

Robotics to Improve Patient Care for Highly Infectious Diseases

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Biomedical Imaging
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NIH R01 EB024330



Ebola Virus Disease



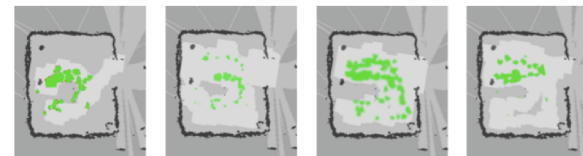
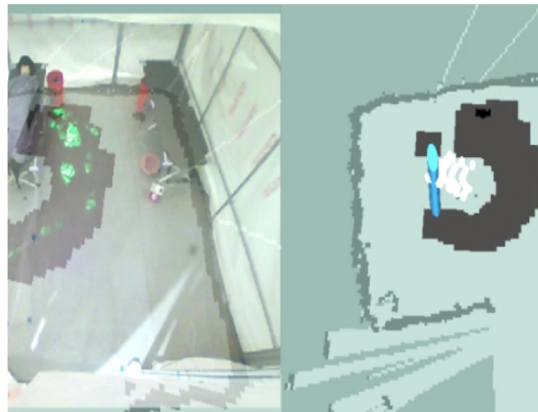
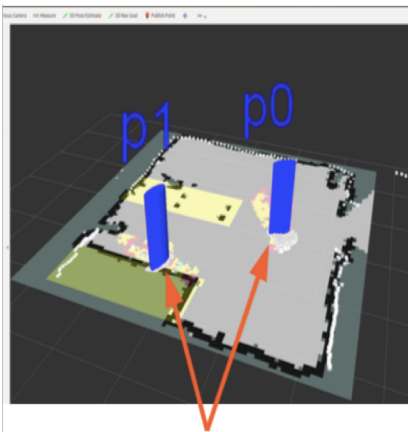
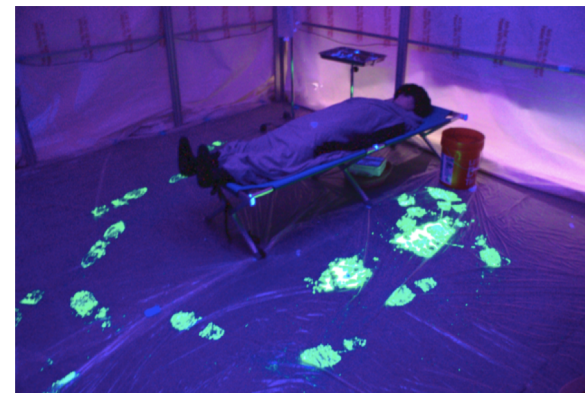
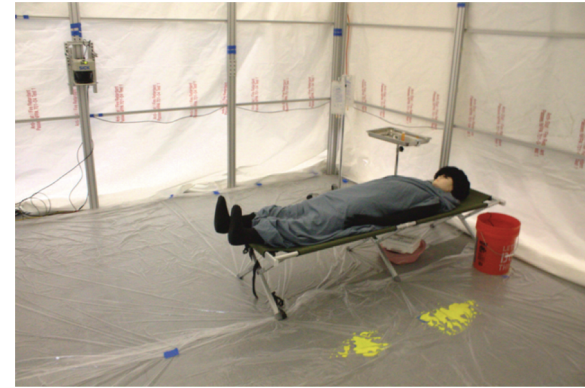
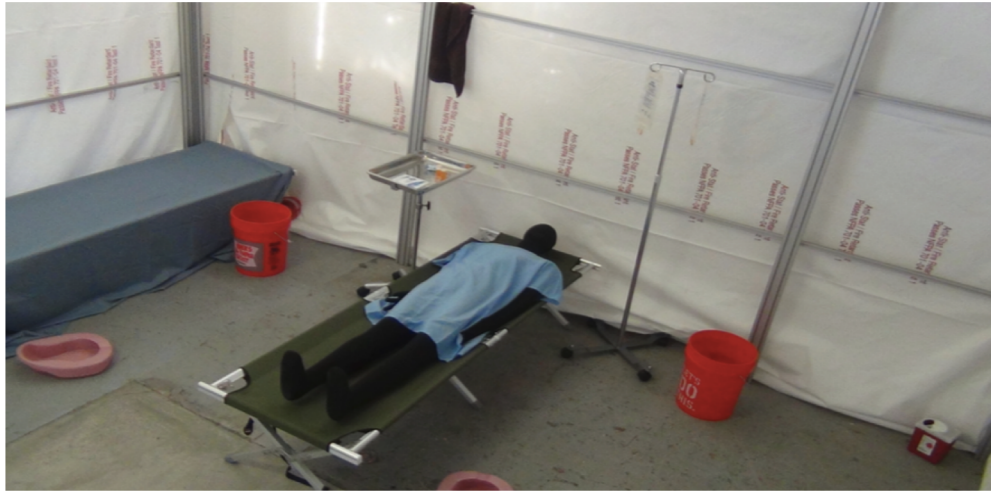
Ebola Virus Disease



