

## EFFICIENT SEARCH AND RESCUE OPERATIONS WITH AN UNMANNED ROBOTIC BOAT

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Kerala had experienced an abnormally heavy monsoon rainfall, which resulted in flooding in 13 out of 14 districts in the state. Today's existing rescue vehicles include helicopters, rescue drones, heavy trucks which have limitations to handle the extreme conditions of flood. Lack of proper landing space, less number of copters and low visibility conditions are the major problems regarding helicopters. Approach roads to the victims are heavily flooded making it difficult for using truck as rescue vehicle. Currently used rescue vehicles lack provision to supply adequate food and medicines to the needy. Another factor that increases the severity of flood is the unavailability of trained personnel. The use of fishing boats in rescue operation saved so many lives. This paved the way to develop an unmanned robotic boat. Unmanned robotic boat (URB) can be used for flood rescue operations and maritime rescue applications. Unmanned robotic boat is a remotely controlled boat which is able to rescue people from flooded water without the need of rescue craft. A surveillance camera is also interfaced for live video streaming so that the operator can view the video images and provide instructions accordingly. Rescue operations are made easier and quicker with this vehicle. To supply lifesaving equipment, food packets and medicines robotic arm is used. Unmanned robotic boat is also provided with a special Ramp like platform to help the victims to enter into the boat. It can be used as a day and night operation equipment and can perform tasks which manned vehicles cannot do.

**KEYWORDS:** Unmanned robotic boat (URB), Life saving equipments, Robotic arm, Surveillance camera, RF remote.

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### 1. INTRODUCTION

Unmanned robotic boat is far better than the existing unmanned surface vehicle for multi-mission application [1]. Helicopters, rescue drones, heavy trucks and fisher boats are used as the rescue vehicles. Helicopters need proper landing space and good visibility conditions. The number of helicopters available for rescue mission are less. Approach roads are also flooded which makes it difficult for the truck to reach the flood affected areas. Another factor that increases the severity of flood is the unavailability of trained personnel. The use of fishing boats in rescue operation saved so many lives, making the flood rescue operation a huge success. This led to the development of unmanned robotic search and rescue boat [1].

Unmanned robotic boat makes the rescue operations simpler without putting rescuers life in danger. URB is a remotely controlled boat that can be operated from a safe distance on land/ship. It has no human occupants onboard. Therefore there is no need for trained personnel. URB shows precise and quick action as it is provided with robotic hand which supplies life saving equipments, food packets etc in the hands of the victims. Additional flow sensors are provided in the boat which makes the boat to flow against the water twirl, during heavy flood. The live video streaming makes it possible for the rescuers to evaluate and remotely assist the victims. The obstacle detection sensor/PIR motion/human sensor helps to identify trapped and isolated human beings during flood.

Unmanned robotic boat is provided with a special Ramp like platform to help the victims to enter into the boat. If the control station is built/ installed into a ship, URB can easily transport the rescued victims to the ship to ensure their safety and to efficiently utilize time for further rescue operations. The working range of URB can be increased by using higher frequency transmitters and receivers or it can be uplinked for wide range applications. As the frequency increases the attenuation decreases, noise decreases, and the antenna height decreases hence the distance of transmission increases. Moreover the range depends on the transmitting power also. In real time applications, 2.4GHz and 5.8GHz frequency bands with a maximum controller range of 4.3miles (7kms) can be used. When URB is outfitted with different appliances and instruments, it can be used for various other applications which dramatically cut costs for ocean research, water quality sampling, harbor surveillance etc.

### 2. MATERIALS AND METHODS

Unmanned Robotic Boat is a remotely controlled water vehicle. URB have a control unit and a robotic unit. The data is transmitted and received between the control unit and robotic unit with the help of RF communication. The control unit contains RF module, arduino uno, propulsion control, robotic arm control, camera mount control, and a LCD. The propulsion control, is to control and ride water vehicle. Robotic arm control controls the pick and place of the robotic arm on the vehicle. To rotate the camera, camera mount control is used [3]. The

LCD display shows the distance to obstacles from the water vehicle/motion detection/other sensor values. The instructions from the operator is fed to arduino uno, which is then encoded and converted into serial data. It is then transmitted through RF transmitter of frequency 433MHZ.

