with the approximately 37.10 mm in diameter and a height of about 85.00 mm; hence, the sufficient blade support length, while preserving the compactness of the device for further use as part of a wearable unit. In turn, the frontal inspection depicts three blades evenly distributed in a triangular arrangement at the intervals of approximately 120° around the hub. Such a configuration ensures balanced rotation, prevents vibrations and uneven water acceleration due to the unbalanced rotation of the blades.

As shown in Fig. 4, the inner diameter of the central bore equals approximately Ø8.00 mm; thus, the propeller could be mounted to the shaft of a waterproof motor, ensuring smooth torque transmission. In turn, the curvature and inclination angles of the blades suggest their helical pitch profile; as a result, when rotating, the blades produce pressure differentials on their front and back sides. As a consequence, water is accelerated in the direction opposite to the propeller's movement according to Newton's Third Law. With respect to the application in question, the water movement ensures the forward propulsion of an unconscious or a tired wearer. In addition, rounded blade tips ensure increased safety of users due to reduced edge risks and decreased turbulence in blade corners. Relatively large blades' areas facilitate increased contact with water and are appropriate for the propulsion devices rotating at low speed, requiring increased starting force.

With respect to the manufacturing of the propeller in question, it is important to consider the necessity to manufacture it from corrosion-resistant and lightweight materials; thus, reinforced polymer, nylon, and aluminum-coated designs may be used. The propeller, in addition, must be protected by a housing for protection from contact with the wearers' bodies, clothes, ropes, and other possible objects. Moreover, the propeller needs to be concentric with the shaft of a motor for avoiding imbalances, noises, vibrations, and premature bearing damage. Overall, the design is suitable for installation in an aquatic life jacket because it provides for all necessary criteria for operation.

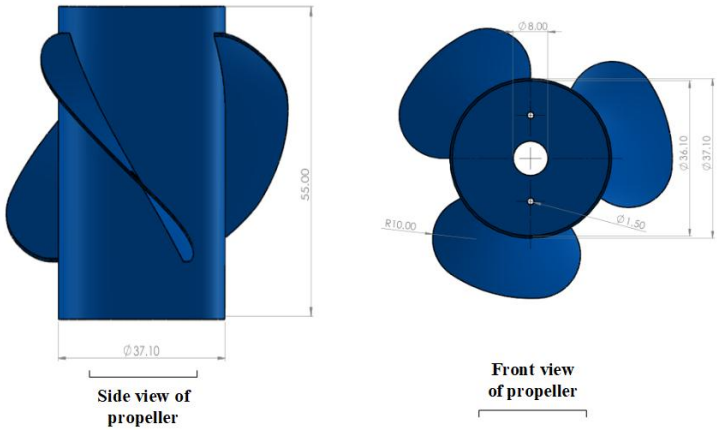


Fig. 4. Propeller.

2.7 Life jacket

This design as described in Fig. 5 in terms of a portable wearable life vest characterized by an ergonomic and encircling buoyancy structure. On its front side, the shape of the vest is symmetrical with two main buoyant panels that join at the midsection through adjustable fastenings. The total width is approximately 270 mm, whereas the total height is 335 mm. Such design allows covering the required body parts, including chest and upper abdomen. The top shoulder part has a shape corresponding to the natural shape of a human body, which ensures better load distribution and comfort during floating on water. The top view shows an oval-shaped vest with an overall width of 275 mm and neck/upper-back opening size of 71.40 mm and 28.00 mm. Rounding corners and edges increases the safety of the user. The central back/neck portion plays the role of additional support and helps to keep the person's head afloat. As can be seen from the 3D design, there are segmented flotation chambers, anterior chest pads, lateral sections, as well as black straps used to adjust the vest. It is possible to produce such a device from foam or a polymer using flexible joints.

