

METHOD AND SYSTEM FOR PROGRAMMABLE PRESSURE ACTIVATED FLOATATION TRIGGER DEVICE

Field of the Invention

5 This invention relates to a system and a method for a floatation device. More particularly, this invention relates to a system and a method of activating a floatation device. Still more particularly, this invention relates to a system and a method of activating a trigger device to inflate a floatation device.

Prior Art

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 In the maritime and shipping industries, millions of workers are employed for ship repair, oil rig construction, ship forwarding, etc. Accidents such as vessel collision happen very suddenly which result in workers being unable to respond or react accordingly. The Workplace Safety and Health Council has reported on The Business Time, May 21, 2013
15 that the marine sector is one of the top three contributors in term of number of fatal incidents. Hence, it is important that workers working in the marine sector are provided with a life vest that is easily activated as and when required.

 Still further, in water sport activities such as sailing, rowing and motor boating,
20 participants are required to wear a life vest for safety reasons. Various types of life vests are available. One typical inflatable life vest that is commonly used in the maritime and shipping industries and water sports participants includes an air chamber with an inlet coupled with a canister. In order to activate the inflatable life vest, the user only needs to pull a cord to puncture the canister such that gas in the canister escape into the air
25 chamber and thereby inflating the inflatable vest. However, studies have shown that during emergencies, the user is in extreme duress and hence, it is a challenge to the user

to even locate the cord. Therefore, there are known apparatus that uses depth sensors to automatically activate a life vest. However, reliability is a concern.

In another known inflatable life vest as described in Singapore patent number 169596, trigger device is provided to puncture the canister. In particular, the trigger mechanism of the trigger device includes a paper diaphragm, a miniature motor pump with internal reservoir to shoot out jets of water to disintegrate the paper diaphragm for activating canister. However, one common issue is that the miniature motor pump is unable to accurately shoot out the water to disintegrate the paper diaphragm. Hence, there is a reliability concern on the use of such a trigger device.

Therefore, those skilled in the art are striving to provide an improved apparatus and method that provides a more reliable activation of a life vest.

Summary of the Invention

The above and other problems are solved and an advance in the art is made by trigger device in accordance with this invention. A first advantage of a trigger device in accordance with this invention is that the trigger device provides the flexibility and intelligence needed for enhancing the existing life vests, without affecting the current functionalities of life vests or other floatation devices. A second advantage of a trigger device in accordance with this invention is that the trigger device allows easy connectivity to the existing life vests. Hence, this avoids incurring additional cost for producing a new life vest. A third advantage of a trigger device in accordance with this invention is that the trigger device allows configurable depth setting to suit different mode of operations. Hence, the trigger device can be used by different organisation. A fourth advantage of a trigger device in accordance with this invention is that the trigger device automatically inflates the life vest as and when required. This ensures that lives would not be

compromised at all times, especially since the users are likely to be under duress when they fall or jump into water during accidents or emergencies. A fifth advantage of a trigger device in accordance with this invention is that the trigger device is not bulky and easy to install. Inevitably, the trigger device is not obstructive when used on a life vest.

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In accordance with an aspect of the invention, a trigger device for inflating a life vest is provided in the following manner. The trigger device for activating a canister coupled to a life vest, the trigger device comprises a pyrotechnic, a circuitry, and a housing adapted to house the pyrotechnic and circuitry. The circuitry comprises a battery,
10 a water probe sensor, a pressure depth sensor, a fall detection sensor, a pyrotechnic actuator in communicatively connected to an igniter of the pyrotechnic, a processing unit having a processor and memory, The memory comprises instructions executable by the processor to analyse input received from each of the water probe sensor, pressure depth sensor, and fall detection sensor, and activate the pyrotechnic actuator based on a result
15 from the analysis.

In accordance with an embodiment of the invention, the processing unit is fully switched on in response to determining a fall via the fall detection sensor. In accordance with an embodiment of this embodiment, the instructions to analyse input received from
20 each of said water probe sensor, pressure depth sensor, and fall detection sensor are provided in the following manner. First, the water probe sensor determines whether water is being sensed on the probe of the water probe sensor. In response to determining water being sensed on the probe of the water probe sensor, activates the pyrotechnic actuator. In accordance with another embodiment of this embodiment, the instructions to analyse
25 input received from each of said water probe sensor, pressure depth sensor, and fall detection sensor are provided in the following manner. First, the fall detection sensor determines the trigger device falls above a predetermined distance. In response to

determining said trigger device falling above said predetermined distance, activates the pyrotechnic actuator.

