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Development of Economical Overload Detection System for Maritime Vehicles in Bangladesh

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ABSTRACT

Developing nations are a victim of numerous maritime accidents each year, and a large portion of which are due to overloaded vehicles causing casualties and loss of properties. Current methods for detecting overloaded vehicles are sensor based and image processing based systems but they are sometimes significantly expensive or their analysis and problem detection are excruciatingly complex. Therefore, keeping the economic prospects in mind, in this research endeavor a simple overload detection system is designed and developed that is very low-cost and can be manufactured by using locally available materials. The system developed is mainly for the maritime vehicles of Bangladesh but if it is tested with commercial cruise/cargo ships, then it can prove its effectiveness for much wider range of ships.

1. Introduction

Maritime accidents - an unfortunate term but a highly important topic to consider, because in third world countries, numerous casualties occur due to maritime accidents and because of poverty mass people of these poor countries have no alternative to ferry travel. There are many news and papers reporting the spread of these accidents in most of the third world countries and showing the dreadful aftermath of these accidents (*Bangladesh?s worst ferry disaster claims nearly 200 lives, 2001, Over 100 dead as ferries capsize, 2003, Ferry disaster claims hundreds, 2003, Ferry sinks in Bangladesh, 400 feared dead, 2003, Hope fading for 78 still missing after Indonesia ferry sinking: officials, 2015*) . Even in the 21st century there have been, on average, over 1,000 fatalities per year (Lawson, 2005). The causes to these accidents are many but the measurements taken to avoid and/or prevent them are meagre. Although a considerable portion of these accidents take place due to the attitudes of the operators, there are several other reasons such are unfitness of a vehicle, overloading, collisions, disasters etc. (Islam and Degiuli, 2015). Among these major reasons overloading has been the culprit for 20% of the accidents (Huq and Dewan, 2003). From the launch disaster statistics for Bangladesh (1977-2000) we can verify this information as among 140 accidents 28 has been caused by overloading (Z. I. Awal, 2007). If a broader time span is taken into consideration (1975-2009) we can see overloading has been the reason for 24.9% of all accidents (AZAD, 2009). Even the accidents that occur due to collision has some link to overloading (Zobair Ibn Awal, 2007). In the developed countries the systems used to detect this overloading are often not used in third world countries mostly because of their price, complexity and need of skilled engineer. Other so called innovative features also adds more complexity and have requirement for additional measuring devices (Xie et al., 2012; Rahman and Rosli, 2014). In a nutshell, this work is an approach to develop and test the performance of an economically viable overload detection system with pipe and float mechanism to address the problem that has been the culprit behind at least one of every five maritime accidents occurring in third world countries like Bangladesh.

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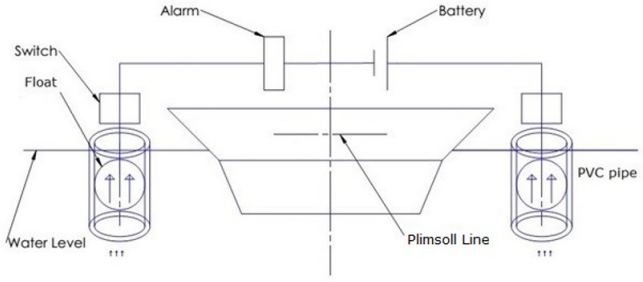
2. Materials and Method

The entire system is made up of plastic material and few electronics items. The parts chosen for the system are readily available and the system can be reproduced easily without expertise. The system has altogether 8 components which are: PVC pipe, Floats, Strainer, Rubber Insulation, Switch, Alarm, Battery and Wires. The schematic is shown in Figure 1 and the electric circuit is shown figure 2. The system works in an easily comprehensible manner - in the overloading point of a particular vehicle, the float will rise up through the cylinder, touching and pressurizing the switch of the circuit, therefore completing the simple electric circuit with an ordinary power supply which will turn the alarm on and concern the respective authority ? prohibiting them from overloading the vehicle. The mechanism is explained in figure 3(a), 3(b) and 3(c). The overloading point is known by observing the Plimsoll line (Taylor, 1996; Tupper, 2004). The pipes were attached to the rectangular vessel with tapes and glues as shown in figure 4, in case of actual vessel this can be replaced with industrial glues. The function of the strainer is that it prevents debris to enter into the cylinder with the water, and also holds the floats in the cylinder in normally loaded condition. The rubber insulation is glued in the top of the cylinder. It supports the switch, and prevents it to get in touch with water, thus saving the electric circuit. The switch used in this experiment was soft touch type as the buoyancy force from the floats are not enough to activate a normal push-button switch even though 4 table tennis balls were used as floats in each cylinder. Although we have included an alarm in the system, experimentally we used an LED bulb for visually expressing the overloaded condition. The 3D model of the setup is shown in figure 5(a), 5(b) and 5(c).