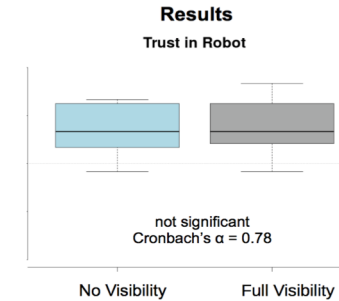
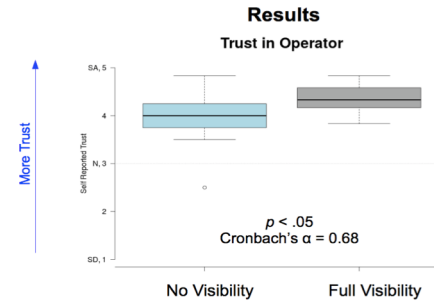
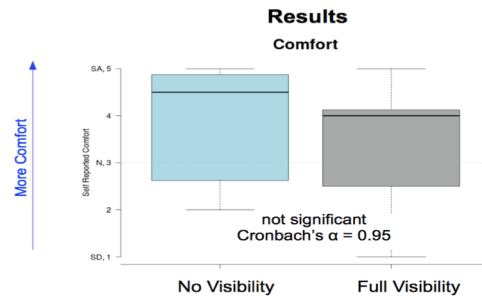
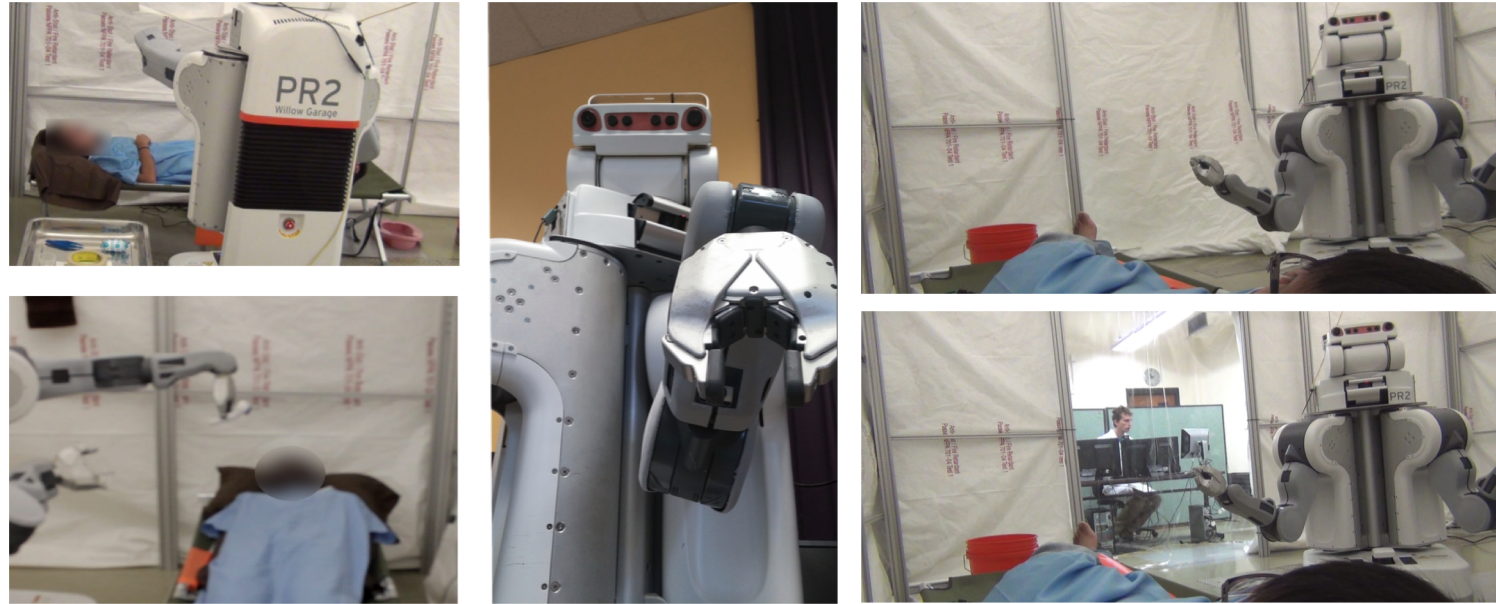
Can Robotics and Automation Help?