The robotic unit consists of an RF module, Arduino nano, motor driver, PIR sensor, ultrasonic sensor and a gas leakage sensor. The RF receiver (315MHZ) receives the transmitted signal, and decodes and fed to arduino nano. Since arduino nano cannot meet the current requirement of motors, a L293D motor driver is used to drive the motors. The visuals from IP camera is transmitted through wireless LAN to the computer/tab placed on the control unit. According to the video images and values from different sensors, operator can remotely control the direction of the boat using joystick. When URB detects the presence of an obstacle using ultrasonic sensor, it can stop at a safe distance and can take reverse mode to avoid collision in autonomous mode [3].

When a victim is detected by using the video image/PIR sensor values, the operator can remotely control the supply of life saving equipment, food or first aid box. Supply is done with the help of a pick and place robotic arm. Since 2 servo motors are used, the movement of robotic arm is possible in x and y directions. The robotic arm and the food packets/ life saving equipments etc. contains electromagnet which gets energized and attracts during the picking movement of the arm. When the object is about to place in a desired location, the magnets are de-energized, making the object repel from the robotic arm. The movement of pick and place robotic arm is remotely operated from the control unit. URB is also provided with a special Ramp like platform to help the victims to enter into the boat and then they can be transported to a secure place.

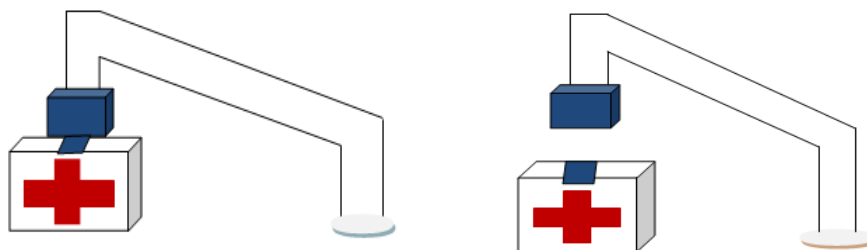
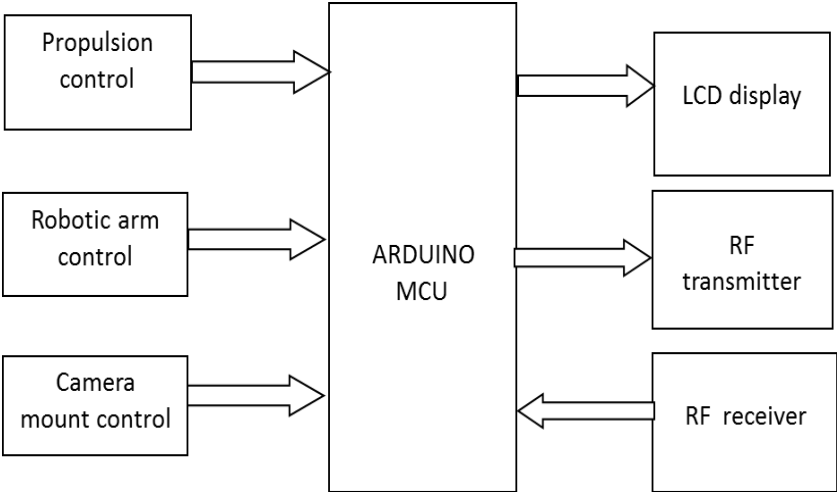


