

## FY24 Strategic University Research Partnership (SURP)

## **Applying Human Certification Approaches to Autonomy Assurance**

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## Objectives

- Develop Stochastic Programming (SP) solver for autonomy V&V.
- Test its feasibility for a user-centered certification methodology.
- Use the Endurance rover project as exemplary motivation.
- Develop effective system for establishing a probabilistic map for lunar traversability.



## Background

# Motivated by the Endurance rover concept.

Satellite imagery is used to path plan on the moon.

Certification of an autonomy's decision-making process needs an accurate basis for evaluation, which can be achieved by using an approach such as Stochastic Programming, able to converge towards the optimal decision given more time and computational resources than would be available for autonomy executing on a space system.



Satellite imagery is a "blurred version" of the real surface. (.5m/px max resolution)

It would be useful to predict the unknown surface using the blurry satellite imagery.

### **Approach and Results Traversability prediction model Expected value path planning Multiclass classification** Cost map **CV** labeling technique Path finding testing summary Path planning Turn expected values into Solve cost map using A\* search to Label image Score image Probability Average Average max a cost map for the entire minimize path cost. path score risk score imagery region. 1799 Human 58.2 1102 Model 46.4 $\overrightarrow{\mathbf{X}}$ Max resolution **Blurred** Best 831 39 The model is trained "knowing" possible the true score but only "seeing" Model outperforms human 1 <-Traversability Score-> 10 the blurred image. SP cost map example Cost example **Stochastic programming** R25 Cost for a move assessed based \*Using a 2-outcome scenario G50 G50 path planning R50 R50 R25 on successful route for the example. G75 G50 **Probability x Velocity/distance** R25 R25 R50 G50 Passable (G) & R50 G75 R50 All possible outcomes for Cost for initial move North R25 Impassible (R) R50 G50 initial move North. G50 **P=0.5** G50 R50 Two potential successful paths: G75 R25 set to 50-50. R50 R50 R25 =0.017578125 G75 R25 G75 G50 R25 G50 G25 G75 R75 R25 R25 G50 R50 R50 G75 R50 G75 R25 R50 P=0.03515625 P=0.09375 R25 G50 P=0.375 R50= R25 G25 G50 G75 G50 G50 R50 R50 R25 Placed in a region R75 R50 G75 R25 G25 G50 R75 i R50 P=0.017578125



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### **Publications:**

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