# A Study on Risk Response against Ship Fire using Robot

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***Abstract*— It is endeavoring for sea safety and fire[1] at sea prevention solidifying control of standard technology and safety supervision aspect in IMO[2] but sea accident and ship fire are happening continuously. Because using Robot in artistic talent of ship in this treatise, studied that correspond to Risk and manage. Attach fire perception sensor for Robot's Risk confrontation, and because using infrared rays sensor, TOUCH SWITCH, sound perception sensor, gas perception sensor, light perception sensor that is threaded in Robot and is achieved, controlled Robot, and establish Low-High value the speed of sound output use and DC MOTOR and COM SEN of when indicate Risk confrontation to Robot and establish Robot's Risk confrontation administration action.**

***Index Terms*— IMO (International Maritime Organization), Ship Fire, Robot, Risk Response, Fire Sensor.**

## I. INTRODUCTION

**ACCORDING** to Article 2 of the Disaster Management Act, disaster, fire, collapse, explosion, transportation accidents, chemical or biological incident, such as environmental pollution accidents in people's lives and property damage could have been defined as an accident. Except for natural disasters, traffic accidents, automobile accidents, boat accidents, aircraft accidents, broken down.

The fire ships and vessels of high-loaded cargo, passengers and crew sank into the sea of life and property can be. Ship fire, especially as the fire quickly spread throughout the vessel is stopped by vessel function. The ship is operated by the sea or lake water is difficult to escape, because unfavorable conditions for ship fire precautions should made adequate precautions and escape.

Table 1 Occurrence of marine accidents in 2006 and 2010 for different types of accidents recorded on the table.

Fire on ship incidence of accidents does not differ greatly related to the Total tonnage of the ship or type, compared to other accident incidence rates of deaths is much higher situation. The ship fires are showing growth, unlike other accidents.

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In this paper, research to respond Risks which may occur when Ship on fire Using Robot Technology recently developing, with operating robot.

Especially, for Ship's fire prevention and Pre-detection operate sound detection, smoke detection, gas detection and light detection sensor of the robot. Is the value from a sensor, and infrared (IR) sensors as the icon moves through the port of Robot Risk and Response Management through the sound output by turning on and DC Motor Robot's movement and obstacle avoidance operate.

TABLE I
STATUS OF MARINE ACCIDENTS
(BY ACCIDENT TYPE)

| Type | Crash | Sink | Fire Explosion | Engine Damage | Casualties | Etc | Total |
|---|---|---|---|---|---|---|---|
| 2006 | 104 | 33 | 21 | 10 | 11 | 3 | 182 |
| 2007 | 96 | 32 | 18 | 17 | 4 | 1 | 168 |
| 2008 | 94 | 36 | 23 | 8 | 9 | 2 | 172 |
| 2009 | 91 | 39 | 17 | 13 | 11 | 1 | 172 |
| 2010 | 99 | 54 | 16 | 18 | 16 | 2 | 205 |
| Total | 385 | 140 | 79 | 48 | 35 | 7 | 899 |

In this paper, I. Risk of fire from two vessels respond to the need of managing the operation of the Robot, II. Related research vessels in the growth of the fire and auto navigation devices, etc. III. Risk of fire support by Robot Ship Management operates the fire sensors and robots to respond to respond through the Risk, IV. Conclusions and future research were.

## II. RELATED WORKS

### *2.1. Growth of the fire in ship*

The cause of the fire and the fire growth process are similar to the land, but it is only one to evacuate from ship to a safe place with using Extinguishing systems and evacuation of the ship. Evacuate at sea is limited at the space and facilities so it demands more time and has low success rate. Therefore, when the ship fires, fire suppression and fire growth rate is very important.

Fire growth is typically reach the maximum temperature in 2-3 minutes, As shown in Figure 1, it shows the difference at heating rate in order of from the Top center to the Bottom center. This is due to rising of generated fire and combustible gas to the ceiling and as time passed, falling to the floor so for Overall, fire grows larger. Therefore, on the Ship, The fire performance evaluation method is different about Bulkhead[3], ceiling, interior material, the surface of the floor material and the first deck coatings. At the Ship fire, not only generated heat but also the density of smoke and toxic is important. It is difficult to escape a fire in early is due to not easy to find Shelters because of the occurrence of excessive smoke, and killed by toxic gas. Therefore, In the FTP (Fire Test Procedures) Code of Part 2 of Annex 1 uses The value of smoke density and toxicity are divided into Bulkhead, ceiling, interior material, the surface of the floor material and The first deck coatings.