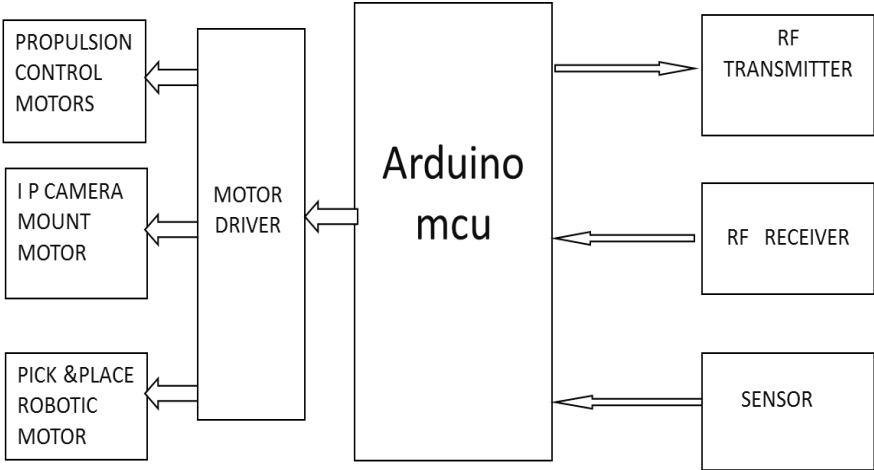
Figure 2.1 Magnetizing & Demagnetizing

## A) Block diagram

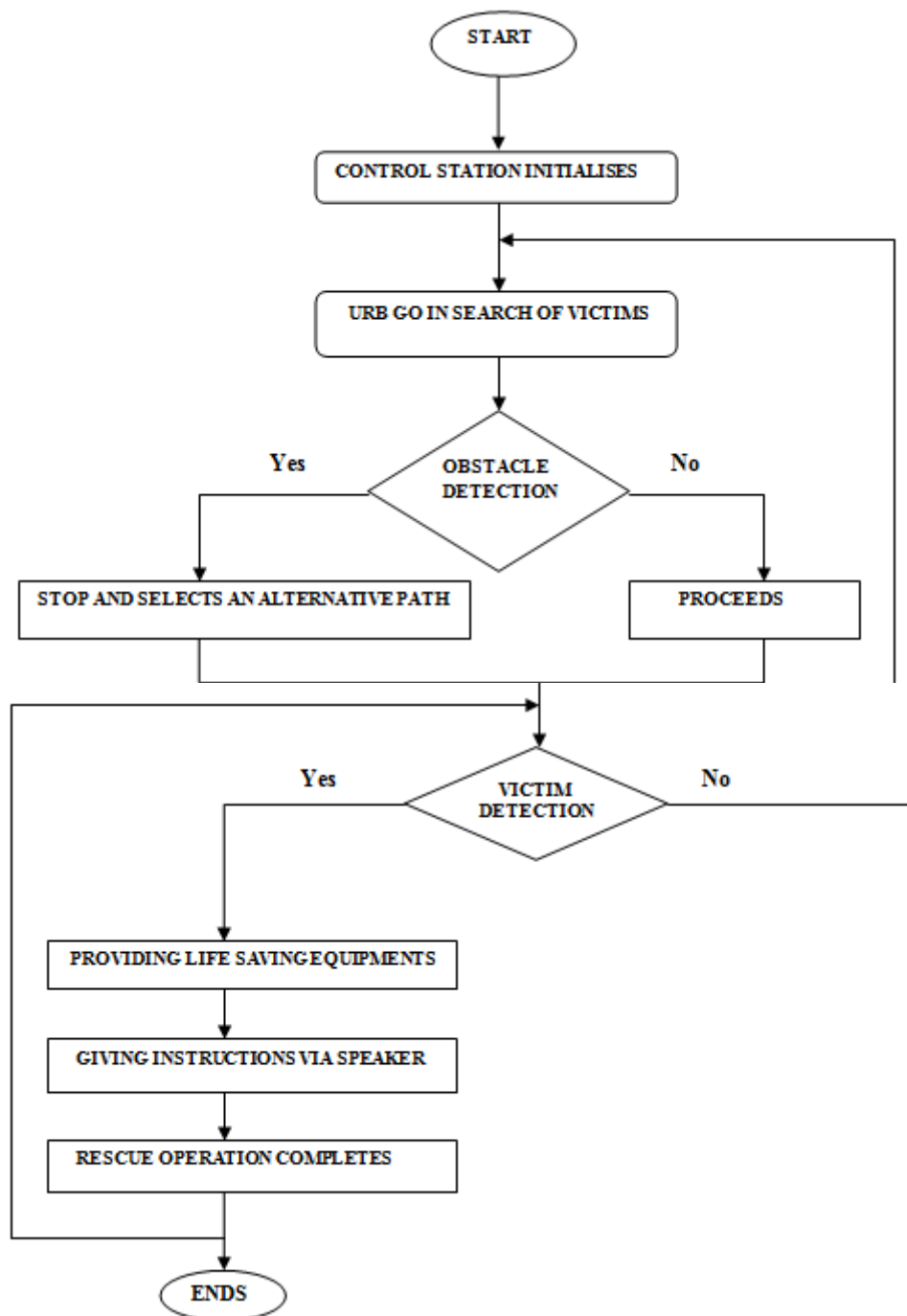
*Control unit*



*Robotic unit*



**C) Flow chart and algorithm**



Flood rescue operation starts with initializing the control station and the robotic unit go for searching the victims. The control unit and robotic unit exchange information through RF communication. The surveillance camera that is placed in the robotic unit is turned on, so that the operator can view the video images and control the direction of the boat accordingly using joystick. The URB starts searching for trapped and isolated people according to the operator's instructions. On the way, if there is any obstacle for the boat movement, it will stop at a safe distance and then takes an alternative path to resume searching for victims. URB go on for searching until human presence is detected in the live video image or by using PIR sensor. When a human presence is detected, the robotic arm that is attached to the boat will be able to supply the life saving equipments, first aid box and food packets to the victim. The operator can also give safety instructions to the victim via a speaker. After ensuring the safety of the victim, URB proceed forward for searching another victim.

### 3. RESULT AND DISCUSSION

For an object to float on the water surface, it must be sink enough to displace a volume of water equal to its own weight. For example, if a Boat is used to carry three people, their fishing gear and outboard motor and a supply

of food, which becomes a total weight of about 500 kg, then the boat must be made long and large enough to displace 500 kg of water without sinking below the water level. The heavier the material used to build the bottom, the larger the boat has to be. That is the total load that can be handled by unmanned robotic boat depends on the buoyancy. If there is a need of additional load Occupancy, additional bogies floats can be placed in the bottom region of the boat in order to increase the surface area. More the surface area, more will be the volume. Therefore the capacity of the boat can be increased. The prototype of unmanned robotic boat can bear approximately 1kg distributed load. In real case hydraulic Motors and Hydraulic pumps are used instead of Servo Motors. The mechanical design of URB depends on the factors like angle arrangement, the force exerted on water, the position of centre of gravity, properties of the materials, design constraints etc.