In accordance with an embodiment of the invention, the processing unit is fully switched on in response to determining water on a probe of said water probe sensor. In accordance with an embodiment of this embodiment, the instructions to analyse input received from each of said water probe sensor, pressure depth sensor, and fall detection sensor are provided in the following manner. A depth of the trigger device is determined via the pressure depth sensor. If the depth is below a predetermined depth, the pyrotechnic actuator is activated.

In accordance with an embodiment of the invention, the water probe sensor comprises three water probes for sensing water and impedance. In accordance with an embodiment of this embodiment, the instructions to analyse input received from each of said water probe sensor, pressure depth sensor, and fall detection sensor are provided in the following manner. First, water and impedance are determined on at least two of the three water probes. In response to determining water and impedance on at least two of said three water probes, executes a first setup mode. After the first setup mode is executed, further determines whether water and impedance are sensed on at least two of said three water probes. In response to determining water and impedance on at least two of the three water probes after end of the first setup mode, executes a second setup mode. Preferably, the first setup mode is changing of a predetermined depth threshold and the second setup mode is changing of a mode of operation.

In accordance with an embodiment of the invention, the processing unit further comprises a wireless transmitter. In accordance with an embodiment of this embodiment, the trigger device further comprises a Global Positioning Unit (GPU) having a wireless

receiver, a processor, a memory, a Global Positioning System (GPS) module, a light and sound beacon, a water probe sensor, and a long distance Radio Frequency (RF) transmitter. The memory has instructions executable by the processor in response to sensing water on the water probe sensor. The instructions executable by the processor
5 comprises receiving a signal from the wireless transmitter, receiving coordinates via the GPS module, transmitting the coordinates via the long distance RF transmitter, and activating the light and sound beacon at intervals.

Brief Description of the Drawings

10 The above and other features and advantages in accordance with this invention are described in the following detailed description and are shown in the following drawings:

Figure 1 illustrating a known life vest;

Figure 2 illustrating a trigger device in accordance with embodiments of this
15 invention being incorporated on a known life vest;

Figure 3 illustrating a housing of the trigger device in accordance with an embodiment of this invention;

Figure 4 illustrating a pyrotechnic in accordance with an embodiment of this invention;

20 Figure 5 illustrating a circuitry in accordance with an embodiment of this invention;

Figure 6 illustrating a processing unit in accordance with an embodiment of this invention;

Figure 7 illustrating an architecture of GPU in accordance with an embodiment of this invention;

25 Figure 8 illustrating a flow diagram of a first mode of operation performed by the circuitry in accordance with an embodiment of this invention;

Figure 9 illustrating a flow diagram of a second mode of operation performed by the circuitry in accordance with an embodiment of this invention;

Figure 10 illustrating a flow diagram of a third mode of operation performed by the circuitry in accordance with an embodiment of this invention;

5 Figure 11 illustrating a flow diagram of a process for changing the threshold of depth and mode of operation in accordance with an embodiment of this invention;

Figure 12 illustrating a flow diagram of a process for transmitting of location performed by the GPU in accordance with an embodiment of this invention.

10 Figure 13 illustrating a cross sectional view of the trigger device in accordance with an embodiment of this invention; and

Figure 14 illustrating another cross sectional view of the trigger device in accordance with an embodiment of this invention.

Detailed Description

15 This invention relates to a system and a method for a floatation device. More particularly, this invention relates to a system and a method of activating a floatation device. Still more particularly, this invention relates to a system and a method of activating a trigger device to inflate a floatation device

20 It is envisioned that a system and a method in accordance with embodiments of this invention may be used for floatation devices such as a life vest. In particular, the system and method incorporates various sensors to activate a floatation device. This ensures that the floatation device is activated as and when required.

25 Figure 1 illustrates a known floatation device 100. Floatation device 100 includes a pneumatic vest 110 having a piston regulator 150, strap 120, a reinforced patch 140, a canister 130 coupled to the reinforced patch 140 and piston regulator 150. The canister

130 has an outlet coupled to an inlet of the piston regulator 150 and the pull cord 160 is coupled to the piston regulator 150 such that pulling the pull cord 160 causes the piston in the piston regulator 150 to puncture the canister 130. With the canister 130 punctured by the piston, gas in the canister 130 escapes out of the canister 130 and into the pneumatic vest 110 through the piston regulator 150. A paper diaphragm trigger mechanism 180 is also coupled to the piston regulator 150 to puncture the canister 130. In particular, paper diaphragm trigger mechanism 180 comprises a paper diaphragm that disintegrates upon contact with water and in turn triggers a mechanism to puncture the canister 130. In other words, there are two ways to puncture the canister 130, namely pulling the pull cord 160 or disintegrating the paper diaphragm in the paper diaphragm trigger mechanism 180.

