DEVELOPING A RELIABLE AND AUTONOMOUS MAN-OVERBOARD DETECTION SYSTEM

MARSS
EXTRASENSORY PROTECTION

MAN-OVERBOARD: A MARSS WHITE PAPER

IT IS A SAD REALITY THAT ACCORDING TO THE US COAST GUARD FROM JANUARY 2006 TO MARCH 2018 305 PEOPLE WERE LOST OVERBOARD (MOB) FROM CRUISE SHIPS. THIS IS AN AVERAGE OF 25 INCIDENTS PER YEAR.

This is not just a tragedy for the individuals involved but also for their families as well. In many cases the bodies are not recovered and the circumstances of the incident remain unknown.

Rescue rates are very low at only 16.7% compared to the US Coast Guard Search and Rescue (SAR) goal of 77%. Unless there is an eye-witness that raises the alarm, crew remain unaware that an individual is lost overboard and therefore the exact location of the incident is unknown making successful rescue unlikely. MOB events are typically not discovered until several hours, if not days after they occur and often not before the vessel docks at the next port.

Not only is this a human tragedy but there is also a financial cost. It is estimated that for a typical search in US waters, the US Coast Guard will incur costs in excess of $9M in searches over vast areas of sea with limited chances of success.

According to US Coast Guard data, 75% of incidents happen at night. Knowing exactly when and where an incident occurs vastly increases the chances of success in SAR operations. Therefore, the desirability of an 24 hour effective alert system has become an increasing priority for both legislators and vessel operators.

LEGISLATION

As a consequence of these concerns, in 2010 the US Congress passed the Cruise Vessel Security and Safety.

Act (CVSSA) which applies to all US cruise ship operators and all foreign cruise ships operating within US waters. The Act states that "The vessel shall integrate technology that can be used for capturing images of passengers or detecting passengers who have fallen overboard, to the extent that such technology is available."

The choice of whether to install a full MOB system or just CCTV has until now fallen to the Cruise operators, however the Cruise Passenger Protection Act recently suggested amending the act to require operators to install both systems.

In January this year, the International Organization for Standardization (ISO) issued a Publicly Available Specification (PAS): Ships and marine technology — Systems for the detection of persons while going overboard from ships, the first step to the implementation of a full International Standard.

EXISTING SOLUTIONS

Whilst this is progress, the fact remains that eight years after the Act was passed, MOB systems are not routinely fitted to cruise ships. So why not?

The primary problem facing the cruise ship industry and technology providers is the harsh maritime environment in which cruise ships and other vessels operate. Heavy rain and wind conditions, extremes of high and low temperatures, sea spray and fog all contribute to the challenges of detection. These conditions have meant that existing MOB technology has proved unreliable.

Due to their dialogue with the cruise ship operators the US Coast Guard in their Preamble Section IV entitled *"Comments on 2011 Notice" (See 80 Fed. Reg. 2351-2352), concluded that "given that the industry view is that fall detection technology is not yet reliable under marine conditions, we expect that owners and operators will select the image capture option provided by Congress until such time that fall detection technology is believed to be sufficiently reliable."*

Consequently, industry has concentrated on improving their infrared and CCTV systems. Whilst these improvements in image capture systems have resulted in providing enhanced forensic data for criminal and MOB incidents, they have not led to the hoped-for improvements in immediate detection and survival rates in MOB incidents. In fact, the number of incidents has steadily increased.

Most of technology vendors have developed automated MOB detection based on video analysis only, but because of the complex environment and the video-specific problems like for example sun glare and moving background, in addition to the weather conditions mentioned above, performance is challenged.

A RELIABLE SYSTEM

In light of the above, MARSS have developed MOBtronic, a fully automated system that instantly detects and classifies a human falling overboard a vessel or structure.

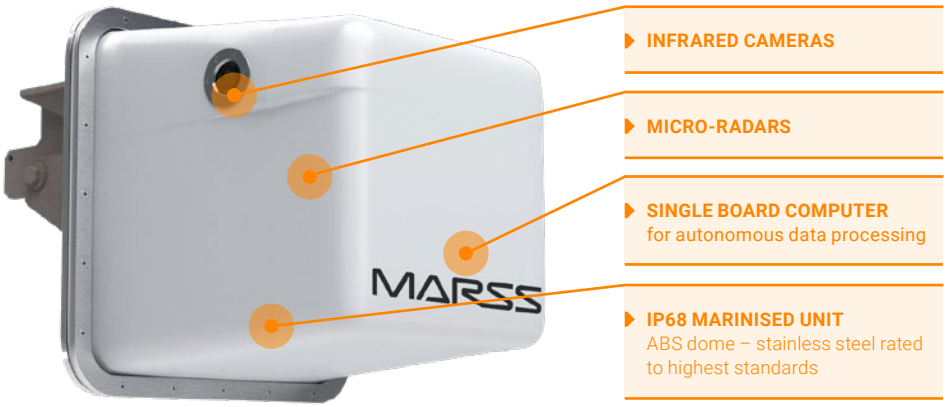

FIG.1
MOBtronic uses a multi-sensor, multi-layer approach providing complimentary data merged and analyzed by means of proprietary sophisticated algorithms.