Unmanned robotic boat can bear maximum weight that is equivalent to the weight of the water displaced by the boat. That is the total load to be handled by the boat depends on the buoyancy. The amount of the load can be increased by increasing the area of the hull. Here the balance of weights from side to side must also be arranged to lessen the danger of Capsizing, the combined center of gravity of all weights must be sufficiently low in the boat. If other factors make it necessary that the centre of gravity be high, then the chance of Capsizing must be offset by increasing the width of the hull. URB consists of a Servo Motor having capacity of 9g and it can make a force of 1.2 kg/cm acting at a radius of torque.

*Table .1 Comparison Table*

<b>PROTOTYPE URB</b>	<b>PRACTICAL URB</b>
Range is 100 m	Range is 7 km
Arm length is 15 cm	Arm length is 6 m
Max capacity boat can hold is 1kg ( distributed wt)	Max capacity boat can hold is 400 kg
Servomotors are used	Hydraulic arms are used
Capacity to lift 1.2 kg/ cm	Capacity to lift 1tonne (1000kg)
Frequency used is 433 MHZ and 315 MHZ	Frequency used is 2.4 GHz and 5.8 GHz
Battery powered	Both battery and solar energy can be used

#### 4. OTHER APLICATIONS

URB can be used for harbor surveillance, as it becomes more significant to safeguard ports and sea-route against unwanted intruders. A number of IP cameras are needed to monitor an important area from different positions. URB cruising in the harbor area with the camera onboard can take pictures at expected position and transmit it through the wireless LAN to the control station. URB can be equipped with advanced instrument for water quality sampling and it can transmit the result data to the control station immediately after the analysis. For collecting the water samples, a sampling system should be installed in the URB which consists of containers, tubes, and valves.

#### 5. CONCLUSION

URB are vehicles that operate on the surface of water without a crew. Therefore it is a safer rescue vehicle to operate under different environmental conditions. It can operate in fully autonomous mode or remotely operate from a control station. It can dramatically cut costs for ocean research, border security, water quality sampling and harbor surveillance by installing different appliances and instruments in Unmanned Robotic Boat [4]. URB are more stable and offers more mission functionality because of enough speed, endurance, survivability under bad flood conditions, enough payload capacity, reliable communication with its control station on/off shore and enough communication range. They are more cheaper than commercial ships and it can be made as a day and night operation equipment when the IP camera is replaced with thermal camera. Therefore it can be concluded that Unmanned Robotic Search and Rescue Boat is an efficient water vehicle capable of performing distinctive missions.

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