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Distributed Swarm Flotation and Keep-Afloat Stabilisation Method and System in which Buoyancy-Capable Drones Attach Around a Hull and Hold a Swamped Small Vessel Level and Afloat Until a Crewed Rescue Arrives

Marginal · 64.4/100 | 12 claims

TECHNICAL FIELD

Maritime life-safety support by unmanned vehicles, specifically a coordinated swarm of buoyancy-capable drones that distribute around the hull of a swamped or unstable small vessel and apply righting support to keep it level and afloat pending crewed rescue.

ABSTRACT

A method and system for keeping a swamped or unstable small vessel level and afloat use a swarm of buoyancy-capable drones that autonomously approach the vessel, distribute around its hull, and attach to or bear against the hull at distributed support points. Each drone deploys or activates a buoyancy element and the swarm coordinates the distribution of support so that the combined righting and buoyancy effect resists capsize and holds the vessel substantially level. A roll, pitch, and freeboard estimator drives a shared controller that allocates buoyancy across the support points to counter a sensed list. The system is scoped to a life-safety support role: it holds the vessel in place and afloat and is constrained by a human-authority hand-off interlock so that on arrival of a crewed rescue the swarm relinquishes control to the rescuers. The system does not autonomously relocate, tow, or otherwise interfere with an occupied vessel against the wishes of its occupants. Generic inflatable rescue collars and salvage pontoons are not drone-delivered or swarm-coordinated; the disclosed advance is the distributed, sensor-driven, multi-drone keep-afloat stabilisation with an authority hand-off.

BACKGROUND

A small vessel that is swamped, holed, or destabilised can capsize within minutes, and capsize sharply reduces the survival time of occupants in the water. Crewed rescue assets cannot always reach a casualty vessel before it rolls. Passive flotation aids exist: inflatable rescue collars, lift bags, and salvage pontoons can add buoyancy to a hull, and these are well established marine equipment. However, such aids must be physically carried to the vessel and rigged by crew, they add buoyancy at fixed points chosen by hand, and they do not sense or respond to a developing list. They are not delivered by unmanned vehicles and they are not coordinated as a swarm that distributes support around a hull and rebalances buoyancy in response to sensed roll. Drone-delivered single flotation aids for a person in the water are also known, but those deliver one buoyant aid to a swimmer rather than coordinating multiple drones to stabilise a vessel. Autonomous interference with an occupied vessel raises clear life-safety and legal concerns, so any such system must respect the spirit of maritime life-safety convention and defer to human rescuers. There remains a need for a coordinated swarm that autonomously distributes buoyancy support around a swamped hull, actively counters a sensed list to keep the vessel level and afloat, and hands authority to a crewed rescue on its arrival without relocating or interfering with the occupied vessel against its occupants.

SUMMARY OF THE INVENTION

The invention provides a method and a system for distributed swarm keep-afloat stabilisation of a swamped small vessel. Plural buoyancy-capable drones approach a casualty vessel, distribute around its hull, and attach to or bear against the hull at distributed support points using a hull-engagement feature. Each drone provides a buoyancy element, and a shared controller allocates the buoyancy and righting contribution across the support points as a function of a sensed roll, pitch, and freeboard so as to resist capsize and hold the vessel substantially level. The controller rebalances allocation as the list develops, providing closed-loop keep-afloat stabilisation. A human-authority hand-off interlock causes the swarm to relinquish stabilisation control to arriving crewed rescuers and prevents the swarm from autonomously relocating, towing, or otherwise interfering with the occupied vessel against the wishes of its occupants. The result is a life-safety support capability that buys time against capsize until a crewed rescue arrives, distinct from passive hand-rigged collars and pontoons.