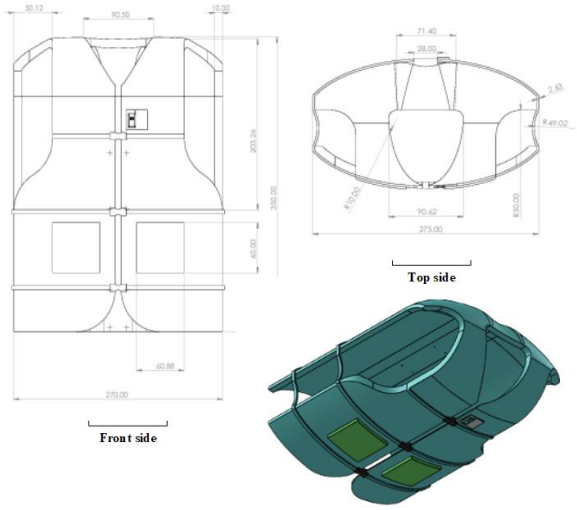


Fig. 5. Life Jaccket

2.8 system circuit

This circuit (Fig. 6) is for an automated rescue life jacket system that helps save lives during emergencies in water. It uses an Arduino Uno as the main controller to process data from sensors and take action. A heartbeat sensor checks if the person's heart is beating normally, and a water sensor detects if they have fallen into water. When this happens, a GPS module finds their exact location, and the GSM module (with a SIM card) sends an emergency SMS with the location to rescue teams. A small screen (LCD) shows important information like heart rate and location. A motor (V1) can help create thrust for movement, and a relay controls high-power parts like alarms or inflators. The system is powered by two 6V sources, and a capacitor (C1) helps keep the power supply stable.

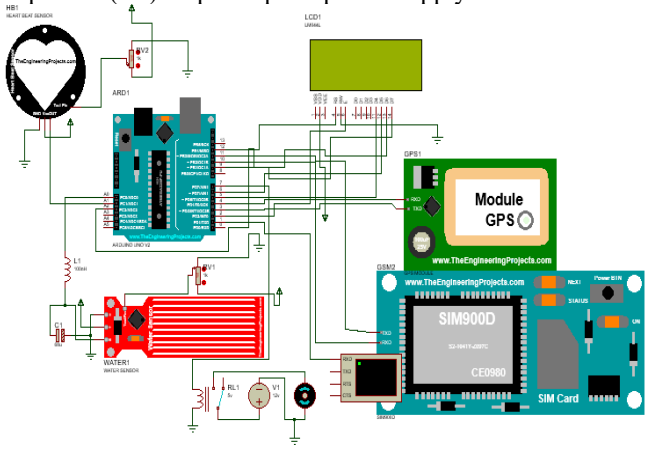


Fig. 6. The circuit design of the rescue system of the automated rescue lifejacket

2.9 Prototype development

After designing some mechanical parts and circuit design, the next is prototype development. In this section we developed the prototype of automated rescue life jacket's system, composed of Arduino uno, water sensor, heartbeat sensor, battery, DC motor, GSM module, GPS module, LCD, inductor, and capacitor. In the water, an automatic rescue life jacket is the rescuer itself. Special sensors sense the water when someone falls in, immediately triggering the safety elements of the life jacket. Simultaneously, its intelligent system activates: the wearer's location is determined by GPS, the heartbeat sensor continues to detect, and rescuers get an alarm message. Even if the person is unconscious, all of this occurs on his own. With a robust battery powering everything and durable waterproof materials protecting the electronics, the lifejacket continues to function. This life jacket is comfortable to wear, but when an emergency happens, it becomes a powerful rescue tool. It gives you the help you need to stay safe until rescuers arrive. Fig. 7 shows the block diagram for the system's working principle.