A robust system with highly reliable probability of immediate detection and acceptably low nuisance activation rates, MOBtronic can pinpoint both the onboard location from which a person fell, for example the deck level or cabin and the exact GPS and chart location of the fall, making identification and recovery of the missing person quicker.

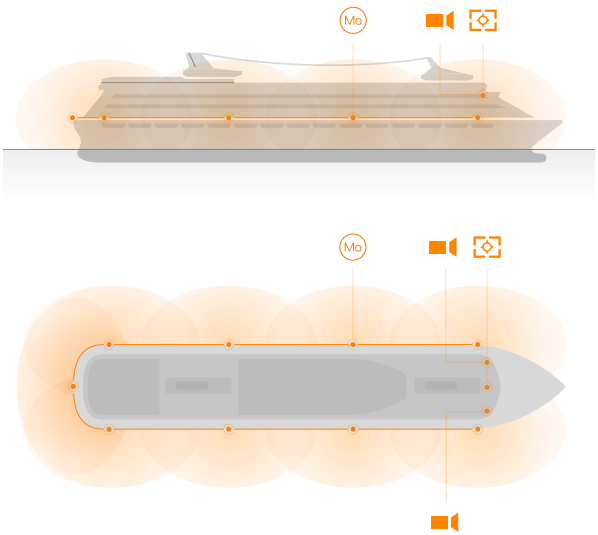

FIG.2
MOBtronic units are positioned around the perimeter of the vessel providing coverage of the entire hull.

The value of a system like this in terms of instant detection of a MOB incident is immeasurable and can make the difference between successful recovery of a person who falls overboard and ultimately a person's life or death. A Navy client has chosen MOBtronic to protect crew onboard a new vessel for deployment in some of the harshest sea conditions in the world.

EXTENSIVE TESTING

The MARSS MOBtronic system is the result of eight years of research, development and experimentation, including an uninterrupted five-year evaluation trial on board a cruise vessel sailing around the world and additional installations on operating vessels.

FIG.3
MOBtronic has undergone extended and rigorous testing with more than 7000 jumps over eight years.

The research and development challenges were obvious from the very beginning: ensuring very high probability of automatically and immediately detecting persons falling overboard, while keeping nuisance activations (e.g. due to waves, water spray, rain, objects thrown overboard, etc.) under acceptable levels.

Testing showed that systems based on a single technology (e.g. image capture via CCTV and infrared, radar or laser) could not guarantee the desired performance levels. MARSS identified the best combination of technologies available on the market.

MOBtronic has undergone extended and rigorous testing with more than 7000 jumps over eight years, from different test platforms (including different cruise ships, ferry boats and even buildings and bridges). Fall dynamics were analysed by recording and automatically detecting real human jumps and the effect of target sizes were investigated by employing both adult-size and child-size training manikins.

The effects of a full spectrum of weather and sea conditions have also been evaluated on the pilot project cruise vessel installation that lasted over a period of five years and included multiple worldwide tours. During this extended test, MOBtronic has experienced nearly all possible weather conditions, from hot and humid climates in the Caribbean, to gale force winds and 10 metre swells in the North Atlantic in winter.

A MULTI-LAYERED APPROACH

To achieve the best possible results MOBtronic uses a multi-sensor, multi-layer approach providing complimentary data merged and analysed by means of proprietary sophisticated algorithms to maximize the probability of detection and minimize nuisance activations.

FIG.4
The MARSS five-layer decision hierarchy leverages sensor redundancy for highest reliability.

1. **FIRST DECISION LAYER – RADAR DETECTION**
   Potential human falls are detected by high resolution microwave radars. MOBtronic radars do not have the typical limitations of optical or InfraRed systems (e.g., poor image quality in case of fog/high humidity, sun glare, unstable horizon), have proven more reliable than LIDAR technology (in terms of capability of detecting and tracking falling objects, maximum detection range and operations in humid climates) and operate in nearly all possible weather conditions. Radars monitor the volume around the ship and track moving objects. As soon as a potential track of interest (i.e., falling human or other object) is detected, it is passed to the next layer.

