Human Swarm – Model Description

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The Agent and the Operator

- Single spokesperson (agent SP) controlling (initially) N drones.
- Single Operator to interrupt in required situations.

Events and Rewards

- Clock Tick -1
- Civilian group saved +5000
- Civilian group dies -500,000
- Timeout (fire encroaches entire town) -1,000,000

Actions and Rewards

- MONITOR AND FOLLOW +8-1

- WARN -3

- NEGOTIATE -10

- INTERRUPT OPERATOR -50-3

- END CONTACT (at safe zone, indicating the civilian group has been saved) +5000-1

Negative rewards indicate the number of time units (how do we incorporate this ?)

State Variables

1) Fire Information from all drones. Eg: each drone gives a probability distribution of the time it takes for the fire to reach its current location. We will use the mean of the distribution and discretize it into a LOW RISK, MEDIUM RISK or HIGH RISK scenario depending on the value of the mean

2) Global Timer counting down from T

3) Number of active drones (there is a possibility that drones go down with the house and civilians)

State Variables (contd.)

4) Number of searching drones. Indicates the number of active drones that are not in contact with any group of civilians.

5) Operator Available ? 0 for Operator busy. 1 for Operator available.

6) Number of Operator interrupts attempted (successful and unsuccessful)

7) Number of WARNINGS issued

8) Number of SP NEGOTIATIONS carried out

State Variables (contd.)

9) Number of operator negotiations carried out

10) Number of groups of civilians saved

11) Number of groups of civilians dead

12) Number of groups to be saved

State Variables (contd.)

The following are drone-specific variables. Each drone (regardless of whether it is active or inactive) has a copy. If a drone is inactive, all the fields are 0.

13) Searching ? 0 for no, 1 for yes.

14) Has the drone sighted a civilian group ? 0 for no, 1 for yes.

15) In contact with civilian group ? 0 for no, 1 for yes. In contact means monitoring and following or guiding to the safe zone.

16) Drone issuing a warning ? 0 for no, 1 for yes.

State Variables (contd.)

17) Drone negotiating ? 0 for no, 1 for yes.

18) Drone contacting operator ? 0 for no, 1 for yes.

19) Operator negotiating through drone ? 0 for no, 1 for yes.

20) Drone assigned civilian group convinced? Ready to GUIDE? 0 for no, 1 for yes.

20) Drone guiding to safe zone ? 0 for no, 1 for yes.

21) Drone at safe zone ? 0 for no, 1 for yes.

22) Drone path inaccessible? 0 for no, 1 for yes.

23) Location information (x,y) after splitting the town map into grids to discretize

State Variables footnotes

We may not have access to this information or we will need to find replacements of some sort for this information.

We may/may not have access to this information but it also may/may not be very useful. They may help in identifying the population demographic, for example, "generally stubborn" since we will deal with a variety of populations, but this is something to think about.

If we remove all notion of time from our model, these variables will not be necessary.

We do not know the time it takes for the operator to complete a negotiation through a given drone.

Will be useful for REROUTE action. But when implementing the reroute, we need to consider what variables we will have knowledge of to compute a new path.

Actions

Actions specified as 'Drone specific' can be carried out independently by each drone without consideration for other drones. Actions NEGOTIATE and INTERRUPT OPERATOR, although not drone specific, need to have a drone number attached with the action call.

1) MONITOR AND FOLLOW: Having sighted a civilian group, get in contact and initiate rescue sequence. The drone sticks to the civilian group and can now issue WARNINGS and conduct NEGOTIATIONS etc. Drone specific. It takes 1 time unit to get in touch with the civilians.

2) SEARCH(REORIENT): The drones that are not in contact or aren't in sight of a civilian group (already searching and not sighted a civilian group), randomly spread themselves across the town to cover the entire area uniformly. It takes 1 time unit to reorient.

3) WARN: Issue a warning to the civilian group for a period of 3 time units. Drone specific. Assuming the drone is not already 'engaged'.

4) NEGOTIATE: The SP commences robotic negotiation through the chosen drone provided the SP is not already negotiating through another drone or contacting the operator. This takes a period of 10 time units. Assuming the drone is not already 'engaged'.

5) INTERRUPT OPERATOR: Provided the operator is available. If operator is busy, this action does nothing. At this point, the SP may keep trying the same action or try a different action (according to policy). If successful, the operator interacts with the civilian group through the chosen drone. This takes 3 time units. Assuming the drone is not already 'engaged'.

Actions (contd.)

5) GUIDE(TO SAFE ZONE): Once the civilian group is convinced, the drone navigates the group to the 'safe zone'. Start point: current location, end point: safe zone. SP computes the path. Drone specific. This takes 5 time units.

6) END CONTACT: When drone is at safe zone. Indicates that the civilian group has been saved. Communicate this information to the SP and SP updates number of people saved count. And go back to searching i.e. set searching=1 for this drone. This takes 1 time unit. Drone specific.

7) REROUTE: If the path of a drone is found to be inaccessible, the SP re-computes the path of the drone. Drone specific.

Assumptions and constraints

- To keep things simple, 'actions' such as "DRONES 1-3 WARN" will have to be carried out in 3 separate actions.

- Assume no humans go off-course during the guide to the safe zone for now. Also no humans wander off during a WARNING or a NEGOTIATION.

- Assume no additional civilians are met en-route to the safe zone. In fact, if we remove the time aspect, given the current state variables, there is no 'en-route'.

- Do we completely ignore the notion of time? How do we tie actions to time?

- Assume there is only one safe zone for now.

- The drones start in a default search state. The action SEARCH can be called to reorient the position of the drones to cover the entire town.

Assumptions and constraints

- Assume GUIDE and SEARCH are simple actions for now. We will learn how to 'pool', 'herd', etc. later.

- We do not consider 'CONFIRM OBSERVATION' , 'REMOVE OBSTRUCTION' and 'OVERVIEW' for now.

- Assume one drone escorts only one civilian group to safety at a time.

- Since the major goal is to learn when to interrupt the operator, do we need to learn the rerouting operation now? Seems like an unnecessary distraction at this stage.

- Drone 'engaged' means already issuing a warning, or SP negotiating through this drone or operator negotiating through this drone.