DETAILED DESCRIPTION

FIG. 1 is a plan view of a swamped small vessel (100) with a swarm of buoyancy-capable drones (102a to 102d) distributed around its hull (104) at distributed support points (106). FIG. 2 is a side view of one drone (102) showing a buoyancy element (108), a hull-engagement feature (110), and an attitude sensor (112). FIG. 3 is a block diagram of the shared controller (114), a roll, pitch, and freeboard estimator (116), and a buoyancy-allocation module (118). FIG. 4 is a flowchart of the keep-afloat stabilisation method. FIG. 5 is a state diagram of the human-authority hand-off interlock (120). FIG. 6 is a detail of the hull-engagement feature (110) bearing against the hull (104) without piercing it. FIG. 7 is a sequence diagram of swarm arrival, distribution, stabilisation, and hand-off. Referring to FIG. 1 and FIG. 2, on tasking to a casualty position the drones (102) approach the vessel (100) and distribute around the hull (104) so that the support points (106) are spaced to span the beam and length. Each drone (102) engages the hull (104) through the hull-engagement feature (110), which may be a suction pad, a conformal cradle, a strap, or a magnetic pad selected to bear against the hull without holing it, and deploys or activates its buoyancy element (108), for example an inflatable collar or a buoyant body. Referring to FIG. 3 and FIG. 4, each drone (102) reports attitude and local freeboard from its sensor (112) to the shared controller (114). The estimator (116) fuses these into a vessel roll, pitch, and freeboard estimate. The buoyancy-allocation module (118) then commands each drone to increase or decrease its buoyancy and bearing force so that the distributed support counters a sensed list and holds the vessel (100) substantially level and afloat. As the list develops the controller rebalances the allocation in closed loop, biasing buoyancy to the low side to right the vessel. The swarm thus actively keeps the vessel afloat rather than merely adding fixed buoyancy. Referring to FIG. 5 and FIG. 7, the hand-off interlock (120) gates the system to a life-safety support role. The swarm holds the vessel in place and afloat; it does not autonomously relocate, tow, or otherwise interfere with the occupied vessel against the wishes of the occupants. On a hand-off condition, such as detection or operator confirmation that a crewed rescue has arrived, the interlock (120) causes the swarm to relinquish stabilisation control to the rescuers and to await release or recovery. In an embodiment the controller logs the stabilisation and the hand-off event for an after-action record.

DRAWINGS

FIG. 1 is a plan view of a swamped small vessel with a swarm of buoyancy-capable drones distributed around its hull at distributed support points; FIG. 2 is a side view of one drone showing the buoyancy element, hull-engagement feature, and attitude sensor; FIG. 3 is a block diagram of the shared controller, the roll, pitch, and freeboard estimator, and the buoyancy-allocation module; FIG. 4 is a flowchart of the keep-afloat stabilisation method; FIG. 5 is a state diagram of the human-authority hand-off interlock; FIG. 6 is a detail of the hull-engagement feature bearing against the hull without piercing it; FIG. 7 is a sequence diagram of swarm arrival, distribution, stabilisation, and hand-off to a crewed rescue.

CLAIMS

1. A method of keeping a swamped or unstable vessel level and afloat using a plurality of buoyancy-capable unmanned vehicles, the method comprising: causing the plurality of unmanned vehicles to approach the vessel and to distribute around a hull of the vessel at distributed support points; engaging each unmanned vehicle against the hull at a respective support point and providing a buoyancy element at each support point; estimating a roll, a pitch, and a freeboard of the vessel from sensors of the unmanned vehicles; allocating, by a shared controller, a buoyancy and righting contribution across the support points as a function of the estimated roll, pitch, and freeboard so as to resist capsize and hold the vessel substantially level and afloat; and on a hand-off condition indicating arrival of a crewed rescue, relinquishing stabilisation control to the crewed rescue under a human-authority hand-off interlock, wherein the method holds the vessel in place and does not autonomously relocate or tow the vessel against occupants of the vessel.

