Self - Stabilizing Boat by Using the Principle of Gyrostabilizer

[1]Minikumari G, [2]Parthasarathy B.M , [3]Abhijith S, [4]Kavya M. S, [5]Badeea Mohammed Ibrahim
[1]Assistant professor, [2,3,4,5]B. Tech. Student, [1,2,3,4,5]Department of ECE, College of Engineering Attingal, Kerala, INDIA.

***Abstract*— Every job has its own risks and importance. One of the most risky jobs in our society is fishing. The climatic conditions of oceans are unpredictable. There are many accidents being reported in deep oceans on every month. Most of these accidents occur due to the instability of boats in ocean. Not much attention given towards the safety of fisherman and no efficient life saving mechanism to ensure their safety in these adverse conditions of oceans. This paper deals with maintaining the stability of small boat in the cheaper way. In this paper we introduce a system for achieving stability of boat by using the principle of gyrostabilizer. It also enables system to track the position of boat when the accident occurs by using GPS module and sending SMS using GSM module**.

***Keywords*— Gyrostabilizer, GPS module, GSM module, Stability , Accidents, Unpredictable .**

I. INTRODUCTION

The life of each human being is important. Everyone is linked with land, water and air, either for transportation or occupation .There are many life saving mechanisms are use there in land including helmets and seatbelts. In air also there are air jackets and belts are used for save the life of human beings. But in water except the lifejackets there is no lifesaving mechanisms are exists in cheaper way. Reporting of accidents is increased in day by day due to the instability of boats and the unpredictable climatic conditions. Even though the accidents are occurred in deep oceans, there is no efficient way for communicate it with the concern authorities in shores. Some life saving mechanisms still exists but it is costly. So it cannot be implemented in small fishing boats. By solving these issues we can assure the safety in the life of fisherman. In order to reduce the accidents in Deep Oceans, first we need to maintain the stability of boats. In this paper we propose the system to maintain the stability of boat by using simple gyrostabilizer. If the accidents are occurs beyond the stability in oceans, we can send the SMS along with the position of boat to the concern authorities within no time. In this way we can save the life of fisherman to a particular extent.

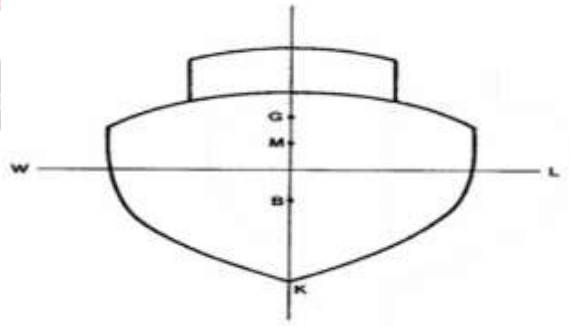
II. LITERATURE REVIEW

A. Principles behind the stability

According to Archimedes principle, the physical law of buoyancy, states that anybody completely or partially submerged in a fluid (gas or liquid), at rest, is acted upon by an upward, or buoyant, force, the magnitude of which is equal to the weight of the fluid displaced by the body. Gravitational forces are acts downward which is distributed along the body's length and the buoyant forces act vertically upwards on the body.

According to law of floatation, the buoyancy and gravitational force are acts on same vertical line with equal magnitude as the body is immersed on liquid at rest.

A boat is always acted upon by several external forces like winds, tides etc. So it is important to maintain the stability of boat in all conditions.



When the body of weight (W) is immersed on water, volume of displacement of water (Δ) is given by the expression;

$$\Delta = W / pg$$

Where p is the mass density of the fluid and g is the acceleration due to gravity.

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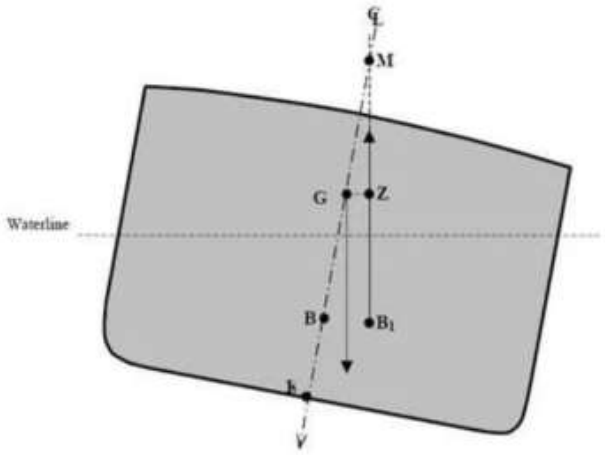


B is the centre of buoyancy, G is the centre of gravity and M is the metacentroid.