Year 1 and Initial Work



Year 1 and Initial Work



Year 1 and Initial Work

- Determine high-value tasks to automate in Ebola Treatment Unit
 - and attempt to translate from human-readable descriptions



Group A	Level 1	Level 2	Level 3	Level 4
Hygiene	self care	self care	assisted daily	assisted 4x
Nutrition	distributed 3x	encouraged 3x	encouraged 3x drinking encouraged (2 hrs)	eating encouraged 3x drinking encouraged hourly
Sup. Care	ORS distributed 4x	ORS encouraged 4x	ORS assisted 4x	ORS assisted 4x
Sys. Care			presumptive meds	presumptive meds
Lab Testing			Electrolytes days 0 & 3	electrolytes daily Hepatic enzymes daily
Monitoring	temperature 2x symptom check 2x contact 2x/shift	vital signs 2x symptom check 3x contact 2x/shift	vital signs 4x symptom check 4x contact 4x/shift	continuous elec. vitals symptom check every 4 hr contact 1x/hr

Group B	Level 1	Level 2	Level 3	Level 4
Hygiene	assisted 4x	assisted 4x	assisted 4x	assisted 4x
Nutrition	assisted 3x	assisted 3x	assisted eating 3x assisted drinking (2 hrs)	assisted eating 3x assisted drinking hourly
Sup. Care	ORS assisted 4x	IV fluid and electrolyte	IV fluid and electrolyte	IV fluid and electrolyte parenteral nutrition
Sys. Care	presumptive meds	IV presumptive meds	IV presumptive meds	IV presumptive meds
Lab Testing		electrolytes days 0 and 3	electrolytes daily	electrolytes every 6 hrs hepatic enzymes daily
Monitoring	symptom check 2x contact 3x/shift	vital signs 2x symptom check 3x contact 3x/shift	vital signs 3x symptom check 3x contact 4x/shift fluid balance	continuous electronic vitals symptom check every 4 hrs contact 1x/hr fluid balance

Group C	Level 1	Level 2	Level 3	Level 4
Hygiene	assisted 3x	assisted 4x	assisted 4x	assisted 4x
Nutrition	assisted 3x	assisted 3x	assisted eating 3x assisted drinking (2 hrs)	assisted eating 3x assisted drinking hourly
Sup. Care	ORS assisted 3x	IV fluid and electrolyte	IV fluid and electrolyte	IV fluid and electrolyte
Sys. Care	presumptive meds	presumptive meds	IV presumptive meds	IV presumptive meds
Lab Testing		electrolytes days 0 and 3	electrolytes daily	electrolytes every 6 hrs hepatic enzymes daily
Monitoring	vital signs daily contact 3x/shift	vital signs 2x symptom check 3x contact 3x/shift	vital signs 3x symptom check 3x contact 4x/shift fluid balance	continuous electronic vitals symptom check (4 hrs) contact each hour fluid balance central venous access

Group D	Level 1	Level 2	Level 3	Level 4
Hygiene	assisted 3x	assisted 4x	assisted 4x	assisted 4x
Nutrition	assisted drinking	assisted 3x	assisted eating 3x assisted drinking (2 hrs)	assisted eating 3x assisted drinking 1x/hr
Sup. Care				
Sys. Care				
Lab Testing				
Monitoring	symptom check 2x contact 3x/shift	vital signs 2x symptom check 3x contact 3x/shift	vital signs 3x symptom check 3x contact 3x/shift	vital signs 3x symptom check 4x contact 4x/shift

Group E	Level 1	Level 2	Level 3	Level 4
Hygiene	self care	self care	assisted 1x	assisted 1x
Nutrition	distributed 3x	encouraged 3x	encouraged 3x	encouraged 3x
Sup. Care				
Sys. Care				
Lab Testing				
Monitoring	vital signs 1x symptom check 2x contact 3x/shift	vital signs 2x symptom check 3x contact 3x/shift	vital signs 3x symptom check 3x contact 3x/shift	vital signs 4x symptom check 4x contact 4x/shift

