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Unmanned Aircraft Systems... Technology Creating New Perspectives That Will Open The Imagination of Future Generations

by Jonathan Beck

Imaginations fueled with fascination continue to explore the potential Unmanned Aircraft Systems (UAS) have to positively benefit our lives and change the way we look at the world. UAS are another contributor in the aviation community fostering excitement and intrigue, driving people's creativity, and inventions for new ways to utilize technology. UAS continue to be an exciting technology with broad impact to many disciplines.



Jonathan Beck

Although a small acronym, UAS are a very large topic raising hot debates across the county. Five years ago, headlines were filled with controversial stories about bringing military technology used overseas in war back to the United States and into the airspace overhead. This raised privacy concerns and fears of what else might accompany the use of UAS technology.

In the last few years, there has been a dramatic shift with the emergence of small UAS for a wide range of civil applications, demonstrating the positive impact these systems offer for diverse industries and applications. Some of the most predominant industries impacted by the technology today include cinematography, agriculture, land survey and mapping, infrastructure inspection, logistics, and public safety. Although the positive benefits are being realized, the proliferation of small UAS has caused concerns with routine sighting of UAS in areas posing safety hazards.

A key to advancing UAS technology safely will be the education of the technicians who operate and maintain

UAS. Effective use of the technology will require technicians skilled at operating the systems for a wide range of demands including the processing and analysis of the imagery and data collected. Future technicians and entrepreneurs pursuing UAS technology must understand the differences in system interfaces and their correlation relating to specific tasks.

There are many platforms with a wide range of options and accessories available based on how the operator intends to use the system. Two of the most well known manufacturers in the small UAS industry are DJI and 3D Robotics.



The "DJI Go" application can be downloaded to a smart device and used with a DJI remote control for flying DJI UAS and to monitor and capture live video and imagery.

DJI is an industry leader in small UAS and offers platforms that utilize an application that can be downloaded on iPhones or other smart devices. The "Go Pilot" app provides a user-friendly interface the operator can use to monitor digital readouts for altitudes, distances, rate of change measurements and battery status. Operators are

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able to perform automatic flight modes with the click of a button for multiple functions including takeoff, GPS waypoint navigation, return to home point and landing. The application on the smart device, paired with the remote control, allows the operator the ability to maneuver the aircraft and the built-in camera sensor while monitoring the live video downlink. With the latest platforms, 4k-resolution video and 12 mega pixel still imagery can be captured. Imagery and data is stored onboard the aircraft, but it can also be seamlessly transferred to a smart device or a computer for further processing.

3D Robotics manufactures a number of systems compatible with typical remote control, but can also perform a variety of automated flight modes. Switches on the remotes can be programmed to perform functions of altitude hold, position hold, orbit a point or transfer control to a ground control station (GCS) computer. Once control is transferred to the GCS, the operator has a much more detailed view of the performance of the aircraft, along with control functions, such as preprogrammed flight plan navigation. Flight plans can be generated to perform specific patterns that may assist in collecting the desired imagery and data for specific applications.

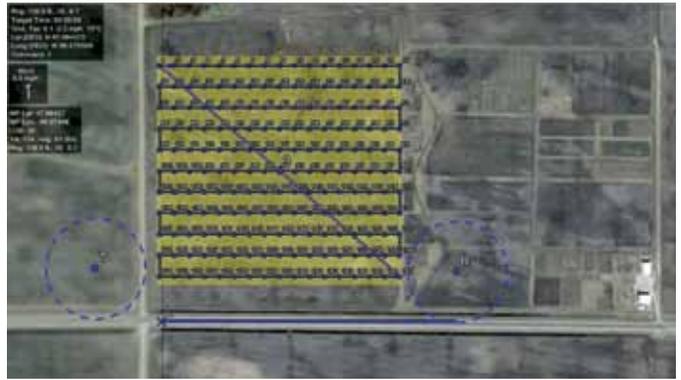
There are many do-it-yourself homebuilt UAS that provide a platform to install aftermarket parts and camera systems. These additions may or may not tie directly into the electronic control unit for the system.

A common example of a stand alone after market add-on is to mount a Go-Pro camera system onto a UAS. The Go-Pro system allows the operator to start recording before the aircraft takes off and continues to record the whole time the aircraft is in flight. This might be good for cinematography as it offers a good solution to capture high-resolution video, but it requires additional data storage and post flight editing.

Engineers continue to invent new designs and features to increase the capabilities of UAS. However, many manufacturers have also recognized hazards UAS can pose when operated in certain areas, such as airport environments, temporary flight restrictions (TFRs), or at distances and altitudes not allowing the operator to visually monitor the aircraft to perform see and avoid. As a result, many systems now employ “geo-fencing” defined boundaries in the control software that can be adjusted by the operator.

A geo-fence is a boundary created using GPS technology that defines a specific area or distance including the altitude that the aircraft can fly from the operator. This provides a control zone or containment area that can be very useful and assist in situational awareness for operating UAS.