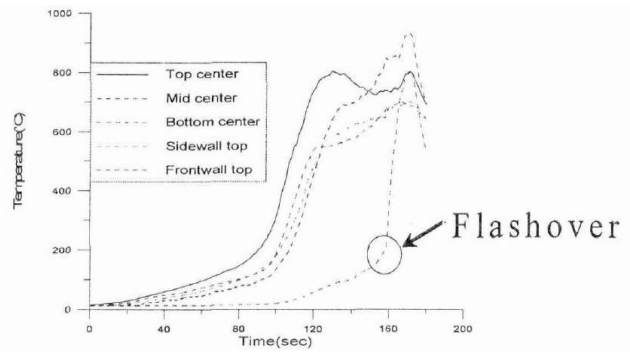


Fig. 1. Growth curves of ship fire.

*2.2. Ship's Navigation System*

Navigation System Automation is an important part in the bridge, the boat at the center of the system to determine the various environmental factors, including weather, considering you need to navigate to the destination system is composed of [4].

*2.1.1. Marine Positioning Systems*

■ boat measuring system

Boat navigation, and astronomical navigation, the measuring system, such as fingerprints using traditional navigation and radio navigation systems that measure the location for the Loran-C and GPS for satellite navigation is of such systems [5].

■ boat Estimation System

Bad weather, instrument failures etc. be at longer intervals when measuring boat, meanwhile, were seeking precisely the location of the algebraic system by measuring how the speed and yaw rate and yaw of the earth by measuring methods and by the inertial navigation how.

*2.1.2. ENC (Electronic Chart) system*

Electronic charts for navigation on the screen if necessary basic information on the boat at the show here to be plotted automatically by means of safe navigation was essential. Mounted on the electronic chart is mandatory vessel IMO (International Maritime Organization) in stages from 2008 to 2012 in the electronic chart system (Electronic Chart Display System) is expected to enforce the of the mounting.

The components of electronic chart is composed with ECDB (Electronic Chart Data Base), ENC (Electronic Navigational Chart), SENC (System Electronic Navigational Chart), ECDIS (Electronic Chart Display and Information System).

*2.1.3 Setting the system routes*

An experienced captain or navigator, the number of data and literature information or weather information at any time based on the same port and port of departure route linking the idea, and if you obtain from the real Way Point the Way Point for each distance and orientation to obtain a work. Figure 2 shows the direction of the magnetic compass is a sensor.

Currently using satellite GPS (Global Positioning System) navigation system, equipped with auto-ship using the electronic chart can be done simply became.

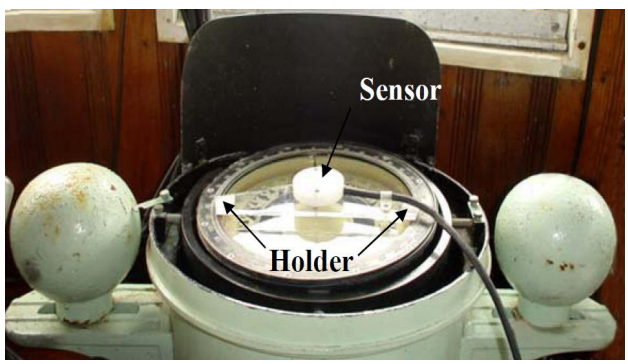


Fig. 2. Magnetic compass direction sensor.

*2.1.4. Route tracking and monitoring system*

Automatic navigation by automatically steering the boat along the route have been set to ensure the hull is a system for automatically controlling movement. Following route from the position sensor provides a way point or sail a boat and then on the destination and the relationship Figure 3 as calculated by the PID control to modify the yaw steering is done by machine automatically entered.

$$\phi_S = \phi_R - (a_1 L_D + a_2 \frac{dL_D}{dt} + a_3 \int L_D dt$$

Fig. 3. Magnetic compass direction sensor.

Here, Ø S recommended route (Recommended ship's route) and, Ø R planned route (Direction of Scheduled Route), and the distance from the planned route deviation (Distance Deviation from the Scheduled Route) is. a1, a2, a3, respectively, proportional, derivative, is an integrating factor.

Following the course of the surveillance system, escape routes and way point approach to the automatic alarm occurs. Also, heading error monitoring, and depth measurements using the sensor information and issued a warning to avoid stranding.

