MIDAS-FAST: Design and Validation of a Model-Based Tool to Predict Operator Performance with Robotic Arm Automation

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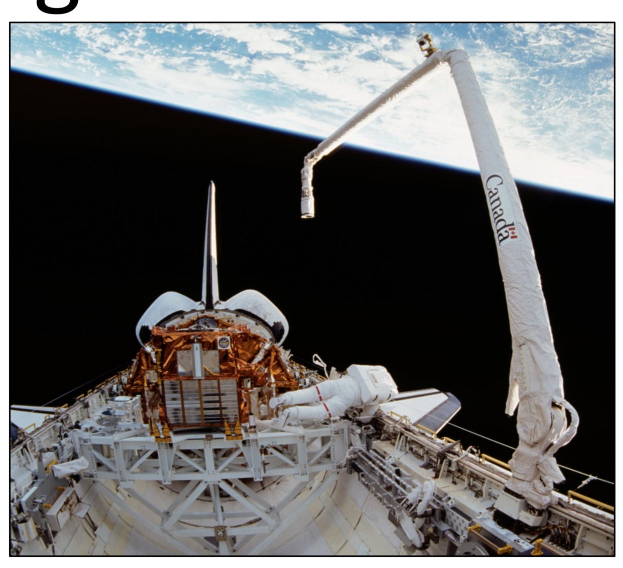
Goals and Approach

- To predict operator performance in robotic tasks
- To use empirical data and targeted experiments to model human interaction with imperfect automation
- To perform empirical validation studies to compare model predictions with human performance results
- To deepen understanding of factors affecting operator performance in robotic missions

Questions about Modeling

- Does it accurately predict what humans will do?
- Does it accurately predict human performance in automation failure conditions?



By NASA - https://archive.org/details/STS072-722-041

Benefits of Modeling and Simulation to Predict Human Performance

- Predict human performance in not yet built systems
- Identify human errors, workload, mission completion times for situations that cannot be tested or are cost prohibitive to test
- Has been used by / to predict:

