Project Introduction

The Unmanned Aerial System (UAS) industry in the United States is still very much in its infancy, but its potential impacts on the geospatial mapping and surveying professions are indisputable.

In future years, requirements for imaging and remote-sensing observations with semi-autonomous operations Unmanned Autonomous Vehicle (UAV) will be key requirements for surveys of other planetary atmospheres and surfaces. In anticipation of these requirements, it is imperative that new technologies with increased automation capability, speed, and accuracy that can be achieved during a single mission are developed, evaluated and implemented.

For this project, a prototype autonomous rover system that provides a framework to collect planetary remotely sensed data and leverage cloud computing services to produce environmental mapping products with that data, was developed and tested.

This innovative technology could potentially support a wide variety of planetary data gathering science missions, while at the same time, offer the flexibility to incorporate additional new techniques that could eventually be applied to swarm rovers that integrate planetary aerial and surface access systems. Additionally, this technology could potentially be used to address SSC related facility monitoring and security issues; such as buffer zone intrusions, and provide support for rapid response capability for both natural and manmade disasters.

In military operations, large remotely piloted UAVs have been successfully deployed for several years. The success in this application has spawned a new area of research - micro-autonomous aerial vehicles (micro-AAVs). Over the past two years, this research area has been exploited by universities, and has resulted in a rich collection of micro-AAVs platforms which range from the small, open-platform system using open source waypoint navigation software; to small, production ready, commercial-off-the-shelf platforms with complex highly intelligent flight management systems. These platforms are capable of supporting a full array of sensors and cameras ranging from high-resolution, true-color, still images to high-resolution real-time video streams. In addition, some platforms are capable of supporting near infrared (NIR) cameras that can be used for Normalized Difference Vegetation Index (NDVI) data products useful for vegetation health monitoring similar to those generated today by our team using Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data.
Additionally, for over a decade now, rovers have been successfully used on Mars to collect terrestrial close-up imagery and other sensor data. For future lunar and planetary exploratory missions, the development of smaller and more efficient micro-rover platforms have been proposed, and have been prototyped in a variety of forms and locomotive means. For successful and safe exploration of these surfaces, ultra-high resolution terrain and feature data, as well as, a flexible autonomous system to gather and process this data over wide areas will be required.

For this project, the potential of simulating a rover-balloon tethered system, autonomous cloud enabled system, for gathering and processing low altitude high resolution imagery for the purposes of terrain model and thematic data product creation was explored, and demonstrated. The tablet cameras and sensors were used as a proxy for the AAV sensor and image data. A typical limiting factor associated with the small payload of these systems (micro-AAVs) is the computational power that can be deployed on them, which, correspondingly, limits their autonomous capabilities. To increase computational capacity, data was pushed to a cloud location for access by the processing system. Therefore, this project explored using cloud computing to increase its computational capacity on a tablet.

The tablet and commercial off the shelf (COTS) smartphone with camera was able to establish communication with the cloud by tethering to a tablet mobile Wi-Fi hotspot for internet access. The tablet allowed for real-time data processing, analysis, and autonomous flight operations based on those observations.

Therefore, for this project, the effective computational power of these platforms was increased by simulating cloud computing services via a local virtual machine data processing system. Using this Virtual Machine to establish communication with the cloud, the computational capacity of the simulated micro-AAV was augmented and enabled real-time data processing and analysis based on those observations.

Future testing of this data processing flow via a virtual machine could be directly translated to current cloud computing services with little modification, and once implemented could enhance available UAV aerial rapid response platforms capabilities in their ability to respond to natural or manmade disasters.

Anticipated Benefits
Benefits to NASA funded missions include enabling SSC to continue cultivating state-of-the-art cloud computing demonstration applications and capabilities, to support SSC science missions, propulsion testing, and base operations. The innovative platform also provides the flexibility to incorporate new techniques, as they are developed, that can be applied to orbital, deep space and planetary missions, such as the development of fault-tolerant, adaptive systems, and coordinated operations of multiple vehicles.

The technical staff at SSC is uniquely qualified to bridge the gap between aerial vehicles, cloud computing and scientific application of this technology. There are science projects across the agency that would directly benefit from this novel technology, including, but not limited to projects in the barrier islands, coastal marshes, and support activities related to the Early Warning Systems for the US Forest Service.

NASA funded remote sensing missions could also benefit from autonomous vehicles with high capacity computational power because it provides a way to get high fidelity data in areas that is not safe, or inaccessible to humans. The computational technology also has potential applicability for providing high-definition video of engine tests using Infrared (IR) sensors to detect hot spots during propulsion tests.

Benefits to NASA unfunded missions and planned missions with UAS represent a new step in aerospace evolution. The lack of crew on-board and the technologies developed for increasing computing capabilities can help increase endurance contributed to a minimum carbon/noise footprint, compared with manned aviation; reduced number of mission cycles due to increased endurance and persistence. Additionally, UAS are an efficient tool for environmental monitoring, complementing current means like satellite and ground sensors.

Additionally, UAS have the potential to revolutionize the geospatial profession.

- less disruptive means of acquiring surveying and mapping versus ground collection,
- safer method of data collection because surveyors are no longer in harm’s way as they attempt to navigate traffic conditions,

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reduction (or elimination) of traffic closures while surveys are performed,
unobstructed property access where formerly data collection may have been obstructed, and
repeated flyovers that improve monitoring (such as construction progress)

Benefits to the commercial space industry are similar to those that would benefit NASA. However, the private sector will probably take the lead on refining these technologies like the autonomous cloud enabled robotic system, and future similar type developments will strengthen the UAS technological and industrial base. The advent of UAS with advanced computational capabilities is the next logical step in the evolution of commercial space industry data collection portfolio, enabling the migration of their existing processes to a more flexible—and, in some cases, more accurate—platform.

Benefits to other government agencies are similar to those that would benefit NASA. The technology provides value to other government agencies such as Homeland Security, EPA, FEMA, and Department of Defense for emergency and potentially covert activities where human traverse would be infeasible or implausible to gather low altitude, high resolution fidelity data. Difficult areas needing traverse could be terrestrial or coastal studies of marsh land.

Primary U.S. Work Locations and Key Partners

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<thead>
<tr>
<th>Organizations Performing Work</th>
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Co-Funding Partners | Type | Location
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None | Industry | 

Primary U.S. Work Locations

Mississippi

Images

**Image Graphically Depicting Unique Approach**
Graphically Depiction (https://techport.nasa.gov/image/3982)

**Testing and Field Photos**
Field Photos (https://techport.nasa.nasa.gov/image/3983)