## III. RISK OF FIRE SUPPORT BY ROBOT SHIP MANAGEMENT

### *3.1. Mount of Temperature, Spark, Smoke Sensors in dangerous zone*

Electrical short circuit at the ship's navigation equipment, faulty wiring, etc. If the spark occurs periodically, and heat, the temperature increases. Ignition temperature is reached, ignition and heat through combustion of materials, light, smoke, fire is born.

Thus, operate Spark sensor in a relatively high risk areas for Possibility of fever, to warn the risk of ship fire for more than the limited value. Especially, the smoke sensor and light sensor through Heat are react immediately, Should be launched in early fire suppression and fire prevention.

### *3.2. Operation of Gas sensors, fire sensors and webcam mounted fire detection Robot*

Risk of fire prevention and detection of ships and for corresponding Robot, created as shown in Figure 4 gas sensors, fire sensors are installed. And risk sites, view real-time fire for the values obtained by mounting a webcam again to determine the robot's behavior to be used as input for the reasoning system should.

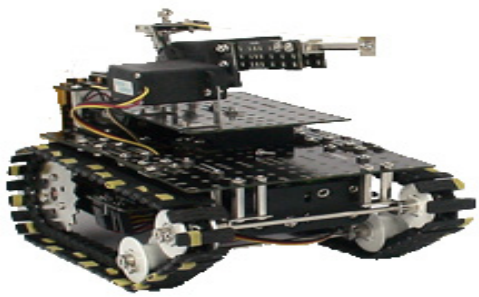

Fig. 4. Fire monitoring and web camera mounted robot.

Made based on expert system rule base needs to be done by a Robot behavior patterns are determined, Robot's behavior patterns to perform the following functions.

· Temperature sensing: measure the temperature and the value of the specified temperature and delivers more value and responsive.
· Spark detection: electrical short circuit, fire due to be delivered spark detection and value.
· Gas Detection: Fire risk exposure of the gas is detected.
· Crime detection: movement and purpose in the event of an emergency case to convey to monitor.
· Web cam screen pass: Robot equipped with the webcam, video screen, or the value passed to the central server, to monitor the appearance of the scene can show.
· Fire Detection: Smoke and fire detection using the light sensor's value is a function[6].
· Users direct control: the user has a PDA and a robot can be controlled directly from the outside can be reported as a PDA or server[7].

### *3.3. Sensor nodes operating and moving for fire detection*

Ship fire temperature sensor for monitoring the fire, sparks sensors mounted on the risk areas of the ship. Sensor values recognized by the Zigbee[8] sensor and RFID (Radio Frequency Identification) tags and monitored through the Robot will be forwarded to headquarters. Robot via the RF transmission risk of fire in the area will be an autonomous mobile.

When met with obstacles on the road with a 4 to Robot Obstacle Avoid using IR sensors will be driving. Robot of the motor driving and IR sensors for obstacle avoidance for the purpose of the ATmega128 are controlled. Two MCU (Micro Controller Unit) on the server PC and the TCP / IP sockets for communication AP (Access Point) to use a USB webcam attached S3C2440 ARM9 processor embedded board and is connected to the serial. Surveillance video from the incoming board of the AP's Ethernet port and the associated TCP / IP socket communication to the monitoring PC and server PC to transfer video from the video and the Robot Robot's current position and the position of the current real-time monitoring will be.

The Robot in the moving DC motor encoder values are self-aware and so-called Feedback Odometry method is used. Some have actually moved Odometry method error is caused by using the PID control to compensate.

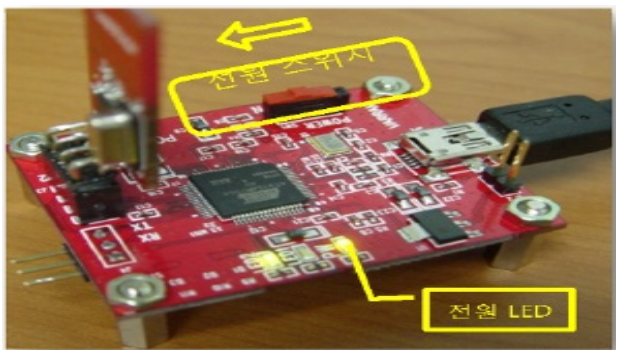


Fig. 5. USB port setting of Robot's identified value of the location.

Robot's position in Figure 5, the USB port is set up to determine the value. So we have adjusted the position of Robot to indicate the coordinates are set randomly, the coordinates of the touch screen whenever you move as well as on an embedded board, coordinates, even on the server PC can also be sent to the server PC Robot's current location in real time so that you know Was.