The Department of Defense

- Optimal staffing in combat vehicles
- Emergency preparedness

NASA

- Robotic mission performance
- Effectiveness of radiation protection procedures

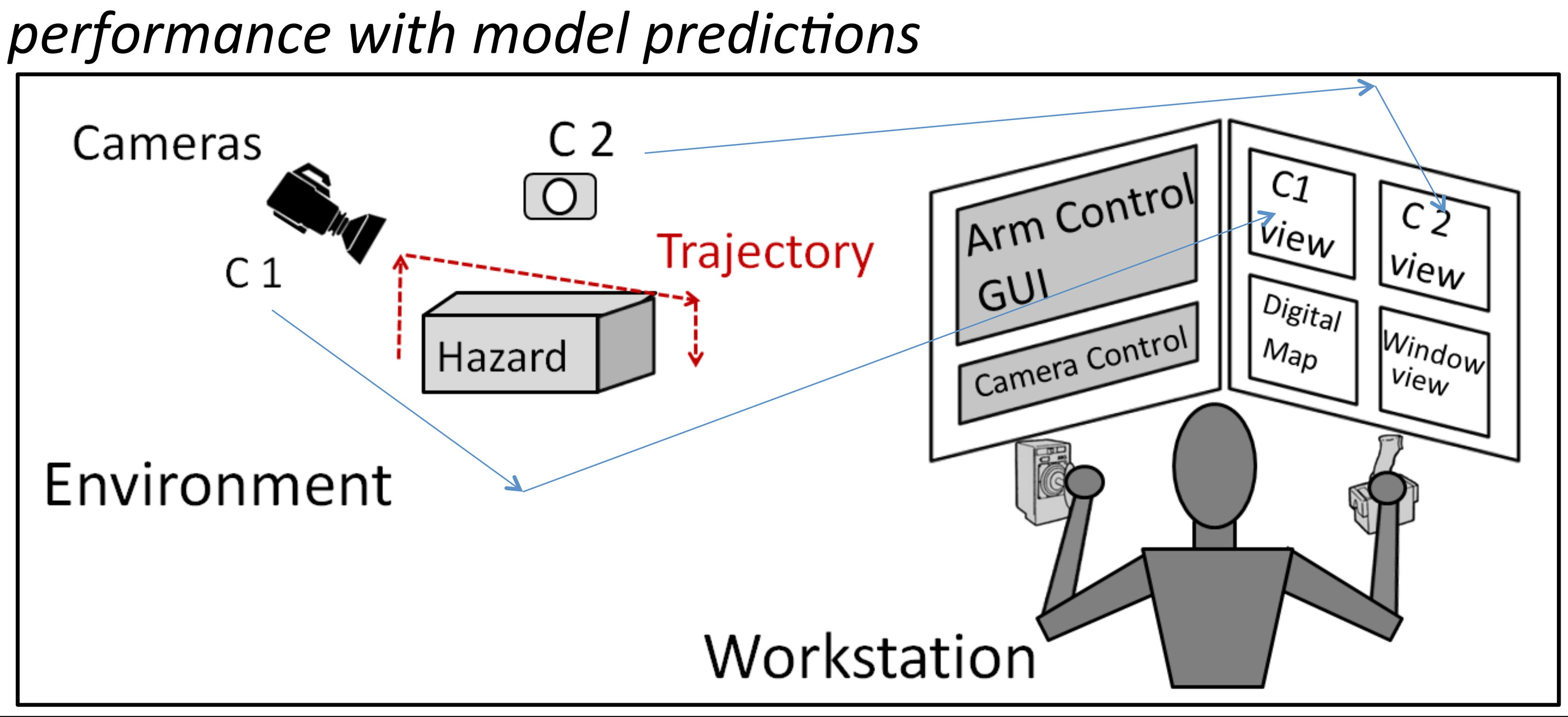
The US Nuclear Regulatory Commission

- Control room crew response to emergency events

Experimental Studies and Validation

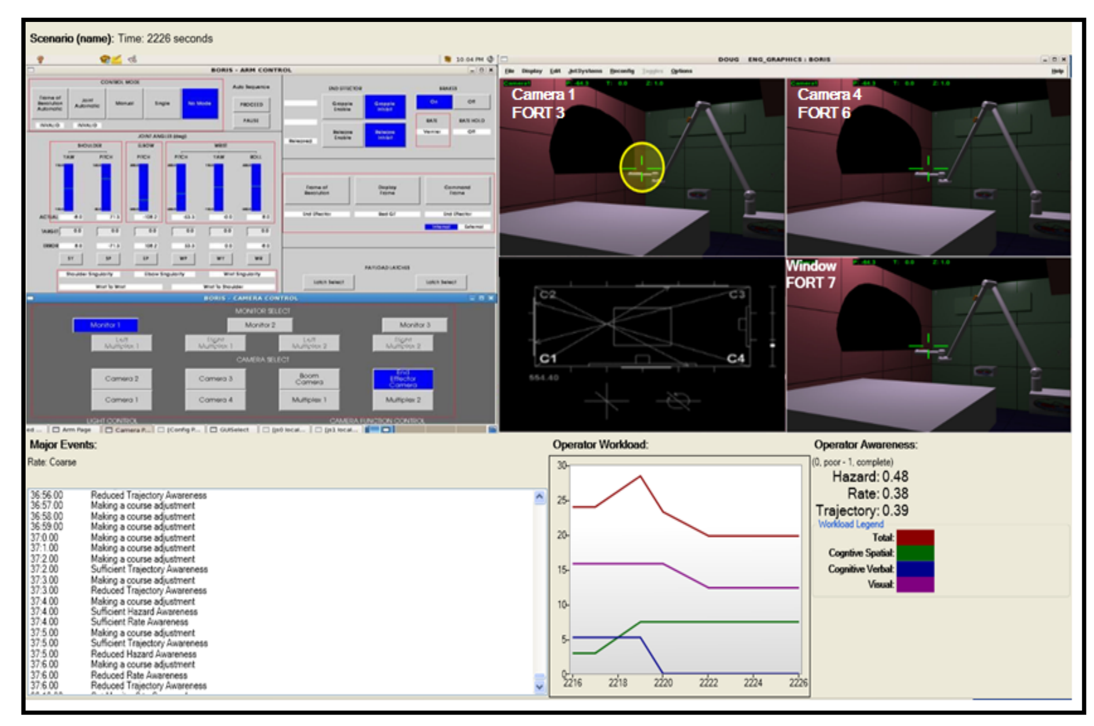
- Different degrees of automation imposed on:
- Trajectory control
- Hazard alerting
- Camera control

Gathered data to compare human performance with model predictions



MIDAS-FAST Model / Software Tool

- User sets up a scenario and runs the model
- The tool provides:
- ***A real-time visualization of the mission***:
- Predicted operator actions
- Visual scanning
- Camera selection
- Workload and situation awareness.
- ***Data files of predicted actions***: trajectory performance, response to automation failure, workload, situation awareness, camera selection, and visual scanning behavior



Contributions of MIDAS-FAST to the field of Human-Automation Interaction

The Lumberjack Analogy – the taller the tree (the more automated the system), the harder it falls (the worse when it fails)