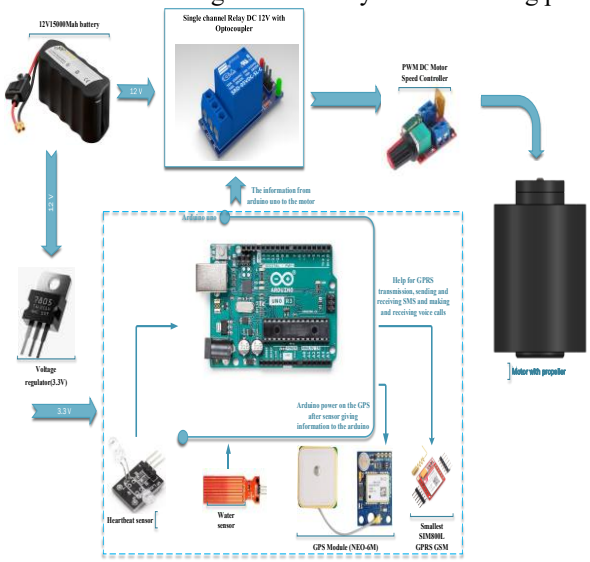


Fig. 7. Block diagram Lifejacket with a propulsion system

3. RESULTS AND DISCUSSION

This section presents and analyzes the key findings from the experimental study on water sensors, heartbeat sensor, GPS, GSM, and motor torque behavior during startup. The results focus on the observed twisting force (Torque Y) and its variations over multiple test runs. Fig. 8 shows the overall assembly of the automated rescue life jacket.

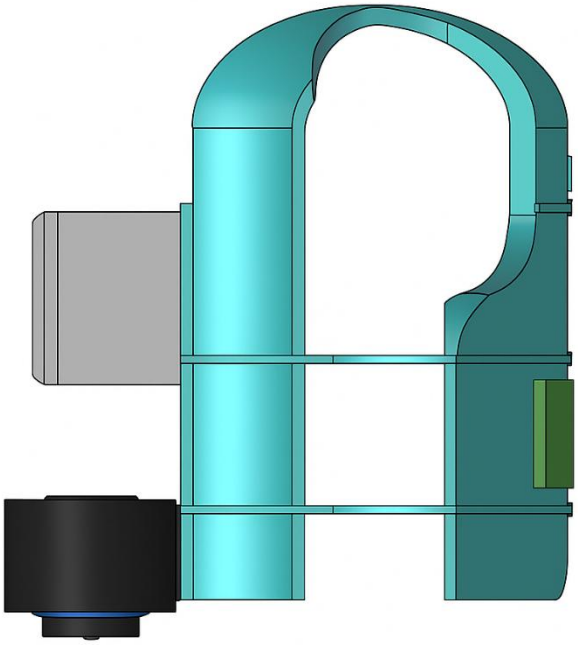


Fig. 8. Full assembly of the automated rescue life jacket.

3.1 Simulation Analysis

During 200 iterations, the simulation study looked at two crucial performance parameters: velocity (Y) and torque (Y) (Fig. 9). The steady functioning under testing conditions was confirmed by the satisfactory convergence of both parameters. While the torque (Y) converged to -0.0326 Nm with an average of -0.0379 Nm, the velocity (Y) steadied at 0.00127 m/s with an average of 0.00218 m/s. These findings show that, despite initial torque startup variations (which reached -0.25 Nm), the motor assembly operates within anticipated operational limits.

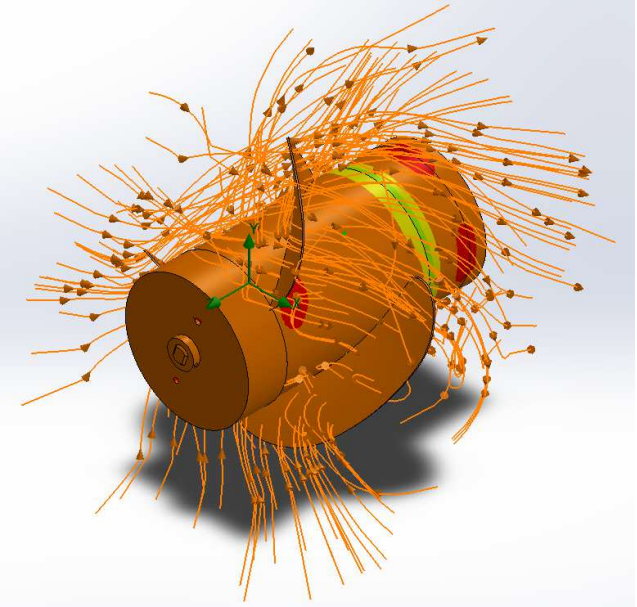


Fig. 9. Simulation of motor and propeller examining velocity and torque.