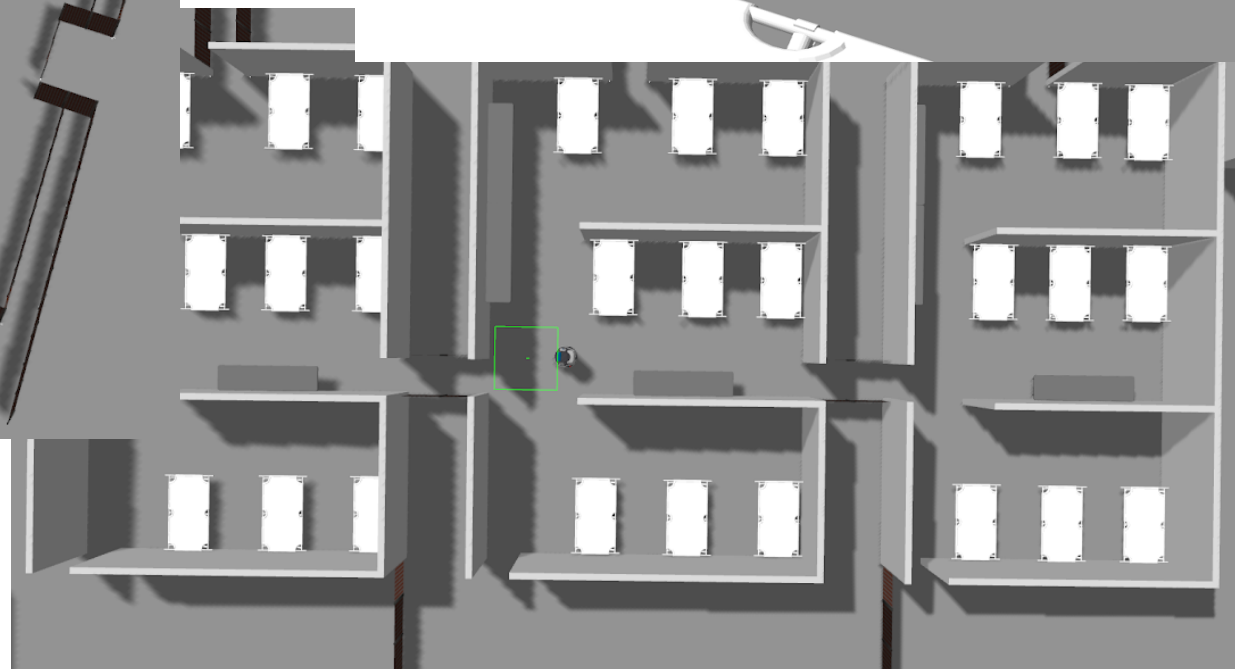
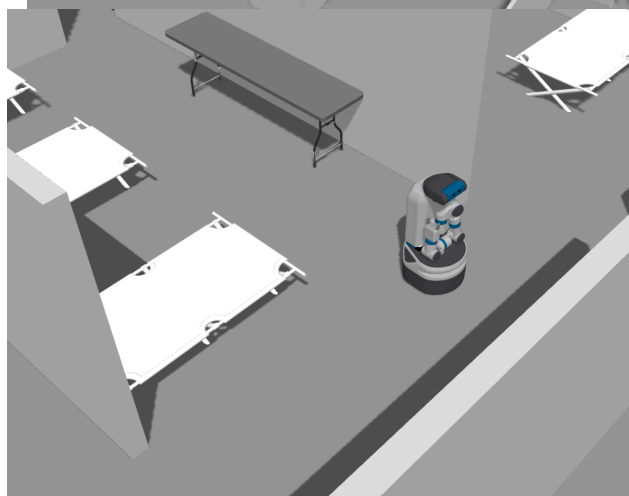