Figure 2 illustrates a trigger device 170 in accordance with embodiment of this invention to activate the canister 130. As shown in figure 2, trigger device 170 is coupled to the piston regulator 150. Essentially, the activation of the canister 130 is via the trigger device 170 or pull cord 160. In other words, the trigger device 170 replaces the paper diaphragm trigger mechanism 180. Briefly, the trigger device 170 comprises a housing 300, a pyrotechnic 400, and a circuitry 500. Further details of the housing 300, pyrotechnic 400, and circuitry 500 will now be described as follows.

Figure 3 illustrates various views of the housing 300 of the trigger device 170, namely top view 301, left side view 302, right side view 303, front view 304 and rear view 305. The housing 300 includes a pyrotechnic housing 310 and a circuitry housing 320.

The circuitry housing 320 has an extension 330 extending from a surface of the circuitry housing 320. The pyrotechnic housing 310 is coupled to the circuitry housing 320 via the extension 330. The extension 330 defines a passageway therein in order for the circuitry housed within circuitry housing 320 to be communicatively connected to a

pyrotechnic actuator housed within the pyrotechnic housing 310. A bracket 340 is provided to secure the pyrotechnic housing 310 to the circuitry housing 320. The circuitry housing 320, pyrotechnic housing 310 and bracket 340 are separate components that are secured together. Sealant may be used to ensure that the joints between each of the components are completely secured such that water is not allowed to seep into the housing 300. One skilled in the art will recognise that the circuitry housing 320, pyrotechnic housing 310 and bracket 340 may be unitarily produced without departing from the invention.

A panel 350 is provided on a top surface of the circuitry housing 320. The panel 350 comprises LED indicator 361, first water probe 362, second water probe 363 and third water probe 364, first 7-segment LED 365, second 7-segment LED 366, and an opening 367 for pressure depth sensor.

The first, second and third water probes 362-364 are flushed with the surface of the panel 350 to prevent water from stagnating on the surface of the first, second and third water probes 362-364. First, second and third water probes 362-364 are arranged apart from one another. Further, first and second water probes 362-363 are spaced apart from third water probe 364 such that first and second 7-segment LEDs 365-366 are between second water probe 363 and third water probe 364. Such arrangement of the first, second and third water probes prevents unintentional triggering of the water probes.

LED indicator 361 is a single tri-color LED that is provided for indicating the battery life. The first and second 7-segment LEDs 365-366 are typical LED display for displaying hexadecimal digit. A pair of 7-segment LEDs 365-366 is used for displaying a range of numerals from 0-99.

One skilled in the art will recognise that any other number of LED indicators, 7-segment LEDs and water probes may be provided on the panel 350 without departing from the invention and the exact number of LED indicators, 7-segment LEDs and water probes is left to those skilled in the art. Further details pertaining to the LED indicator 361, first and second 7-segment LEDs 365 and 366, and first, second and third water probes 362-364 will be described below.

The pyrotechnic housing 310 comprises a first part 311 and a second part 312. The first part 311 houses the main body of the pyrotechnic 400 while the second part 312 houses the plug of the pyrotechnic 400. The second part 312 defines a cavity 370 for connecting the trigger device 170 to the piston regulator 150.

Figure 4 illustrates the pyrotechnic 400 housed within the pyrotechnic housing 310. The pyrotechnic 400 comprises pyrotechnic compound 410, a plug 420, an igniter 430 and a choke 440. A housing 450 houses the pyrotechnic compound 410, a plug 420, an igniter 430 and a choke 440. The pyrotechnic 400 as illustrated in figure 4 only aims to show the main elements of a pyrotechnic 400 used of the trigger device 170. Hence, figure 4 may not be a true representation of the pyrotechnic 400 to be used on the trigger device 170.

A commercially available pyrotechnic such as the METRON™ actuators may be used on the trigger device 170. Such actuator produces a high mechanical work output through rapid movement of a piston. It is electrically actuated and will operate within milliseconds of receiving the appropriate impulse that is a rate which is almost impossible to achieve with a mechanical source of energy.

Pyrotechnic actuation is an accepted methodology used in automotive airbag and other safety gadgets. Hence, the use of pyrotechnic to activate the canister to inflate the life vest inevitably ensures the reliability and safety standard are adhered. It is noted that the pyrotechnic 400 is readily available in the market and hence, is only briefly described
5 herein.