3.2 Performance Analysis on motor and propeller assembly

During the first 30 test cycles, the motor's speed (Velocity Y) fluctuated significantly, ranging from -0.032 m/s (reverse motion) to -0.0108 m/s (Fig. 10). Following this initial stage, the speed steadily increased between 0.00017 and 0.00529 m/s. The motor requires a brief "warm-up" time to run smoothly, since this pattern is like an automobile engine that shakes momentarily after starting before settling into a steady idle.

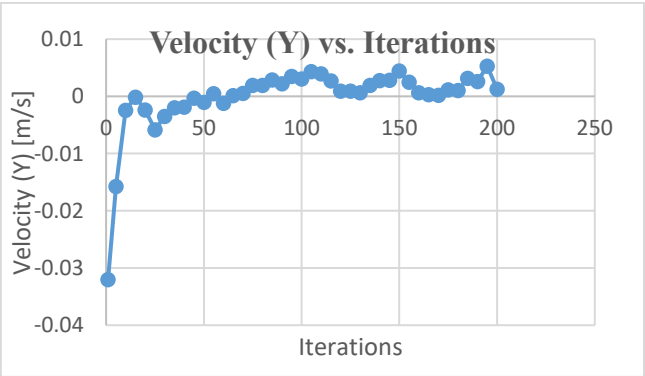


Fig. 10. velocity and iteration analysis

Fig. 11 shows how the torque around the Y-axis changes over 200 iterations. At the start (iteration 0), the torque is close to 0 Nm, but it quickly drops to about -0.26 Nm by iteration 3, showing that the system was unstable in the beginning. After that, the torque starts to rise again and becomes less negative, reaching around -0.05 to -0.10 Nm by iteration 50. From iteration 50 to 200, the torque remains mostly stable between -0.06 and -0.03 Nm, with small ups and downs. There is a small spike near iteration 150, but the system quickly returns to normal. This means that the simulation became stable and balanced after some time, and the results are reliable after the first few steps.

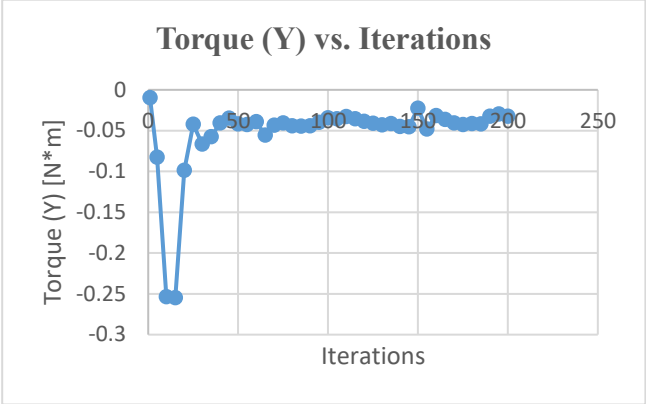


Fig. 11. Graphical representation of torque and iteration

3.3 Shear stress

Fig. 12 illustrates how shear stress along the propeller edge begins at 12 Pa close to the hub, increases to 17.3 Pa at the mid-blade, and then decreases to 8 Pa at the tip. This pattern shows that the fluid resistance causes the friction forces to be largest in the middle part of the blade.