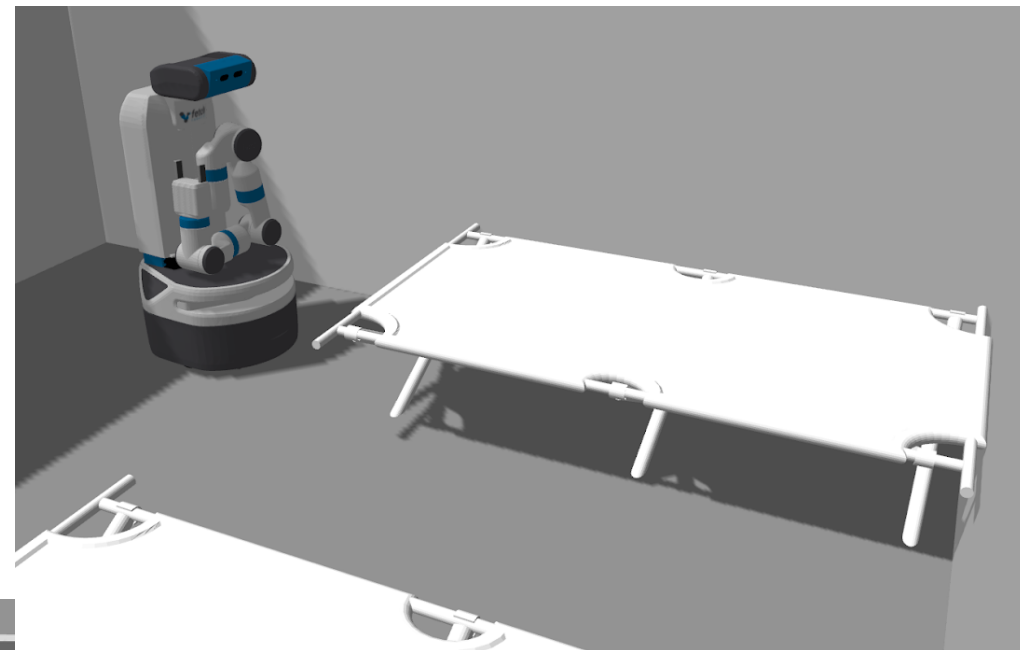
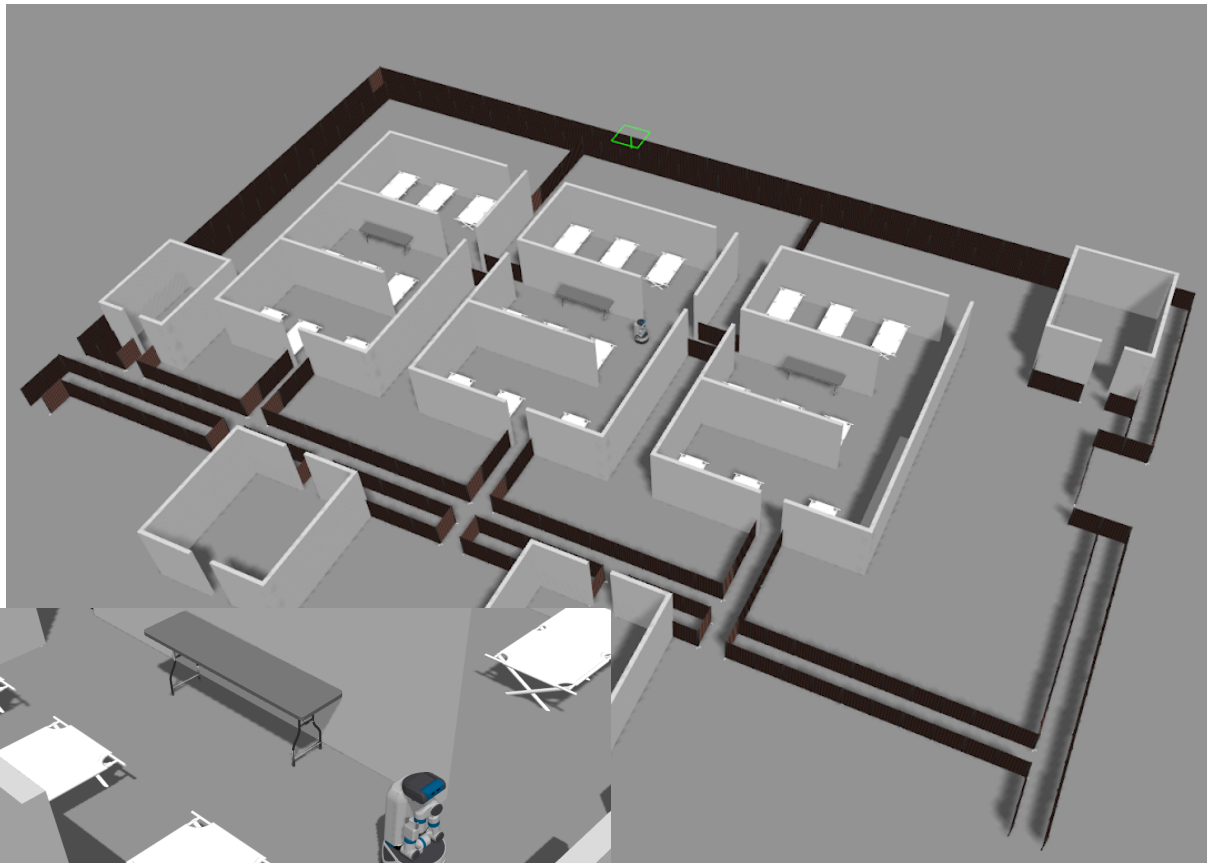
Year 2