2. A distributed flotation stabilisation system comprising: a plurality of buoyancy-capable unmanned vehicles, each having a buoyancy element, a hull-engagement feature arranged to bear against a hull of a vessel at a support point, and an attitude sensor; a shared controller configured to estimate a roll, a pitch, and a freeboard of the vessel from the attitude sensors and to allocate a buoyancy and righting contribution across the support points so as to resist capsize and hold the vessel substantially level and afloat; and a human-authority hand-off interlock configured to cause the unmanned vehicles to relinquish stabilisation control to a crewed rescue on a hand-off condition and to inhibit autonomous relocation or towing of an occupied vessel against occupants of the vessel.

3. The method of claim 1, wherein allocating the buoyancy and righting contribution comprises biasing buoyancy to a low side of the vessel indicated by the estimated roll to right the vessel toward level.

4. The method of claim 1, wherein engaging each unmanned vehicle against the hull comprises one of applying a suction pad, seating a conformal cradle, securing a strap, and applying a magnetic pad that bears against the hull without holing the hull.

5. The method of claim 1, further comprising rebalancing the allocation across the support points in closed loop as the estimated roll changes, thereby providing active keep-afloat stabilisation rather than fixed-point buoyancy.

6. The method of claim 1, wherein the hand-off condition comprises one of a detection of a crewed rescue asset and an operator confirmation, and wherein on the hand-off condition the unmanned vehicles await release or recovery.

7. The method of claim 1, further comprising distributing the support points to span a beam and a length of the vessel so that the buoyancy and righting contribution is applied at spaced locations around the hull.

8. The method of claim 1, wherein the method supports a maritime life-safety role pending crewed rescue and refrains from any autonomous action that relocates or interferes with the occupied vessel against the wishes of its occupants.

9. The system of claim 2, wherein the shared controller is configured to rebalance the buoyancy allocation in closed loop in response to a developing list estimated from the attitude sensors.

10. The system of claim 2, wherein the hull-engagement feature of each unmanned vehicle comprises at least one of a suction pad, a conformal cradle, a strap, and a magnetic pad arranged to bear against the hull without holing the hull.

11. The system of claim 2, wherein each buoyancy element comprises one of an inflatable collar and a buoyant body that is deployed or activated when the unmanned vehicle engages the hull.

12. The system of claim 2, wherein the shared controller is configured to record the stabilisation applied and a hand-off event for an after-action record, and to prevent the unmanned vehicles from towing or relocating the vessel while occupants are aboard absent the human-authority hand-off.

PATENTABILITY SELF-ASSESSMENT (30-FACTOR)

Patentability	76.0%
Prior-art position	60.0%
Technical merit	44.0%
Commercial	68.0%
Composite genius score	**64.4/100 (Marginal)**

FILING ROUTES

United Kingdom (UK IPO)
GB national application at UK IPO with combined search and examination; anchor the independent claims on the sensor-driven distributed buoyancy allocation and the human-authority hand-off interlock to distinguish over passive collars and pontoons.

Ireland (IPOI / Irish PATO)
Parallel IE filing at IPOI; an IE 10-year short-term patent is a realistic quick keystone, with EPO or PCT extension if the swarm keep-afloat allocation feature survives search.

PRIOR-ART VERIFICATION (LIVE SEARCHES)

UK IPO patent search (Ipsum)
UK national register and file inspection
https://www.search-for-intellectual-property.service.gov.uk/SearchByNumber

Espacenet (EPO)
European/worldwide prior-art search
https://worldwide.espacenet.com/patent/search?q=distributed%20swarm%20flotation%20keepaflo%2

Google Patents
Full-text + family view

IPOI (Irish Patents Office)
Irish national filing route (short-term + full-term)
https://www.ipoi.gov.ie/en/types-of-ip/patents/

https://patents.google.com/?q=(distributed%20swarm%20flotation%20keepaflo%20drone%20UAV%20transmedium)&type=PATENT

EPO CPC B64U (UAS)
Unmanned-aircraft classification
https://worldwide.espacenet.com/patent/search?q=cpc%3DB64U