Figure 5 illustrates the block diagram of circuitry 500 housed within the circuitry housing 320. Circuitry 500 comprises a processing unit 510, water probe sensor 520, pressure depth sensor 530, fall detection sensor 540, clock signal 550, and a pyrotechnic
10 actuator 570. The circuitry 500 is driven by the battery 590. Each of the components of circuitry 500 is mounted onto a printed circuit board that provides the required connections between each of the components. Optionally, a Global Positioning Unit 560 driven by battery 595 may be provided.

Processing unit 510 is a system that executes instructions to perform the application described below in accordance with this invention. Processing unit 510 is communicatively connected to water probe sensor 520, pressure depth sensor 530, fall
15 detection sensor 540, and clock signal 550 to transmit and receive information from each of the sensors, clock signal and GPU. Processing unit 510 is also communicatively connected to the pyrotechnic actuator 570 to ignite the igniter 430. Processing unit 510 is
20 communicatively connected to Global Positioning Unit (GPU) 560 via wireless connection to transmit and receive information from GPU. Further details of processing unit 510 will be described below with reference to figure 6.

Water probe sensor 520 is a sensor for detecting the presence of water. The water probe sensor 520 comprises first, second and third water probes 362-364. The use
25 of the water probe sensor 520 is for activating the processing unit 510 upon contact with

water and for configuring the trigger device 170. This minimises the use of battery when the trigger device 170 is not in use. Further details on the activating of the processing unit via the water probe sensor 520 will be described further below.

5 Pressure depth sensor 530 is a commercially available sensor such as Intersema Sensoric SA (Model: MS5541C) for detecting the depth. The pressure depth sensor 530 is communicatively connected to the processing unit to transmit the information pertaining to the pressure. One skilled in the art will recognise that the pressure depth sensor 530 can be any qualified industrial grade sensor for measuring depth without departing from
10 the invention.

 Fall detection sensor 540 is a sensor for detecting a sudden movement. Essentially, the fall detection sensor 540 comprises an accelerometer to measure the speed of movement. The fall detection sensor 540 may be used for activating the
15 processing unit 510 upon detection of a sudden increase in acceleration. This minimises the use of battery when the trigger device 170 is not in use.

 Clock Signal 550 is for synchronising the inputs from the three sensors 520-540 in order to interpret the inputs in real-time. Pyrotechnic actuator 570 is an actuator for firing
20 the igniter 430.

 GPU 560 is a module coupled to the shoulder portion of pneumatic vest 110 and is connected with the processing unit 510 wirelessly. Essentially, GPU 560 is capable of providing the location information and transmitting location data via a RF transmitter.

25 Figure 7 illustrates the architecture of GPU 560. GPU comprises a processor 710, a light

and sound beacon 720, a GPS module, a wireless receiver 740, a water probe sensor 750, a long distance RF transmitter 760, and memory 770.

The processor 710 is a processor, microprocessor, or any combination of processors and microprocessors that execute instructions to perform the processes in accordance with the present invention. The processor 710 has the capability to execute instructions that are stored on the memory 770. Further details of the instructions executable by the processor 710 will be described below.

Light and sound beacons 720 are two separate components for attracting or drawing attention via light or sound. Light and sound beacons 720 communicatively connected to the processor 710.

The GPS module 730 is a module that receives location data such as Global Positioning System (GPS) receiver, Assisted Global Positioning System (AGPS), and Wireless Positioning System. GPU 560 is driven by battery 595 and is wirelessly connectable to the processing unit 510 via wireless receiver 740.

The long distance Radio Frequency (RF) transmitter 760 may be a low-power FM transceiver that is connected to an antenna configured to transmit outgoing data signals over a radio communication channel. The radio communication channel can be a digital or analogue radio communication channel. The long distance RF transmitter 760 is for transmitting the position data received from the GPS module 730.

Similar to water probe sensor 520, water probe sensor 750 is a sensor for detecting the presence of water. The use of the water probe sensor 750 is for activating

the processor 710 upon contact with water. This minimises the use of battery 595 when not in use.

One skilled in the art will recognise that GPU 560 may also be configured to be part of circuitry 500. However, to avoid the GPU 560 from draining the battery 590, GPU 560 is being configured as a separate module driven by battery 595.