- Ebola Treatment Unit simulation
- tele-presence compliance study
- navigation uncertainty minimization

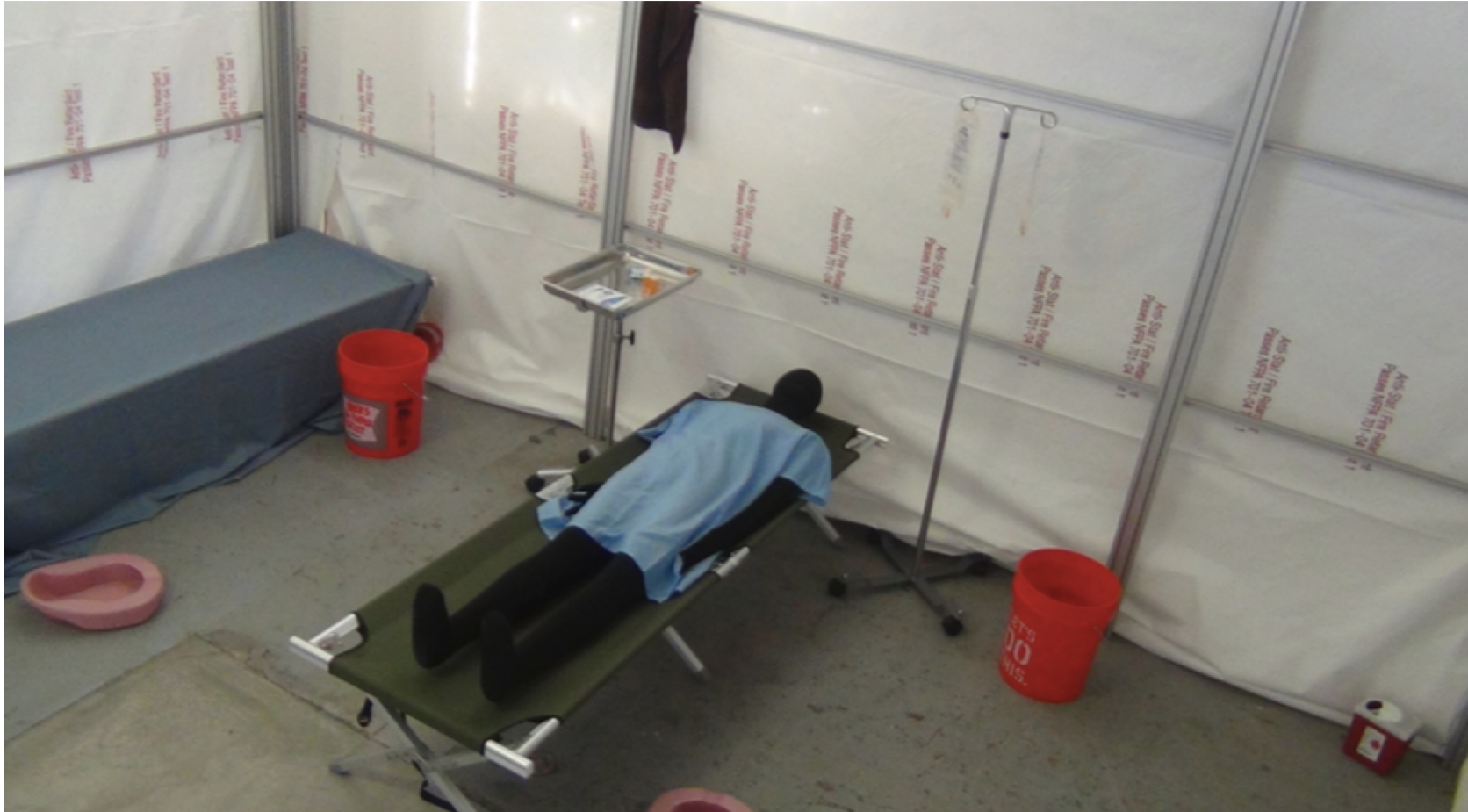
- but...