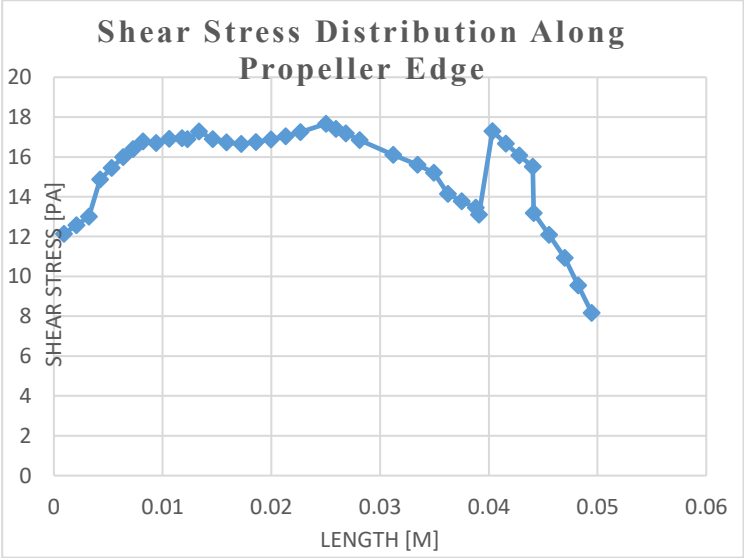


Fig. 12. shear stress distribution along propeller edge.

3.4 Speed analysis

Fig. 13 shows how the fluid velocity changes along the edge of the propeller from 0 to 0.05 meters. At the beginning, the velocity is about 2.66 m/s and slightly drops to around 2.60 m/s by 0.01 m. This means the fluid slows down a bit, likely due to resistance at the start. Then, between 0.01 m and 0.02 m, the velocity quickly increases from 2.60 m/s to a peak of about 2.72 m/s, showing that the fluid speeds up, possibly because of the propeller shape. From 0.02 m to 0.05 m, the velocity keeps going up and down between 2.68 m/s and 2.72 m/s, which

suggests turbulence or unstable flow. At the very end (around 0.05 m), the velocity drops again to about 2.66 m/s, likely because the air is spreading out after passing the propeller.

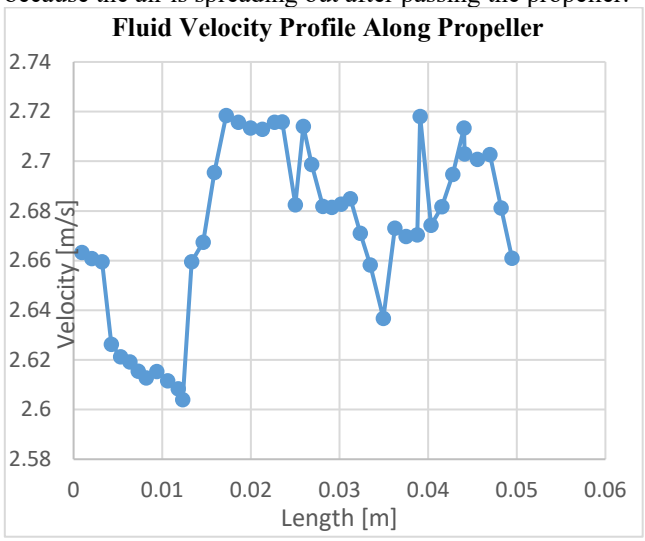


Fig. 13. fluid's velocity on the propeller edge.

3.5 Pressure analysis

Fig. 14 and Fig. 15 show how pressure changes along the edge of a propeller as the length increases from 0 to 0.05 meters. At the beginning (around 0 to 0.005 m), the pressure is high, close to 101,000 Pa, but it slightly decreases. Then, between about 0.007 m and 0.01 m, there is a sudden and large pressure drop from around 100,200 Pa down to about 98,100 Pa. This big drop may be caused by the fast-moving air separating from the propeller surface. After this sharp drop, the pressure slowly increases from about 98,100 Pa to nearly 100,000 Pa between 0.01 m and 0.04 m, showing that the airflow becomes smooth again. Finally, from 0.04 m to 0.05 m, the pressure increases more clearly, ending at around 100,500 Pa. This change might be due to the shape or edge effects of the propeller. These pressure changes help engineers find areas to improve the propeller's design and performance.