The Frame of Reference Transformation (FORT) model of spatial cognition implemented in a dynamic environment

A proof of concept for an approach to model validation using human-in-the-loop experimentation

A proof of concept tool integrating a human model and robotic simulation

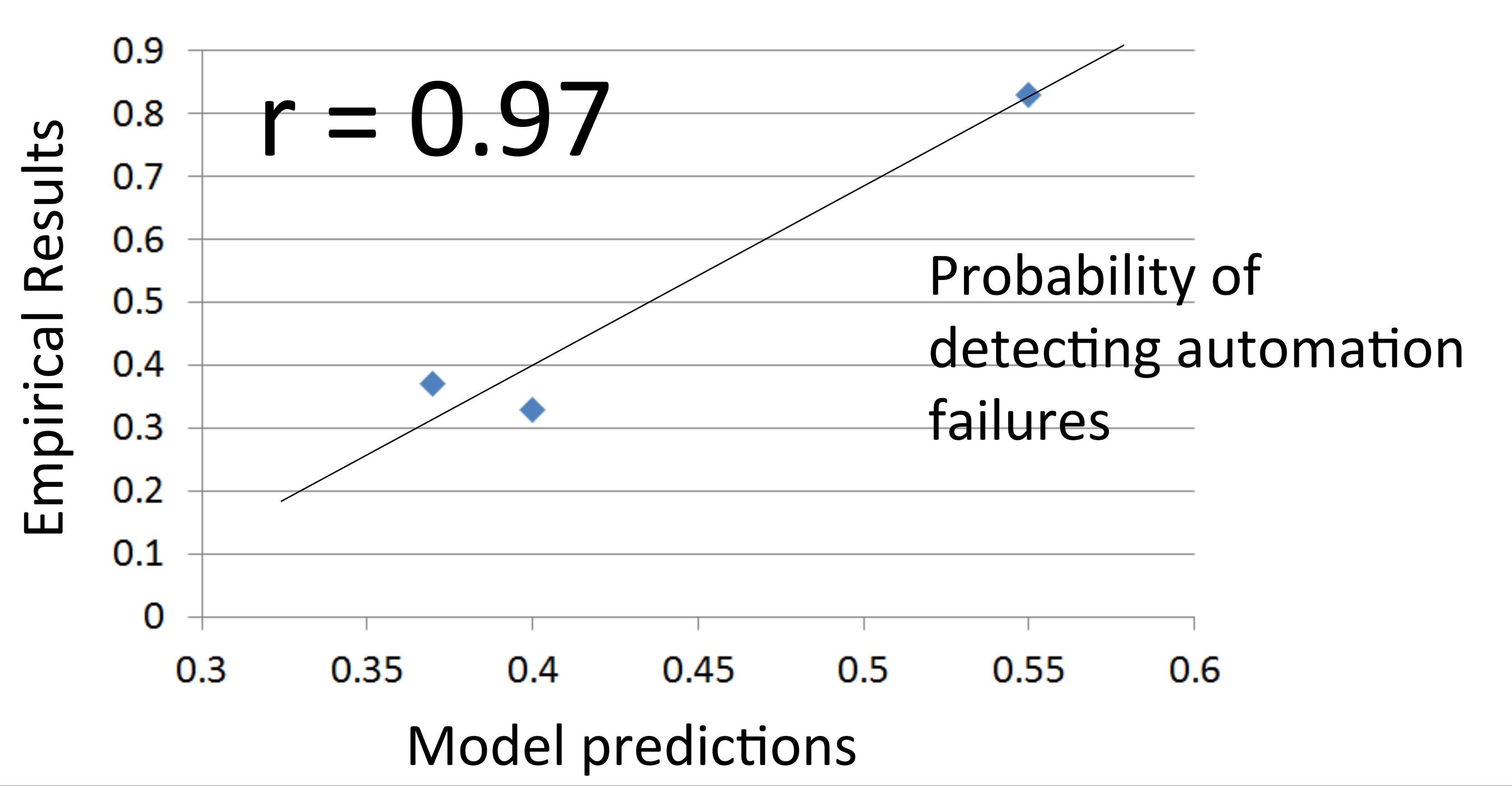
Empirical research into Human-Automation Interaction

Better understanding of ***operator performance*** in robotic missions:

1. The view of the arm and the control dynamics (FORT)
2. Degree of automation
3. Automation success or failure, and TYPE of failure
4. Operator visual scanning behaviors
5. Trajectory complexity - turns, obstacles, potential collision surfaces

Results Indicate Valid Model Predictions

Correlation (r) between model predictions human performance:



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