Year 2: Gazebo Simulation

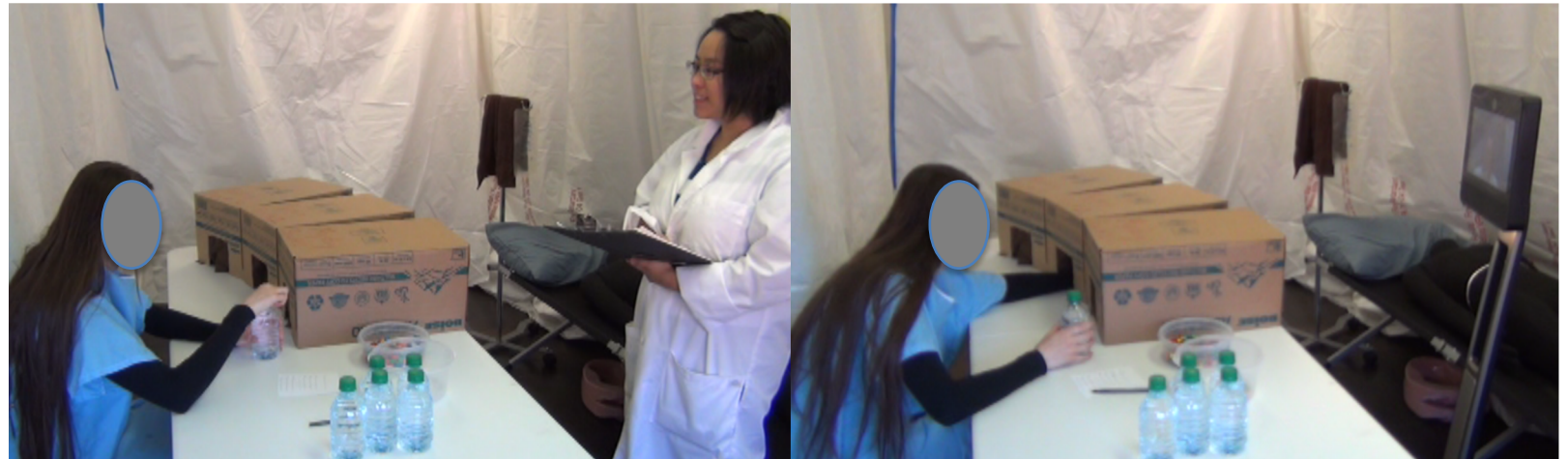


Year 2: Larger Physical Simulation



Year 2: Compliance Study

- will subjects follow instructions
 - in-person medical personnel
 - tele-present medical personnel
- drinking task