Figure 6 illustrates an example of a processing system 600 in the processing unit 510. Processing system 600 represents the processing systems in the processing unit 510 that execute instructions to perform the processes described below in accordance with embodiments of this invention. One skilled in the art will recognize that the instructions may be stored and/or performed as hardware, firmware, or software without departing from this invention. Further, one skilled in the art will recognize that the exact configuration of each processing system may be different and the exact configuration of the processing system executing processes in accordance with this invention may vary.

Processing system 600 includes a processor 610, a memory 620, an audio module 630, wireless transceiver 640, I/O ports 650, battery monitor 670, a LED indicator 680, and 7-segment LED 690.

The memory 620, audio module 630, wireless transceiver 640, battery monitor 670, LED indicator 680, 7-segment LED 690 and any number of other peripheral devices connected via I/O ports 650 connect to processor 610 to exchange data with processor 610 for use in applications being executed by processor 610.

The memory 620 is a device that transmits and receives data to and from processor 610 for storing data. The audio module 630 may include a speaker.

The wireless transmitter 640 allows processing unit 600 to be connectable with the GPU 560 to transmit data. The wireless transmitter also allows a user to wirelessly connect to the processing unit 600 to update applications stored on memory 620 or install
5 new applications onto the memory 620.

Other peripheral devices that may be connected to processor 610 via the I/O ports include a USB storage device, an SD card or other storage device for transmitting information to or receiving information from the processing unit 600. In addition to
10 updating applications stored on memory 620 or installing new applications onto the memory via using the wireless transceiver 640, a user may alternatively install new applications or update applications on the memory 620 through a user interface such as a USB via the I/O port.

15 A LED indicator 680 is provided to indicate the health of the battery 590. The LED indicator is connected to LED 361 on the top surface of circuitry housing 320 to indicate the status of the battery 590. Battery monitor 670 is provided to monitor the health of the battery. Battery monitor 670 monitors the health of the battery 590 and should the health of the battery 590 falls below certain threshold, a signal will be transmitted to the
20 processor 610 and in turn the processor 610 would light up LED indicator 680.

The processor 610 is a processor, microprocessor, or any combination of processors and microprocessors that execute instructions to perform the processes in accordance with the present invention. The processor 610 has the capability to execute
25 various applications that are stored in the memory 620. Some of these applications can receive inputs from the various sensors in order to decide whether to activate the pyrotechnic actuator 570 to ignite the igniter 430.

The trigger device 170 provides the flexibility and intelligence needed for enhancing the existing life vests, without affecting the current functionalities of life vests or other floatation devices. The use of a processing unit provides adaptive depth thresholding and fail-proof trigger mechanism for inflating the life vest at required depth. The use of the GPU 560 enables determination of the locations to allow swift rescue of the survivors or victims, especially in undesirable weather conditions.

The use of the fall detection sensor 540 and water probe sensor 530 allow the trigger device 170 to be used in various modes of operations. For example, in the maritime and shipping industry where a user is on board a large vessel such as a tanker, it is preferred that the life vest is inflated before the user touches the water. This is because a user being thrown overboard from a large vessel would typically sink deep into the water due to high acceleration. Hence, to accurately inflate the life vest under such circumstance, one of the operations includes detecting a sudden increase in acceleration to determine a fall and subsequently detecting falling of a certain distance would provide an accurate decision to inflate the life vest. This ensures that the life vest is inflated before the user falls into the water. In another example, where a user is on board a small vessel such as a recreation powercraft, it is preferred that the life vest is inflated after the user enters the water. Hence, to accurately inflate the life vest under such circumstance, another operation includes detecting a sudden increase in acceleration to determine a fall and subsequently detecting a presence of water to determine the user entering the water. In yet another example, in military operation such as river crossing, the users are in the water and hence detecting the presence of water and subsequently dropping to a certain depth would provide an accurate decision to inflate the life vest. The various modes of operations will be described below with reference to figures 8, 9 and 10.

The circuitry 500 is typically in a sleep mode which draws minimum battery power. Depending on the mode of operation, the circuitry 500 would be activated to determine whether to activate the life vest. Upon activation of the circuitry 500, the processing analyses the input received from each of the sensors, i.e. water probe sensors, pressure
5 depth sensor and fall detection sensor. Based on the input received from these sensors, the processing unit decides on whether to inflate the life vest according to the processes stored on the memory 620. The processes stored on memory 620 executable by the processing unit 510 for inflating a life vest in accordance with an embodiment of this invention will now be described as follows.