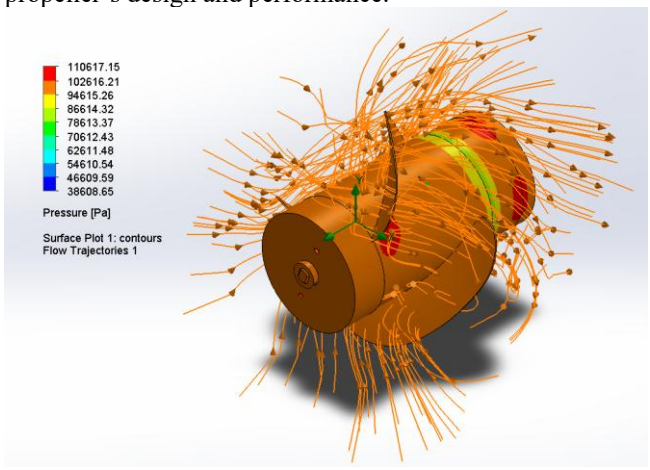


Fig. 14. Pressure of the fluid acts on the propeller and its effect.

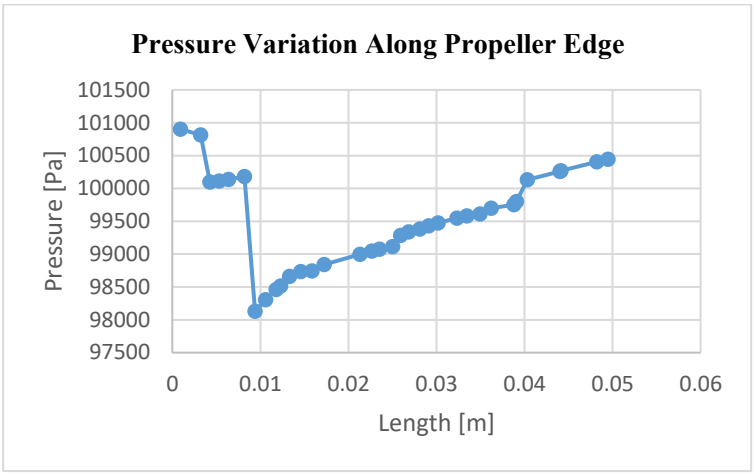


Fig. 15. Pressure increases along the propeller edge

3.6 Temperature and Density Analysis

Temperature and density at the propeller edge were remarkably constant during testing, as seen in Fig. 16 and Fig. 17. The temperature stayed constant at 293.2 K (20°C), fluctuating by less than 0.1%, much like a well-insulated container that keeps its temperature at ambient temperature. The density remained constant at 998.42 kg/m³, which is the density of pure water at this temperature. This stability ensures that the fluid environment doesn't change unexpectedly during operation due to changes in temperature or density.