2. **SECOND DECISION LAYER – RADAR CONFIRMATION**
   A second radar layer monitors the same volume. If a track is confirmed, it is then passed to the next decision layer.

3. **THIRD DECISION LAYER – BEHAVIOUR ANALYSIS**
   The behaviour of the confirmed track is analysed (based on speed, fall direction, shape, strength) to flag a MOB track. MOB tracks are passed to the next decision layer.

4. **FOURTH DECISION LAYER – VIDEO ANALYTICS – MULTI-SENSOR MERGING**
   MOB radar tracks are further classified based on their infrared signature by combining video imagery information with radar information such as range, speed and position. The combination of radar and video allows analysis of object shape, size, and orientation, which would be otherwise impossible if range information was not available (i.e. in video-only systems). Confirmed alarms are passed to the next decision layer.

5. **FIFTH DECISION LAYER – CREW**
   Within few seconds after the event, a video replay of the event is presented to the operator who can review and analyse the video, enabling visual confirmation of the alarm.

The five-layer decision hierarchy leverages sensor redundancy for highest reliability, as well as multi-sensor technology for increased awareness and maximum effectiveness in the most difficult operating conditions.

INTUITIVE USER INTERFACE

The intuitive MOBtronic command and control interface presents clear radar and video evidence for immediate identification and verification by the crew, while tracking of the victim at sea supports rapid response.

FIG.5
MOBtronic pinpoints the exact location of a fall tracking the object in real time to and aid crew in coordinating search and rescue operations.

The alarm view shows details of a fall event including infrared video. A live video stream is immediately displayed from the camera with the best view of the detected fall. When the event video is instantly loaded, the live video stream view switches to a video replay of five seconds before the fall and five seconds after so the operator has full control to replay, pause, rewind the video for confirmation.

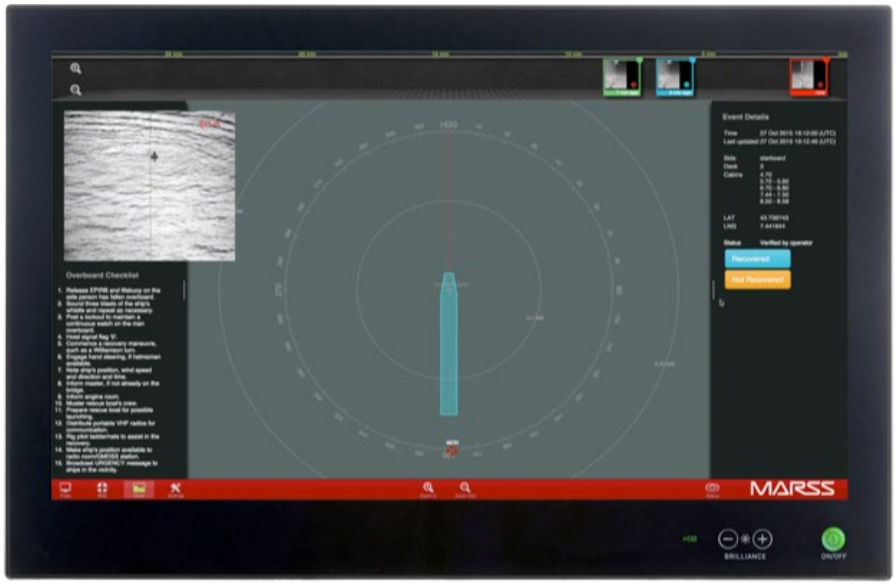

FIG.6
MOBtronic pinpoints the exact location of a fall tracking the object in real time to and aid crew in coordinating search and rescue operations.

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SUMMARY

MOBtronic provides real-time alerts to a vessel bridge team within seconds of a fall so that search and rescue efforts can be launched immediately. This is achieved with less than 0.3 nuisance activations per day (well below the PAS required standard of less than 1 nuisance activation per day), thus boosting operator's confidence in the system.

Furthermore, all of this is undertaken without requiring additional crew to separately monitor the system as it is integrated as part of the existing bridge system display.

Depending on environmental conditions and installation layout, MOBtronic achieves 95% probability of detection, giving those passengers unfortunate enough to find themselves overboard, the very best chance of survival.

COMPANY BACKGROUND

MARSS develops innovative marine and land-based solutions for asset protection and saving life using integrated sensor surveillance and proprietary software. Our systems combine a multi-sensor approach with integration software, open-source intelligence and artificial intelligence to deliver real time analysis and increased situational awareness.

Our technology leadership is founded on over 10 years of research and development collaboration with the European Union, defence agencies, NATO, academia and industry.

MARSS products include NiDAR, RADiRguard and MOBtronic.

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