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Essentially, the processing unit has to be powered up by either detecting a fall or sensing water on the water probes. In other words, the processing unit is powered up by either the fall detection sensor 540 or the water probe sensor 529. Upon powering up of the processing unit 510, the processor 610 will execute according to the instructions
15 stored on the memory 620. The instructions stored on the memory 620 include the operation modes and the setup mode. There are at least 3 operation modes and each of these operation modes will be described below with reference to figures 8, 9 and 10. All the modes of operations are installed on the memory 620 of processing unit 510. Figure 11 describes the setup mode for selecting the mode of operation and changing the
20 threshold of the depth. Alternatively, depending on the preference of the user, only one of the modes of operations is installed on the memory 620 of processing unit 510. This prevents accidental changing of mode of operation.

Figure 8 illustrates a flow diagram of process 800 performed by the processor in
25 processing unit 510 in accordance with an embodiment of this invention. Process 800 relates to a first mode of operation where a user on board a small vessel such as a recreation powercraft uses the floating device. Process 800 begins with step 805 to

detect a fall by the fall detection sensor 540. If a fall is detected by the fall detection sensor 540, process 800 power up the processing unit 510 and proceeds to step 810. Otherwise, process 800 continues to monitor for a fall by the fall detection sensor 540, i.e. continues to be in sleep mode. Sleep mode refers to the circuitry 500 not being powered up fully and consumes the least power since the pressure depth sensor 530, 7-segment LED 690, wireless transmitter 640, LED 680, and audio 630 are not switched on.

In step 810, process 800 determines whether water is sensed by all the three water probes. If all the three water probes are in contact with water, process 800 proceeds to step 815. Otherwise, process 800 repeats from step 805.

In step 815, process 800 activates the pyrotechnic actuator 570 to fire the igniter 430 in turn inflating the pneumatic vest 110 and subsequently activates the GPU 560 by sending a signal via the wireless transmitter 640 to the GPU 560. Process 800 ends after step 820.

Figure 9 illustrates a flow diagram of process 900 performed by the processor in processing unit 510 in accordance with an embodiment of this invention. Process 900 relates to a second mode of operation where a user on board a large vessel such as a tanker uses the floating device. Process 900 begins with step 905 to detect a fall by the fall detection sensor 540. If a fall is detected by the fall detection sensor 540, process 900 power up the processing unit 510 and proceeds to step 910. Otherwise, process 900 continues to monitor for a fall by the fall detection sensor 540, i.e. continues to be in sleep mode. Sleep mode refers to the circuitry 500 not being triggered and consumes the least power since the pressure depth sensor 530, 7-segment LED 690, wireless transmitter 640, LED 680, and audio 630 are not switched on.

In step 910, process 900 determines, via the fall detection sensor 540, whether the user has fallen above a certain distance. If the user has fallen above a certain distance, process 900 proceeds to step 915. Otherwise, process 900 repeats from step 905.

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In step 915, process 900 activates the pyrotechnic actuator 570 to fire the igniter 430 in turn inflating the pneumatic vest 110 and subsequently activates the GPU 560 by sending a signal via the wireless transmitter 640 to the GPU 560. Process 900 ends after step 920.

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Figure 10 illustrates a flow diagram of process 1000 performed by the processor in processing unit 510 in accordance with an embodiment of this invention. Process 1000 relates to a third mode of operation where a user is using the floating device for recreational activities such as sailing or during army's operations such as river crossing.

15 Process 1000 begins with step 1005 to determine if all the three water probes are in contact with water. If all three water probes are in contact with water, process 1000 power up the processing unit 510 and proceeds to step 1010. Otherwise, process 1000 continues to monitor for water on all three water probes, i.e. continues to be in sleep mode. Sleep mode refers to the circuitry 500 not being triggered and consumes the least
20 power since the fall detection sensor 540, pressure depth sensor 530, 7-segment LED 690, wireless transmitter 640, LED 680, and audio 630 are not switched on.

In step 1010, process 1000 determines if the depth, via the pressure depth sensor 530, of the triggering device is below a certain depth for a period of time. If the depth is
25 below the certain depth with the period of time, process 1000 proceeds to step 1015. Otherwise, process 1000 repeats from step 1005.

In step 1015, process 1000 activates the pyrotechnic actuator 570 to fire the igniter 430 in turn inflating the pneumatic vest 110 and subsequently activates the GPU 560 by sending a signal via the wireless transmitter 640 to the GPU 560. Process 1000 ends after step 1020.