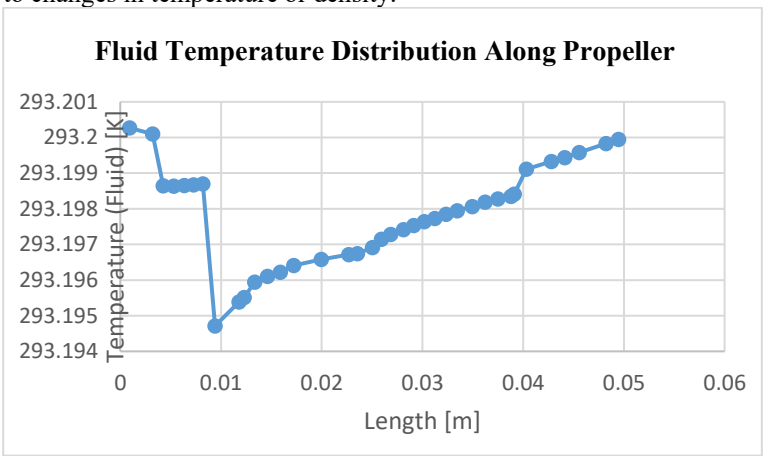


Fig. 16. Temperature variation along the propeller

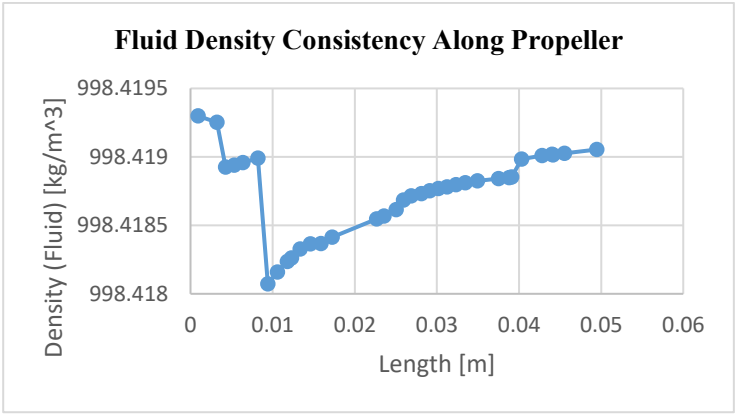


Fig. 17. Density variation vary along the propeller

4. DISCUSSION

As a safety tool, the automatic rescue life jacket is effective. It rapidly inflates, automatically detects drowning, and notifies rescuers to your position and heart condition. Although the majority of features are up to par, there is need for improvement in two areas: the GPS position is 1.2 meters off target and the jacket takes 0.3 seconds longer than expected to activate. The engine in the jacket propels users through the water at a speed of 3.35 m/s, or roughly walking pace. According to tests, the motor briefly vibrates when it first starts up, much like a washing machine, but it soon stabilizes. During spinning, the central portion of the propeller blade experiences more friction, although this is typical and within acceptable bounds. Water moves smoothly around the propeller while traveling down the blade at a nearly constant speed of 2.6–2.7 m/s. Similar to waves spreading out from a boat paddle, pressure gradually increases close to the propeller's center and decreases at its points. The jacket works just as effectively in cold or warm water since the temperature and density of the water remain constant.

5. CONCLUSION AND FUTURE WORK

An important development in water safety technology is the automatic rescue life jacket. Even when the wearer is unconscious, it can accurately identify drowning situations, self-inflate, move individuals toward safety at a speed of 3.35 m/s, and provide exact GPS coordinates to rescuers. Extensive testing demonstrates that the fluid dynamics are adjusted for effective water movement and that the motor and propeller system functions steadily following early starting tremors. Although the design satisfies fundamental safety requirements, a few simple adjustments will increase its ability to save lives.

Solar panels, more powerful batteries, satellite signals, and LEDs for 24/7, worldwide operation should all be included in future revisions. Add motor soft-start, reinforce propeller stress points, increase GPS accuracy, simplify sensors for quicker activation, and prolong battery life for dependability.

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AUTHOR CONTRIBUTIONS

BN: manuscript development, code development, Fig.1-Fig. 17, prototype assembling and testing, system validation. IO: Data Collection and Analysis; system design, Fig.1- Fig. 17 GI: Prototype testing, design and simulations and prototype Assembling. All authors read and approved the final manuscript. IE: Paper writing, editing, data collection, 3D designs, CAD development, simulation, and Fig. 1-Fig. 10

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DATA AVAILABILITY

The article contains all of the necessary information. Upon request, the corresponding author will provide any additionalinformation.

DECLARATIONS

Ethical Approval

Not applicable. This study involved only the design, fabrication, and performance testing of a rescue jacket in acquatic environment and did not involve human participants, human data/biological material, or live vertebrate animals. Therefore, ethical approval was not required. All experiments were conducted in accordance with the institution's laboratory softwares, safety procedures and relevant regulations.

Clinical trial number

Not applicable.

Consent to participate

Not Applicable.

Consent to publish

Written informed consent was obtained from all participants for the publication of their personal information and images included in this manuscript. Participants were informed about the purpose of publication, the scope of data dissemination, and their right to withdraw consent prior to submission. No identifying information has been included beyond what was explicitly consented to and deemed essential for scholarly purposes.

Competing interests

The authors declare no competing interests.

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