When an external force is applied and removed, in order to maintain the boat in stable position, centre of gravity (G) should remain below metacentroid (M).ie, for maintain the stability of boat, metacentric height (GM) should be positive and if it is negative the boat will moves to unstable condition. When boat is inclined, centre of buoyancy shifts from B to B1, which creates a movement and righting lever returns the boat to original position and make its stable position.

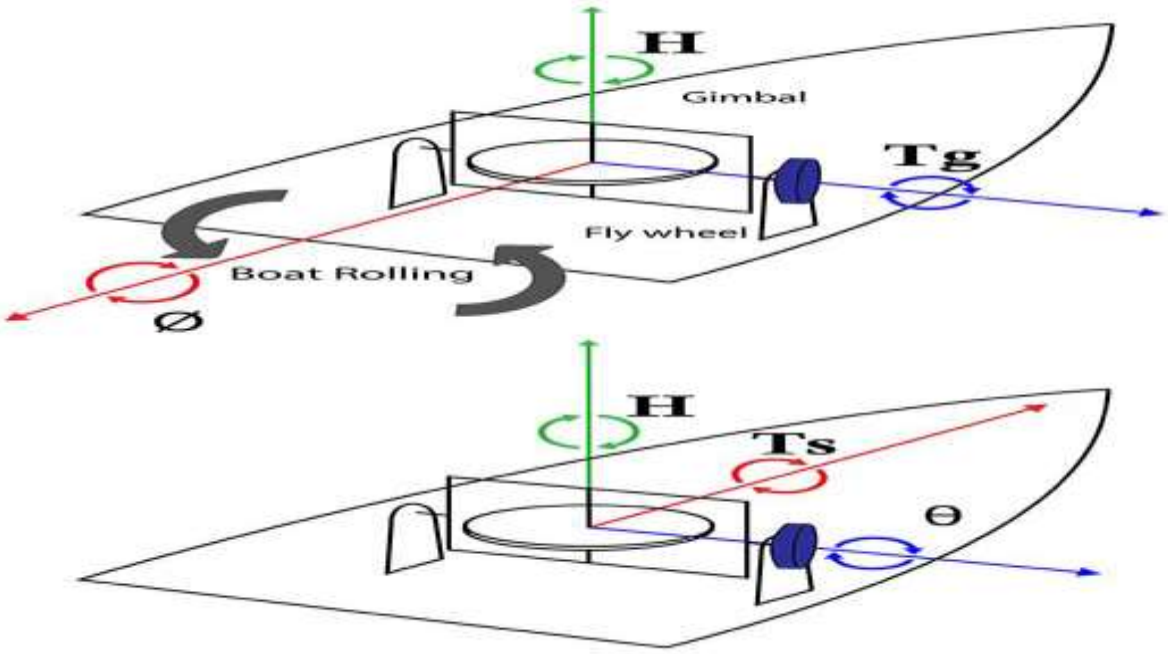
B. Principles behind the Gyrostabilizer

A gyroscope is comprised of three different axes: spin, input, and output. The spin axis is the axis about which the flywheel is spinning and is vertical for a boat gyro. The input axis is the axis about which input torques is applied. For a boat, the principal input axis is the longitudinal axis of the boat since that is the axis around which the boat rolls. That is the gyro will rotate about this longitudinal axis also known as a transverse axis in reaction to an input. This system functions similar to a spinning top. As the rotational speed increases, the tendency to stand straight and maintain an upright position increases.

If the rotated Gyro is inclined sideways, which generates the Gyro force to incline it toward the front and rear direction. This is the principal of the Gyro scope. Angular momentum H of flywheel and roll angular velocity **Φ** produces gyro torque **Tg** in accordance with the Gyro principal. **Tg = H x Φ .** 'Tg' would rotate the gimbal with angular velocity

TI = Tg/C . On the other side, H and TI produce suppression torque Ts also in accordance with the gyro principal. Ts=H x T. Then, Ts acts as suppression torque with proportional to boat rolling angular velocity Φ .

Ts= (H^2/C) xΦ .



III. PROPOSED SYSTEM

A gyrostabilizer is a device which is used to maintain balance based on the principle of angular momentum. The block diagram of gyrostabilizer is shown in figure 1 .The main component of the gyrostabilizer is the flywheel. Flywheel exhibits both longitudinal and latitudinal motion. In our system, longitudinal motion is performed by using BLDC connected to the top of flywheel and latitudinal motion by two servo motor that placed on two sides of flywheel. When the flywheel is rotated at high speed, energy in the form of torque is generated. The energy generated on flywheel can be explained by the equation;

E=I(w)2.