Some manufacturers have gone so far as to build in restriction zones based on airports, airways and critical areas, such as TFRs. DJI has several UAS that incorporate a boundary within certain proximity of airports that will not allow the UAS to turn motors. If slightly outside the boundary area, the operator can fly up to 35 feet and then climb at a slant to 400 feet once 5 miles or greater from an



A typical flight plan, takeoff and landing setup for the ground control station software for operating Sentera's Phoenix UAS.

airport. These implementations are not a perfect solution to prevent common safety hazards, but are a great step to continue advancing the technology, while acting as good stewards of the airspace.

Over the past few years, after obtaining a Certificate of Authorization (COA) or Federal Aviation Administration (FAA) approval, Northland Community and Technical College has conducted extensive work using the Phoenix fixed-wing UAS manufactured by Minnesota-based company, Sentera LLC of Minneapolis. This system is flown completely off of a ground control station (GCS) computer. Operators must ensure proper input of preset information into the software driving the flight of the UAS. The operator always maintains the ability to manually control the aircraft at anytime. When information is properly inputted, the result will allow for many automated flight mode functions.

The configuration of the Phoenix Northland uses is designed specifically around agriculture, but can also be modified based on application. The GCS allows a flight plan to be generated by simply clicking in the middle of a field on a software map for application in production agriculture. A square is generated to define the boundary and the operator can expand the edges to the outside boundaries of the field. Once the boundary is defined, a default flight plan is created consisting of parallel passes the aircraft will fly while capturing still images. If there is a crosswind at altitude, the autopilot turns the aircraft into the wind the necessary amount to compensate and maintain the preprogrammed flight path. The images are captured with a preset amount of overlap to be processed post flight for further evaluation.

In the first year of Northland's UAS flight operations, a lot of images and data were collected and analyzed by growers, commodity associations and industry partners. The result was a Minnesota Department of Agriculture grant being awarded to Northland this past year based on the identification of a handful of field level practical applications for the technology.

The title of the project is “Digital Imagery, Precision Agriculture,” with a goal to streamline the process of turning digital imagery into usable products that could be read and utilized by commercial applicator vehicles in farming. This



More than 500 images collected by the Phoenix UAS have been stitched together into one large mosaic image of the University of Minnesota Magnusson Research Farm in Roseau, Minnesota.

requires applied research to create an efficient and effective use of the information collected using UAS technology.

The Minnesota Department of Agriculture project has led to an understanding of the necessary software tools, database management practices and processing techniques to develop the imagery and data collected for uses, such as identifying specific signatures for weeds and plant stress leading to prescriptions that can be utilized by applicator vehicles. Some of the tools include software to combine or “stitch” the multiple still images by correlating pixel points and geo-tags to make a mosaic or single image of a large section. Once a mosaic is created, it can be imported into a geographic information system tool and used for a wide range of applications, such as marking geo-reference areas, topography mapping, or identifying visual signatures of interest. The outputs of the project will lead to increased yield production, reduction of inputs, and greater environmental stewardship.

Different applications will greatly change the operational concepts and safety considerations that UAS technicians need to take into account. For example, the collection of information to support production agriculture, infrastructure inspection and public safety will all require very different considerations for planning. Production agriculture provides a static environment, typically very little for obstacles and obstructions, and would most likely utilize a preset flight plan in which the UAS technician monitors systems to make sure they are functioning properly. Infrastructure inspection would most likely involve operating around obstructions and understanding the correct stand-off distance for both

safety and capturing the desired information relevant to the application. Public safety requires a high level of safety considerations based on a dynamically changing situation on the ground and during flight. Each application requires a unique understanding of the end user requirements, as well as a comprehensive approach on how to employ UAS effectively, to produce the desired products while doing it safely.

UAS technology is transforming aviation and the demands for future technician education. Northland is developing the necessary technician education programs to support these needs. This year, Northland was awarded a National Science Foundation (NSF) Advanced Technological Education (ATE) Project Grant (DUE 1501629) to develop curriculum and pathways material for emerging careers in UAS technology. This coming summer, Northland will provide workshops for educators and summer camps for secondary students. These opportunities will provide access and create awareness of the potential UAS have and the impact they are creating.

Six National UAS Test Sites are already leading the way on integration initiatives, but the initiative stretches beyond these boundaries and across the country. Now is the time to prepare by leveraging the expertise of aviation innovators who have led us to today to help write the pages of tomorrow. Relationships between education, government and industry partners are key to advance technician education, parallel to significant changes resulting from integration of UAS technology. A highly educated technician workforce will allow for safe and effective integration of UAS technology across a wide range of applications expanding beyond potential into actual transformation of our future. It will also allow for all stakeholders affected by the integration of UAS to advance with the technology, create opportunities, and expand careers in related disciplines. The results will open the doors to advance our knowledge about a technology creating new perspectives that have never existed. These perspectives will open the imagination of future generations, only limited by what we choose to explore.

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