*3.4. Risk Response of Robot's Sensor*

Figure 6 Robot ship from the point of ignition of a fire ship and mounted sensors for Risk Response and Risk for robots to respond to the instructions when each port (port) to perform each instruction is an icon and the contents do.

Equipped with infrared sensors that are performed in Robot icon is the port number 4. TOUCH SWITCH icon port number is 7. Sound detection (MIC) sensor mounting port number is 5 icons. Gas sensor mounting port icon is number 6. Light sensor icon mounting port is 3. Users use a keyboard on the remote can control the Robot, and images that the user specifies a particular color to use when the icons are applied.


Fig. 6. Robot's entering value about Risk respond.

*3.5. Robot's Perform of Risk response Management operation*

Figure 7 shows the ship's fire response of Robot Risk management and performance information for the icon shows. Sound Output (BUZZER) the port number used by 8 Buzzer: 0 → Buzzer OFF, Buzzer: 1 → Buzzer ON is. Servomotors (SERVO MOTOR) The use of Sel: 0 → moved from side to side using a servo motor, Sel: 1 → to move up and down using the servo motor and Position: 0 ~ 180 → is the value of the angle of the servomotor.


Fig. 7. Risk management response of robot.

The use of DC MOTOR Sel: 0 → left DC motors are used, Sel: 1 → right DC motor is used, Speed: 0 ~ 100 → forward rate is the value, Speed: -100 ~ 0 → reverse is the speed value. COM SEN: If the sensor in the case of dividing the number of Low ~ High values can be set. COM Vision: Find Color COM Vision and X-axis in the region by setting the number of case can be made. STATION: In response to the sensor input to configure the behavior or any other application, set the color trace.

## IV. CONCLUSIONS

*A. Final Stage*

We ship to fire prevention, detection, tracking Robot to attach two sensors for Risk and Response, Robot is equipped with infrared sensors that are performed, TOUCH SWITCH, sound sensors, gas sensors, light sensors, using Robot was the control. Risk response actions for the execution instruction, when used with voice output SERVO MOTOR, DC MOTOR COM SEN in the Speed and Low ~ High Risk of Robot by setting the value set using the corresponding management action in response to Risk of fire, the ship was. After the incense as the study, after experimenting with actual fire on board the vessel the actual Robot for Fire Risk Management Plan and the corresponding experiments and studies are needed to analyze.

## REFERENCES


[1] Dong-Chan Kim, Man-Eung Kim, Dae-Hwan Jo and Young-Ho Lee, "Ships on the prevention of fire disasters," Korea Society of Marine Engineers, Nov. 2002.

[2] Seong-Yoon Kim, "IMO FTP Code Amendment Study," Korea Society of Marine Engineers, Chapter 33 No. 2, pp.221-225, Mar. 2009.

[3] Seong-Yoon Kim, Dong-Seok Kim, Byoung-ho Ahn and Ho-Seong Noh, "The ship's bulkhead, ceiling and floors of interior and surface fire safety evaluation methods," Journal of Marine Environment and Safety, Chapter 25, pp.157-159, May. 2007.

[4] Gyae-Kak Park, "The ship automation and marine safety information system's Present and Future," Journal of The Magazine, Article 11, pp.46-60, Nov. 2007.

[5] Gwang-Seop Go and Chang-Muk Choi, "GPS information using the ship's Study on Improving Defense," Korea Institute of Maritime Information and Communication, Section 9, Issue 3, pp.528-533, 2004.

[6] Gi-Ju Lee, Tae-Hyoung Kim, Gang-Rae Seo, Geun-Taek Gang and Won-Chang Lee, "Using a wireless sensor network surveillance system integrated fire," Korea Journal of Intelligent Systems, Chapter 18, pp.245-248, Oct. 2008.

[7] Hyoung-Rae, Woo-Gyeong Choi, Sung-Hyun Kim, Yong-Min Kim and Hong-Tae Jeon, "Using a portable intelligent home service robot control device," Korea Journal of Intelligent Systems, Volume 14, pp.48-51, Oct. 2004.

[8] Jung-Hun Lee, Dea-Woo Park and Eung-Sik Kim, "A study of Assessment and Certification of Power u-IT Fusion Hybrid Unit," The Korea Maritime Institute of Information and Communication, Chapter 13, No. 11, pp2433-2440, 2009.


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