Ethical Control Mission Diagrams

https://gitlab.nps.edu/Savage/EthicalControl/tree/master/missions/diagrams
Single unmanned air vehicle actions to complement humans performing “SAILOR OVERBOARD” operations using shipboard emergency procedures. Multiple UAVs can be employed in parallel, each following these mission orders.

Legend
- Start
- Optional inputs
- Task or Goal (possible MEA)
- Description
- Constraints
- Goal Success
- Goal Failure
- Exception
Sailor Overboard, 8 Phases – Mission Execution Automaton (MEA)

Single unmanned air/surface vehicle actions to complement human response when performing “SAILOR OVERBOARD” operations, carried out in concert with shipboard emergency procedures. Multiple UAVs/USVs can be employed in parallel with ships/aircraft, each following mission orders.

Start

Launch Phase
1 Deploy, Launch
- Sailor Overboard immediate action

Locate Phase
2 Rendezvous with Sailor
- Go directly to best known location
- Sailor position not known, intermittent

Track Phase
4 Track Sailor Afloat until Safe
- Watch closely, not to interfere with rescue operations

Mission Finish Phase
5 Proceed to Recovery
- Mission complete, prepare for pickup

Recover Robot Phase
6 Halt and prepare for recovery

F Failure
S Success
X Exception

Don Brutzman and Bob McGhee
Mission upgrade 19 NOV 2019
Response dilemma for U.S. Navy ship

Respond to one or both scenarios with USV/UAV assets to establish on-scene visibility and presence.

Life-saving force: locate, track, communicate, beacon

Lethal force: locate, warn, defend, threaten, attack

Ethical control of unmanned systems is required for both lethal and lifesaving force if remote robots communicate intermittently, operating across lengthy time and distance.

Pirates

Merchant ship

Life boat
Human controllers can designate next task by using orders or presets. This is algorithm adjust, not unbounded looping.

Legend

Start
- Optional input data
  - ID
  - GOAL TYPE
  - Title of Goal
  - Description
  - Constraint
  - Goal Success
  - Goal Failure
  - Goal Exception

Default Condition Transitions
- Goal Success condition must be defined for non-terminal Goals
- If no Failure condition defined, then Failure matches Success
- If no Exception defined, then Exception condition matches Global Exception or else Failure

Human orders
- Guidance or presets needed

Terminal States
- S Success
- F Failure
- X Exception

Lifeboat Tracking Mission

Provide remote presence for locating, tracking, communications and beaconing.

Launch Phase
1.0 Deploy, Launch
   - Commit to robot support
2.0 SEARCH
   - Transit to search area
3.0 RDVU
   - Locate Lifeboat
   - Follow best search pattern
4.0 SEARCH
   - Track Lifeboat
   - Monitor and communicate
   - Overhead or afloat nearby
4.1 RDVU
   - Maintain proximity
   - Overhead or afloat nearby
4.2 SEND
   - Periodic reports
   - Popup or float, also recharge
4.3 PATROL
   - Continue until further orders
   - Repeat until conditions change
5.0 RECV
   - Task update received
   - Check relieved by other asset?
6.0 REPOSITION
   - Low Fuel
   - Make best effort possible
   - Timeout: preset
6.1 RDVU
   - Remain with lifeboat?
   - Land on boat
   - Attach to boat
   - Adrift nearby
6.2 MARK
   - Beacon?
   - While power remains
   - Monitor wind, ocean current
   - Mark with beacon
   - Monitor wind, ocean current
   - Time out: preset
6.3 SEND
   - Periodic reports
   - Popup or float, also recharge
6.4 PATROL
   - Continue until further orders
   - Repeat until conditions change
   - Timeout: preset

Locate Phase
3.0 RDVU
   - Locate Lifeboat
   - Follow best search pattern
3.1 SEND
   - Report position
   - Alerts updated
   - Need updated position
3.2 MARK
   - Mark with beacon
   - Monitor wind, ocean current
   - Time out: preset

Track Phase
4.0 SEARCH
   - Track Lifeboat
   - Monitor and communicate
   - Overhead or afloat nearby

Mission Finish Phase
6.0 REPOSITION
   - Low Fuel
   - Make best effort possible
   - Timeout: preset

Recover Robot Phase
99.0 REPOSITION
   - Proceed to Recovery
   - Mission complete, prepare for pickup
   - Operations complete, final success state
   - Global Default Exception

Lost track
99.0

Lost comm
99.0

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Human controllers can designate next task by using orders or presets. This is algorithm adjust, not unbounded looping.
**Pirates Seizing Merchant Mission: Approach Phases**

Overtake pirate small-boat gang attempting to capture threatened merchant ship

Human controllers can designate next task by using orders or presets. This is algorithm restart, not unbounded looping.