Figure 1: Overload Detection System with Pipe and Floats



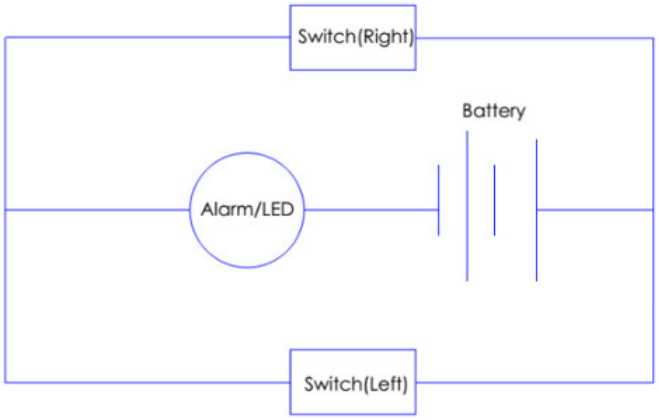
Source: Authors.

2.1. Mechanism of the System

The system is installed with the vessel concerned and modified such that the circuit activates when the uppermost float touches the switch with a certain amount of pressure. At the initial condition i.e. normally loaded situation, the floats rest at the bottom of the cylinder, on the strainer.

When the vessel starts to become loaded, it goes downward into the water. Simultaneously, water enters the cylinder, and the floats rise through the cylinder towards the switch. At the overloaded condition, the uppermost ball touches the switch, and the circuit becomes complete. Thus, the alarm is activated.

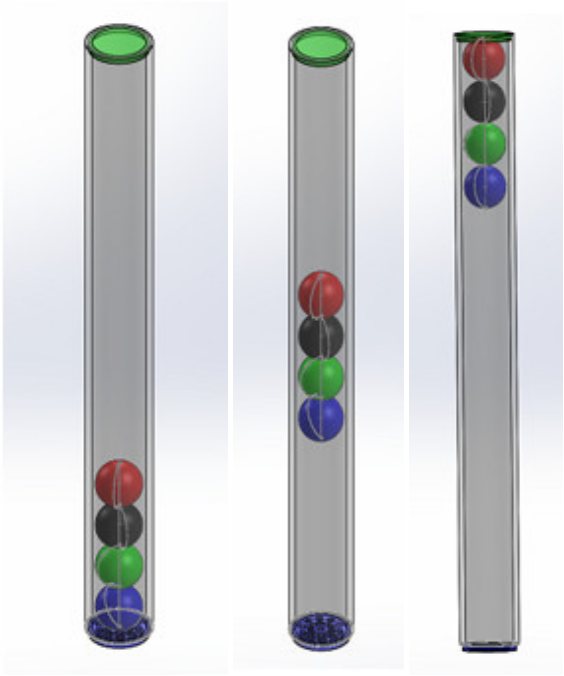
Figure 2: The Electric Circuit of the System



Source: Authors.

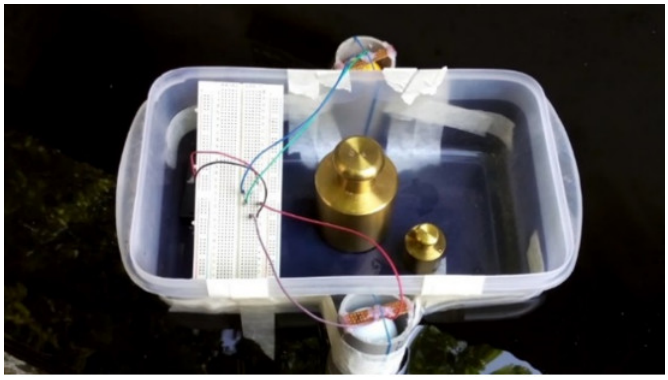
After the alarm is activated, the cause of overloading is removed, and the floats go down again. The uppermost ball gets disconnected from the switch, and the switch goes to OFF state. As a result, the alarm is deactivated.

