



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Ethan M. Uetrecht	Project Number S0835
Project Title Reducing Reliance on the DSN: Autonomous Satellite Location Determination	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Space vehicles that venture beyond an Earth orbit rely on the Deep Space Network (DSN) for determining their trajectory. As concurrent missions increase, DSN may become overbooked, resulting in a reduction in trajectory update frequency, vital communications, or both. The purpose of this project is to study methods to reduce reliance on the DSN by providing autonomous satellite location determination.</p> <p>Methods/Materials A simulation of the solar system, including the eight planets, three large asteroids, and a satellite, was created using MATLAB software. The satellite was modeled to periodically image solar system objects with respect to local star backgrounds and solve for its position using these references. The position was then refined using an Earth beacon ranging function. Multiple simulations were run with varying parameters to assess the performance of the method, which was compared to those of the DSN and AutoNav systems.</p> <p>Results This autonomous method resulted in performance for inner solar system missions somewhere between those provided by DSN and AutoNav. The beacon significantly improved radial accuracy and improved overall performance by approximately 20%. Real-time updating of satellite position and velocity instead of batch processing provided continuously accurate trajectory data. Reliance on only the brightest celestial objects reduced requirements for camera sensitivity and therefore complexity and cost.</p> <p>Conclusions/Discussion The results of this project show that DSN support for most inner solar system missions can be minimized through key improvements to the AutoNav system. This method is primarily successful in the inner solar system but remains viable for certain outer solar system missions.</p>	
Summary Statement The purpose of this project is to study methods to reduce reliance on the Deep Space Network by providing autonomous satellite location determination.	
Help Received I did the research and coding myself with the exception of the functions required to graphically visualize the results, which were written by my mentor, Mr. David Uetrecht, Technical Fellow at Boeing. My mentor also answered my questions and helped me with Matlab syntax as needed.	