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Where **I** is the moment of inertia and **w** is angular velocity.

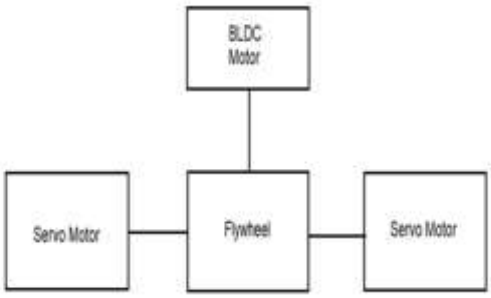

Figure 1: Block Diagram of Gyrostabilizer

By increasing the concentration of mass on outside the body, we can increase moment of inertia and thereby increase the energy. But it is practically difficult to produce hollow structure. So we increase the angular velocity of flywheel by using the BLDC to rotate as 10000 rpm. The energy produced within the gyrostabilizer by rotating the flywheel can be used to overcome the tilt or roll occurs to the boat in its opposite direction. The front view of gyrostabiliser is in figure 2.

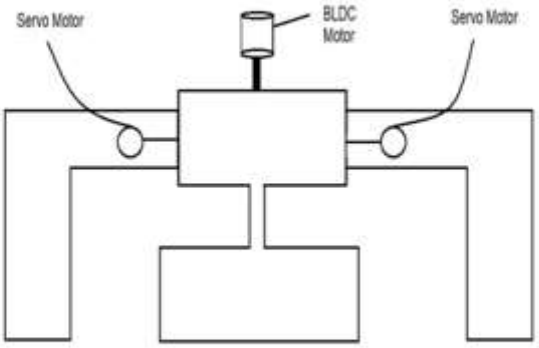

Figure 2: Front view of gyrostabilizer

The block diagram of the proposed system is shown in figure3. Initially there exists small tilt to the boat which is offered by the waves as the boat moves forward. This system is initialized with the threshold roll offered by the boat due to the waves in oceans. The gyroscopic sensor is used to calculate the roll of the boat. If the angle of roll to the boat is within the threshold value of angle, the system stabilizes by using the gyrostabilizer.

Gyrostabilizers consist of rotating flywheel, BLDC motor and servo motor and control mechanism. In this system, we use Brush Less DC (BLDC) motor to rotate the flywheel at the rate of 10000 rpm and Electronic Speed Controller (ESC) to control the speed of gyrostabilizer. BLDC will exhibit longitudinal motion, at the same time two servo motors are also attached with the flywheel for to and fro motion in gyrostabilizer. When flywheel rotates in high speed, the energy is generated and by using that energy we can stabilize the boat in opposite direction to the tilt offered by the waves to the boat. By using breaking mechanism, we can employ the locked and unlocked positions of gyrostabilizers.

If the roll of the boat is beyond the threshold level, this system can't have the ability to stabilize the boat. Then message regarding accident along with the position of boat will be send by GSM module .

Figure 3: Block Diagram of proposed system

IV. ANALYSIS OF ROLL OFFERED BY THE BOAT

The design of the boat for our proposed system is shown in figure 4.

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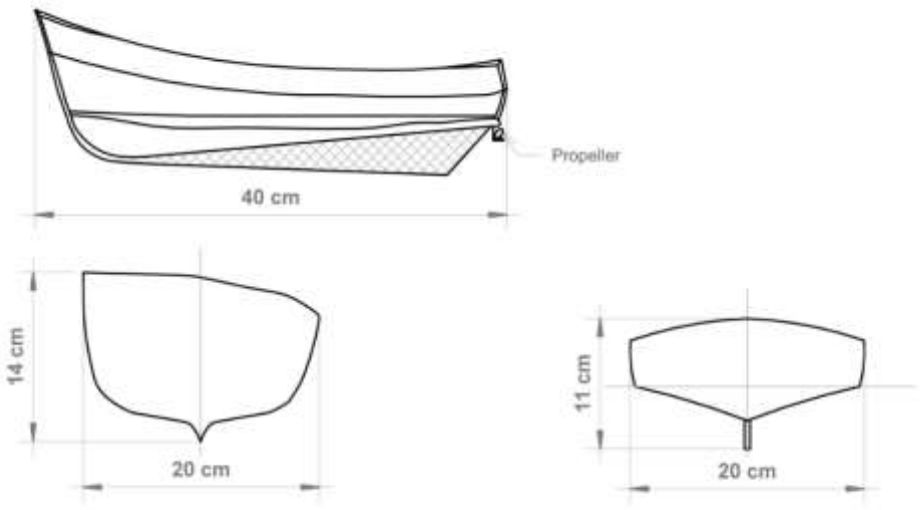

Figure 4: Design of boat

This is the semi displacement type boat. The length of the boat is 40cm, breadth is 20cm and the height is 11cm. Height of the boat above water level is 6cm and below the water level is 5cm.