Figure 3: Multiple images



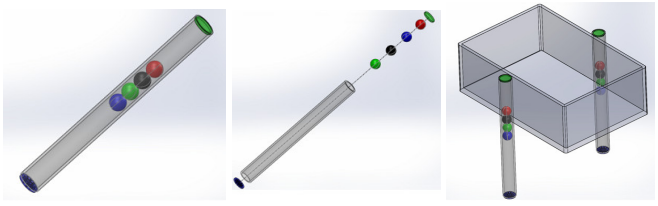
(a) The Initial (Normal Loading) Condition.
(b) The Vessel is Being Loaded Gradually, and the Floats Are Going Upwards.
(c) The Overloading Condition, in which the Uppermost Float Touches the Switch
Source: Authors.

Figure 4: Images of the Pipe and Floats System with the Model vessel and Loads



Source: Authors.

Figure 5: Multiple images



(a) (b) (c)

(a) The Pipe and Floats System.
(b) Exploded View of the Pipe and Floats System.
(c) A Model Vessel with Two Pipe and Floats Systems Installed

Source: Authors.

3. Results

The entire setup was tested in a cistern and loads were applied gradually from 10 grams to maximum 2200 gram and vice versa in case of unloading. The activation of LED light is considered overloaded and the off condition is considered not-overloaded, while blinking condition is considered in the verge of overloading (limiting value). Loads after the overloading point are only taken as a check for system stability/error and are omitted from the table. Table 1 represents the response of the system during loading and table 2 during unloading.

Table 1: Response of the Overload Detection System during Loading

No. of Obs.	Load Applied (grams)	Status of Overload Indicator LED Light	Overload
1	2060	OFF	No
2	2070	Blinking	Yes
3	2080	ON	Yes
4	2090	ON	Yes

3.1. Cost Analysis of the Pipe and Floats System

One of the objectives of this project was to make the system cheap so that mass inclusion of the system to maritime vehicle is possible. From the data in table 3 we can say that this project has fulfilled its objective.

Table 2: Response of the Overload Detection System during Unloading

No. of Obs.	Load Applied (grams)	Status of Overload Indicator LED Light	Overload
1	2090	ON	Yes
2	2080	ON	Yes
3	2070	Blinking	Yes
4	2060	OFF	No

Table 3: Expenditure of the Pipe and Floats System

Name of the Component	Material	Number of Component	Cost in USD (Model Level)	Cost in USD (Prototype Level)
Floats/Floats	Plastic	8	2	5
PVC Pipe	Plastic	1	0.625	3.125
Glue	-	1	0.125	2
Filter	Plastic	1	0.25	1.25
Rubber Insulation	Rubber	1	0.25	1.25
Switch	-	1	0.125	0.625
Alarm	-	1	0.25	15
Battery	-	2	0.25	1.25
Wires	-	4	0.25	1.25
	Total	20	4.125 $	30.75 $

Discussion and Conclusion

From the experimental data we can say that the system works effectively when the water level is steady but the same can?t be said for unsteady water level as it was not tested. Percentage of error is 0.48% which is very accurate but this should be measured for actual prototype vessel before implementing this system. The vessel used in the experiment was of rectangular shape thus the pipes attached to the vessel was vertical, but in case of actual maritime vehicle the pipe has to be attached in inclined manner. This effect of change of orientation of the pipes on the system performance has to be tested before commercial use. The system developed has many advantages and its advantages outweigh the limitations. Some major advantages are low cost, easily manufacturable, easy assembling and dismantling, compact, immediate response and no alteration of the structure is required. But the simplicity in the structure of the system may damage it in adverse weather condition. We positively hope that the overall consideration of the depth of this research and representation of this findings and ideas be well-accepted and applied to the respective field.

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