TASK-SPECIFIC NOVEL OBJECT CHARACTERIZATION

ROBOT FINDS PARTIALLY VISIBLE VICTIMS

| DR. IR. G.J. BURGHOUTS (TNO, NETHERLANDS)
FINDING VICTIMS IN A HOUSE
EVEN IF THEY ARE PARTIALLY VISIBLE, OR BEHIND SMOKE

NEEDS TO BE ABLE TO //

01. FIND THE NEEDLE IN THE HAYSTACK
02. USE KNOWLEDGE ABOUT THE TASK & OBJECTS
03. EXPLAIN ITS ASSESSMENT
HITCH, enabling a search and rescue robot to find victims.
FINDING VICTIMS IN A HOUSE
NEEDLE IN THE HAYSTACK

5 human victims in the villa which is on fire

SPOT searches in the kitchen: no person

robot's status

<table>
<thead>
<tr>
<th>victims</th>
<th>living</th>
<th>hall</th>
<th>kitchen</th>
<th>toilet</th>
</tr>
</thead>
<tbody>
<tr>
<td>father</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>not possible</td>
</tr>
<tr>
<td>mother</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>not possible</td>
</tr>
<tr>
<td>daughter</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>not possible</td>
</tr>
<tr>
<td>son</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>not possible</td>
</tr>
<tr>
<td>fireman</td>
<td>possible</td>
<td>possible</td>
<td>possible</td>
<td>not possible</td>
</tr>
</tbody>
</table>

robot enters the villa to search

robot plans to search in the kitchen first
ABOUT VICTIMS – A TAXONOMY

REQUIRES WORLD KNOWLEDGE

robot knows that it needs to search for humans which may be partially visible

robot recognizes it is in the bedroom of the parents, searches, and detects a torso & hand

robot understands that a victim is detected that should be assisted. As such, search is paused and robot plans to assess the person

robot reports that a victim was found in the parent’s bedroom

HITCH, enabling a search and rescue robot to find victims
MORE AUTONOMY
LESS HUMAN INTERVENTIONS

HITCH, enabling a search and rescue robot to find victims

taxonomy captures the world knowledge that is required to find victims robustly with partial evidence
FAST DEPLOYMENT
LESS HUMAN PREPARATION

<table>
<thead>
<tr>
<th></th>
<th>Google</th>
<th>USG</th>
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<tbody>
<tr>
<td>Available labor</td>
<td>$10^5-10^6</td>
<td>100-1000</td>
</tr>
<tr>
<td>Cost of labor</td>
<td>$1.25/hr</td>
<td>$34.00/hr</td>
</tr>
<tr>
<td>Cost to</td>
<td>$41m</td>
<td>~1bn</td>
</tr>
<tr>
<td>translation model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to</td>
<td>0.5 yrs</td>
<td>17 yrs</td>
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<tr>
<td>translation model</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DARPA, July 2018

> taxonomy is reconfigurable

> efficient learning of taxonomy components few-shot technique
EFFICIENT LEARNING
FEW-SHOT DETECTION OF TAXONOMY NODES

HITCH, enabling a search and rescue robot to find victims
good results with only 10 labels per leaf node
TAXONOMY FOR BETTER PREDICTIONS

EVIDENCE PROPAGATION

better detection of persons by accumulation of partial evidence
MANY TASKS ARE HIERARCHICAL
LEVEL OF DETAIL DEPENDS ON THE CURRENT TASK

obstacle avoidance:
no difference between chairs

route clearing:
there is a difference, because robot is able to move the chair with wheels

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LONGER AUTONOMY
RESOLVING UNCERTAINTY BY AUTONOMOUS PLANNING

not getting closer
(no increasing evidence of victim)

going closer!
(increasing evidence, until sufficient confirmation)

HITCH, enabling a search and rescue robot to find victims
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THANK YOU

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