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Figure 11 illustrates a flow diagram of process 1100 performed by the processor in processing unit 510 in accordance with an embodiment of this invention. Process 11 is a process for selecting the depth and mode of operation in accordance with an embodiment of this invention. Process 11 begins with step 1105 by determining whether
10 signals are received from water probe probes 362-364. If water is being sensed on only two of the water probes 362-364, the processing unit 510 is power up and process 1100 proceeds to step 1120. Otherwise, process 1100 repeats step 1105, i.e. continues to be in sleep mode. Sleep mode refers to the circuitry 500 not being triggered and consumes the least power.

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In step 1120, process 1100 goes into the first setup mode which is changing the threshold of the depth. The setup mode is activated only if a user uses 2 wet fingers to touch two of the water probes 362-364 for a predetermined time period. In particular, water and human skin impedance close the circuit flow to distinguish whether the system
20 is in setup mode or operation mode. In the first setup mode, the process 1100 lights up 7-segment LED and monitors for duration of the contact on the water probes 362-364. Dependent on the contact on the water probes 362-364, the process 700 will cause the 7-segment LED to light up the appropriate numbers. For example, if only the first water probe 362 senses water, a first default depth is being displayed on the 7-segment LED; if
25 only the second water probe 363 senses water, a second default depth is being displayed on the 7-segment LED; if only the third water probe 364 senses water, a third default depth is being displayed on 7-segment LED; if the third water probe 364 and one of the

first and second water probes 362-363 sense water, both 7-segment LED display zero and wait for further sensing of water on either third water probe 364 or one of the first and second water probes 362-363 (or both first and second water probes 362-363). In the fourth configuration, a further sensing on either or both first and second water probes 362-363 causes the 7-segment LED to increment by 5 and a sensing on the third water probe 364 causes the 7-segment LED to decrement by 5. The first, second and third default depths are stored on the memory. Hence depending on the choice selected, the processor will retrieve the default depth stored on the memory and display on the 7-segment LED. The 7-segment LED shows the depth in meters. During setup mode, the 7-segment LED is blinking. After no water is being sensed on the three water probes 362-364 for a predetermined time period, the 7-segment LED will stop blinking and will display the final depth for a few seconds. Subsequently, the process will update the default depth on the memory with the final depth being displayed by the 7-segment LED.

After the first setup mode, process 1100 proceeds to step 1125 to determine whether signals are received from water probe probes 362-364. If water is being sensed on only two of the water probes 362-364, process 1100 proceeds to step 1130. Otherwise, process 1100 repeats step 1105, i.e. continues to be in sleep mode.

In step 1130, process 1100 goes into the second setup mode which is changing the mode of operation. The second setup mode is activated only if a user uses 2 wet fingers to touch two of the water probes 362-364 for a predetermined time period after the first setup mode. In particular, water and human skin impedance close the circuit flow to distinguish whether the system is in setup mode or operation mode.

In the second setup mode, the process 1100 lights up 7-segment LED and monitors for duration of the contact on the water probes 362-364. Dependent on the

contact on the water probes 362-364, the process 1100 will cause the 7-segment LED to display a number corresponding to the mode of operation. For example, both 7-segment LED are caused to display the number corresponding to the current mode of operation and wait for further sensing of water on either third water probe 364 or one of the first and second water probes 362-363 (or both first and second water probes 362-363). In particular, a further sensing on either or both first and second water probes 362-363 causes the 7-segment LED to increment by 1 and a sensing on the third water probe 364 causes the 7-segment LED to decrement by 1. During the second setup mode, the 7-segment LED is blinking. After no water is being sensed on the three water probes 362-364 for a predetermined time period, the 7-segment LED will stop blinking and will display the final mode of operation for a few seconds. Subsequently, the process will update the mode of operation on the memory with the final mode of operation being displayed by the 7-segment LED.

Process 1100 ends after step 1130.

Figure 12 illustrates a flow diagram of process 1200 performed by the GPU. Process 1200 begins with step 1205 by determining whether signals are received from water probe sensor. If water is being sensed by the water probe sensor, the GPU is power up and process 1200 proceeds to step 1215. Otherwise, process 1200 repeats step 1205, i.e. continues to be in sleep mode. Sleep mode refers to the GPU not being powered up and consumes the least power.

In step 1215, process 1200 monitors for signal from the processing unit 510 via the wireless receiver for certain period of time. If the processor does not receive any signal from the processing unit 510 via the wireless receiver over the period of time, process 1200 repeats from step 1205 in sleep mode to reserve battery. In the sleep mode,

the wireless receiver, GPS module, long distance RF transmitter, light and sound beacon are switched off to conserve battery. If the processor receives a signal from the processing unit 510, process 1200 activates the GPS module to receive the coordinates in step 1220. The coordinates are then transmitted via the long distance RF transmitter in step 1225. Thereafter, process 1200 activates the light and sound beacon in step 1230 to attract attention for a predetermined amount of time. Depending on the battery level, steps 1220-1230 are repeated at certain intervals. Process 1200 ends after step 1230.