The threshold roll offers by the waves to the boat can be explained by using the figure 5.

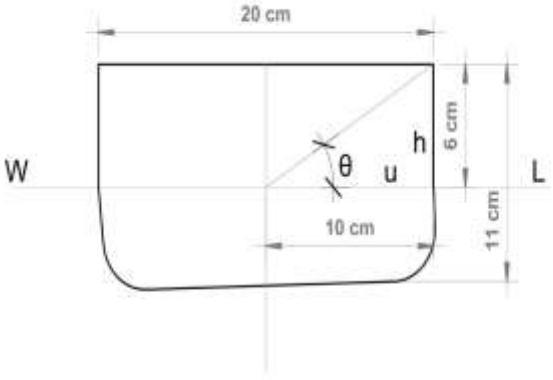

Figure 5: Section of the boat

h is the height of boat above the water level.

U is the half breadth of the boat.

$\tan(\boldsymbol{\theta})=(h/u)$

$\boldsymbol{\theta = \tan^{-1}(h/u)}$

$\boldsymbol{= \tan^{-1}(6/10)}$

= 30 degree

That is, if the roll of the boat is within 30 degree, we can stabilize the boat by using our proposed system. If the roll of the boat is beyond 30 degree, water will enters to the boat and destroys its stability. So by using our system emergency message along with the position of the boat is send to the concern authorities.

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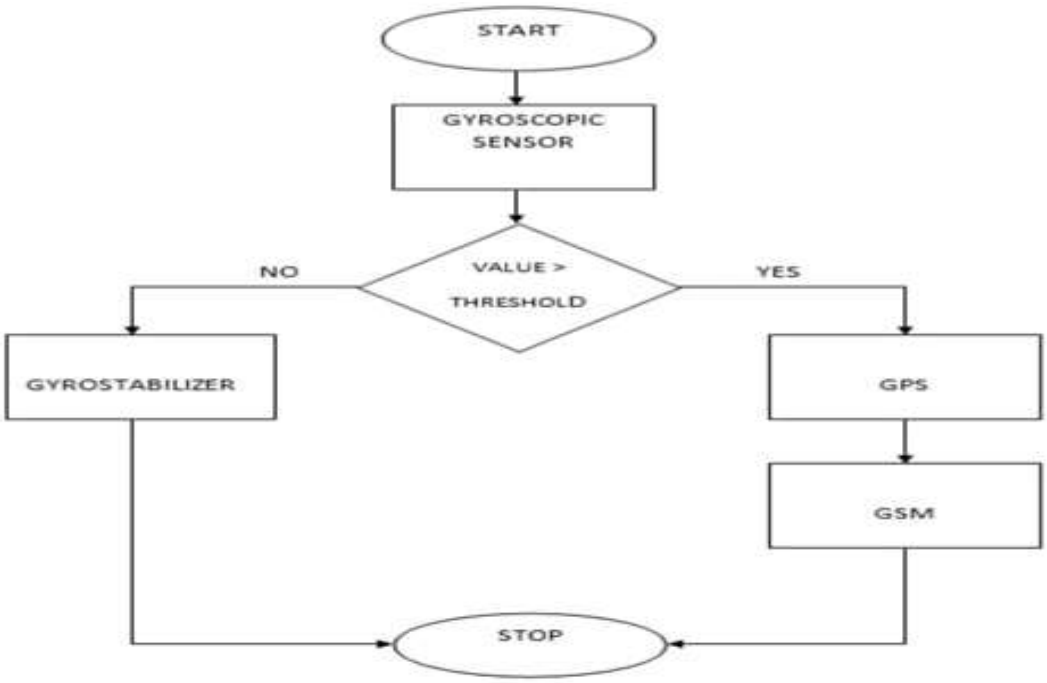
FLOW CHART



V. CONCLUSIONS

The life of fisherman in the deep oceans is very risky one. We do not pay much attention to improve the life condition of fisherman in oceans. Our project is a lifesaving mechanism to save the life of fisherman. Most of the accidents occurs in deep oceans are due to the instability of boat. According to our proposed system if the roll of the boat is within 30 degree, we can stabilize the boat by using the principle of gyrostabilizer .Otherwise water will enters to the boat and destroys its stability. So by using our system emergency message along with the position of the boat is send to the concern authorities. By implementing our project it is very useful to fisherman who goes deep into the ocean to save their lives and to communicate with concern authority in a cheaper way.

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