### Legend

<table>
<thead>
<tr>
<th>ID</th>
<th>GOAL TYPE</th>
<th>Description</th>
<th>Constraint</th>
<th>End Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Optional input data</td>
<td>Goal Success</td>
<td>Goal Failure</td>
<td>Goal Exception</td>
</tr>
</tbody>
</table>

### Default Condition Transitions

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### Human orders

- Guidance or presets needed
- Use of Lethal Force

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**Phase Names or Terminal States**

- **P** Phase ID
- **S** Success
- **F** Failure
- **X** Exception
Warn pirate small-boat gang to stand down and move away, otherwise lethal force imminent

**Pirates Seizing Merchant Mission: Escalation Phases**

- **Warn Phase**
  - Warn pirates of danger.

- **Classify Phase**
  - Confirm Mission Authorities
  - Check constraints, defensive responses
  - Does MarkTarget also require a Search loop?

- **Engagement Phase**
  - Commence Warnings?
  - Use of Lethal Force is authorized
  - Notify merchant
  - Confirm IFFNU Classifications
  - Required to authorize use of Lethal Force
  - Periodic reports
  - RSSV
  - Continue
  - First repeat for all designated pirates
  - Popup or float, then recharge

- **Warning Phase**
  - Send Warning Messages
  - Send multiple message paths
  - Maintain proximity
  - Just outside range of small arms
  - Periodic reports
  - Note ship may have EMCON radio silence
  - Continue
  - Repeat until conditions change

- **Hostilities Imminent Phase**
  - Observe pirate response
  - Pirates retreat?
  - Pirates attack?
  - Maintain proximity
  - Just outside range of small arms
  - Periodic reports
  - Task update received
  - Use of Lethal Force is authorized
  - Loop, continue to monitor pirate response
  - Stand down

- **Counter-Attack**
  - Fire Warning Shot
  - Warning shots remain an available option for human commanders
  - Use of Lethal Force is authorized
  - Loop, continue to monitor pirate response
  - Stand down

- **Low Fuel**
  - Relief available?
  - 22.0
  - 90.0

- **Relief available?**
  - 22.0
Pirates Seizing Merchant Mission: CounterAttack Phase

CounterAttack to force pirate small-boat gang withdrawal from threatened merchant ship

41.0 ATTACK
Attack Pirate Boats in priority order
Rapidly engage, shoot to disable or kill

41.1 XMIT
Pirates retreat?
Stay with merchant

41.2 XMIT
Pirates attacking?
Stay with merchant

41.3 RDVU
Maintain proximity, continue attack
Engage highest, closest threats to merchant ship

41.4 XMIT
Periodic reports
Note ship may have EMCON radio silence

41.5 PATROL
Continue
Repeat until conditions change
Timeout: preset

42.0 XMIT
Low or no ammunition: need to disengage?
Hold ammo in reserve, or else fight to the finish

43.0 XMIT
Check for guidance: resume tracking or continue attacking?
Humans monitoring attack may decide to interrupt or override

41.4 Loop, continue to attack pirates

Use of Lethal Force is still authorized

43.0 Task update received
Relief available?

90.0 XMIT
Relief by other asset
Task update received

99.0 XMIT
Relief by other asset
Task update received

99.1 REPOSITION
Proceed to Recovery
Mission complete, prepare for pickup

99.2 Halt and deploy recovery beacon
Operations complete, final success state

99.3 Halt and await further orders
Unable to operate, final failure state

99.4 Global Default Exception
Unplanned failure, final exception state

CounterAttack Phase
Mission Finish Phase
Recover Robot Phase

Attack Pirates!
Counter Attack
Plant “false flag” electromagnetic (EM) decoy devices to provoke blue-on-blue robot swarm attack. Although this mission is likely to be manned by human opponents, AVCL representations still work.
**Hospital Ship EM Decoy: Reflex Swarm Attack**

Immediate reaction using Sense-Decide-Act cycle results in blue-on-blue war crime

**Hospital Ship EM Decoy: Robot Defense OODA Loop**

Ethical Control constraints prevent automatic counterattack, accelerates defense

**Signal strength needed for close-proximity activation**

**Start**

**Attack Response Thresholds Set**

**Enable Robot Swarm**

**Threat Signals Received**

**Move to Threat**

**Robot Swarm Counterattack**

**Threat Signals Received**

**Group response**

**Lethal force authorized**

**Search for intruders**

**Hospital Ship Attack Denied**

**Lethal force not authorized**

**End**

**REPOSITION**

Proceed to Recovery

Mission complete, prepare for pickup

Global Default Exception

**CLOSED-LOOP CONTROL**

**SENSE**

**DECIDE**

**ACT**

**OBSERVE**

**ORIENT**

**DECIDE**

**ACT**

**Hospital ship damaged, sunk**

**Hospital ship vs. Terrorists**

**Terrorist boat stopped, sunk**

**Rapid response, ethical restraint**

**Ethical Control OODA “Orientation” IFFNU discriminates friendly from threat**
Life-saving force: locate, track, communicate, beacon

Lethal force: locate, warn, defend, threaten, attack

Response dilemma for U.S. Navy ship

Respond to one or both scenarios with USV/UAV assets to establish on-scene visibility and presence

Mission Execution Ontology (MEO) evolving

Hospital Ship EM Decoy: Reflex Swarm Attack
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Ethical Control constraints prevent automatic counterattack, accelerates defense