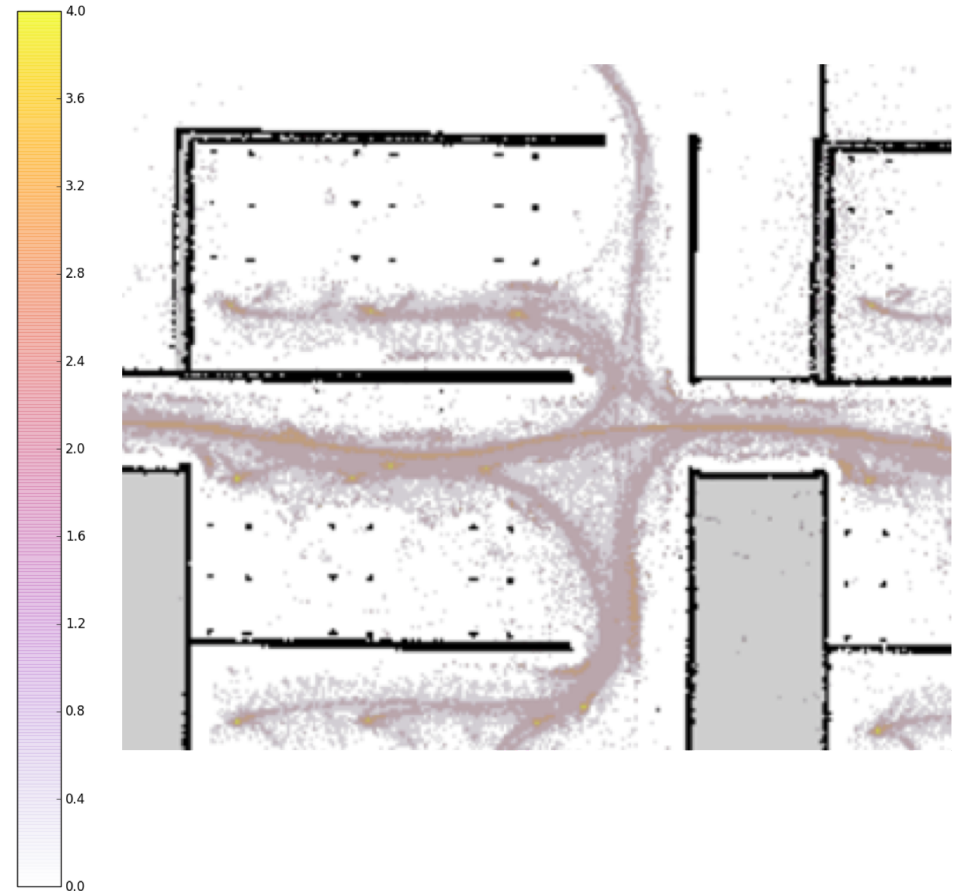
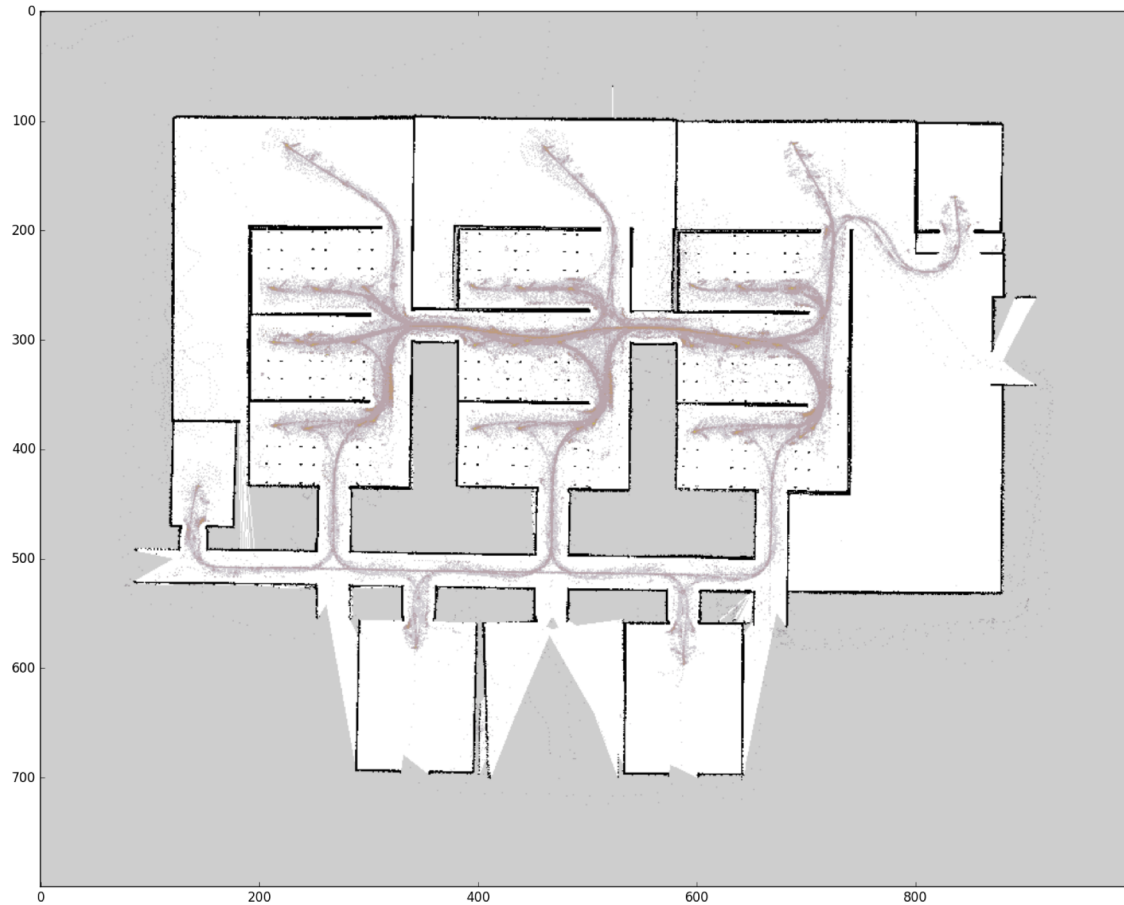
Year 2: Compliance Study

- no strong difference between in-person and tele-present
- identified some flaws in experimental design
- running new experiment in year 3

Year 2: Navigation Uncertainty

- want to focus on allocating tasks to humans and robots to minimize variance in task execution time
 - reliably execute core set of tasks in ETU
 - without running over time
- identify (and fix) problem navigation areas in ETU

Year 2: Navigation Uncertainty



Year 3 Plans

- reconnect with Médecins Sans Frontières
- new compliance study
 - PPE vs tele-presence in self-care task
 - measure stickiness of complicity
- blame allocation study
 - does blame stick to a particular robot in a delivery task
 - long-term, working with local nursing students

Year 3 Plans

- uncertainty-aware navigation planning
 - more reliable end-to-end navigation times
 - deep network prediction of problem areas in novel maps
- human-robot team task allocation
 - feeding and vital-sign monitoring task

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