Figure 13 illustrates a cross sectional view of the trigger device 170 before the pyrotechnic 400 is being activated. Figure 14 illustrates a cross sectional view of the trigger device 170 after the pyrotechnic 400 is being activated. As illustrated by figures 13 and 10, the firing of the igniter 430 causes the pyrotechnic compound to explode and in turn driving the plug 420 towards the canister 130, causing the piston 910 to puncture the canister 130. With the puncture of the canister 130, gas in the canister 130 escapes into the pneumatic vest 110 via the piston regulator 150.

The above is a description of exemplary embodiments of a trigger device in accordance with this invention. It is foreseeable that those skilled in the art can and will design alternative systems based on this disclosure that infringe upon this invention as set forth in the following claims.

Claims:

1. A trigger device for activating a canister coupled to a life vest, the trigger device comprising:

a pyrotechnic;

5 a circuitry comprising:

a battery,

a water probe sensor,

a pressure depth sensor,

a fall detection sensor,

10 a pyrotechnic actuator in communicatively connected to an igniter of said pyrotechnic,

a processing unit having a processor and memory,

instructions stored on said memory to:

analyse input received from each of said water probe sensor,

15 pressure depth sensor, and fall detection sensor, and

activate said pyrotechnic actuator based on a result from said

analysis; and

a housing adapted to housed said pyrotechnic and circuitry.

20 2. The trigger device according to claim 1 wherein said a processing unit is switched on in response to determining a fall via the fall detection sensor.

3. The trigger device according to claim 2 wherein said instructions to analyse input received from each of said water probe sensor, pressure depth sensor, and fall detection

25 sensor further comprises instructions to:

determine water on a probe of said water probe; and

activate said pyrotechnic actuator in response to determining water on said probe of said water probe sensor.

4. The trigger device according to claim 2 wherein said instructions to analyse input received from each of said water probe sensor, pressure depth sensor, and fall detection sensor further comprises instructions to:

determine whether said trigger device fall above a predetermined distance via said fall detection sensor; and

activate said pyrotechnic actuator in response to determining said trigger device falling above said predetermined distance.

5 The trigger device according to claim 1 wherein said processing unit is switched on in response to determining water on a probe of said water probe sensor.

6. The trigger device according to claim 5 wherein said instructions to analyse input received from each of said water probe sensor, pressure depth sensor, and fall detection sensor further comprises instructions to:

determine a depth of said trigger device is below a predetermined depth via said pressure depth sensor; and

activate said pyrotechnic actuator in response to determining said trigger device is below said predetermined depth.

7. The trigger device according to claim 5 wherein said water probe sensor comprises three water probes for sensing water and impedance.

8. The trigger device according to claim 7 wherein instructions to analyse input received from each of said water probe sensor, pressure depth sensor, and fall detection sensor further comprises instructions to:

determine water and impedance on at least two of said three water probes;

5 execute a first setup mode in response to determining water and impedance on said at least two of said three water probes;

determine water and impedance on at least two of said three water probes after end of said first setup mode; and

10 execute a second setup mode in response to determining water and impedance on said at least two of said three water probes after end of said first setup mode.

9. The trigger device according to claim 8 wherein said first setup mode is changing of a predetermined depth threshold and said second setup mode is changing of a mode of operation.

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10. The trigger device according to claim 1 wherein said processing unit further comprises a wireless transmitter.

11. The trigger device according to claim 10 further comprising:

20 a Global Positioning Unit (GPU) comprising a wireless receiver, a processor, a memory, a Global Positioning System (GPS) module, a light and sound beacon, a water probe sensor, and a long distance Radio Frequency (RF) transmitter, said memory having instructions executable by said processor in response to sensing water on said water probe sensor.

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12. The trigger device according to claim 11 wherein said instructions executable by said processor comprises instructions to:

receive a signal from said wireless transmitter;
receive coordinates via said GPS module;
transmit said coordinates via said long distance RF transmitter;
activate said light and sound beacon.

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13. The trigger device according to claim 7 wherein the circuitry further comprises a first 7-segment LED and a second 7-segment LED.

14. The trigger device according to claim 13 wherein said first and second 7-segment

10 LEDs are arranged between said three water probes.