A Multipurpose Unmanned Aerial Vehicle (UAV) for Water Sampling and Mapping in a Flooded Mine Pit

Ian S. Fairweather (ian@fairweatherit.com) (Fairweather IT LLC, Bozeman, MT, USA)
Loren Burmeister (Atlantic Richfield Company, Butte, MT, USA)
Jim Jonas (Copper Environmental Consultants, Anaconda, MT, USA)

Background/Objectives. Water-filled mining pits and their monitoring is an important task for mining remediation work today. Sampling the water for chemical analysis and mapping the shoreline and pit walls to assess geologic stability are primary concerns of liability managers. Due to acidic pit waters and the geologic instability of the its walls, direct human water sampling is not recommended and often not permitted. The size of some pits makes assessing pit wall stability difficult from a remote, safe location. With the technological advent of unmanned aerial vehicles (UAVs), The team has developed a multi-use unique flying platform capable of collecting in-situ water samples at depths up to 200 ft, and collecting photogrammetric imagery of pit mine walls and shore.

Approach/Activities. Out team partnered to develop a system to accomplish the goal of remotely collecting water samples and mapping using a UAV. Our method uses commercial off the shelf DJI Matrice 600 Pro hexacopter modified with a level-wind fishing reel controlled by a continuous rotation servo. The Kemmerer collection bottle is connected to a high tensile strength braided line and the collection messenger is released by a mechanism controlled by a standard servo. Equipment release functionality is controlled using a similar method to the messenger release. All controls are accessed using the standard DJI UAV remote control with the added channel expansion kit. Accurate depths can be attained using the UAV altitude above water surface, measured by GPS and barometer in conjunction with a line counter attached to the reel. Imagery collection of the Pit walls and shore is performed with the onboard gimbaled camera and special UAV flight planning software that allows for the collection of linear features as opposed to areas. This allows the UAV to only collect imagery around the perimeter of the pit shore removing thousands of images of the water surface. Homogeneous images, such as water surface, cannot be stitched using traditional photogrammetry and removal of full water images allows for faster orthoimage and 3-D data product generation using commercial UAV stitching algorithms.

Results/Lessons Learned. Through this process the team has discovered many challenges utilizing this technology in an active mining area. Administrative challenges include the requirement that UAV pilots must first pass a FAA exam and receive a Section 107 UAV Commercial pilots license to operate the UAV for commercial purposes in the USA. In addition, the proximity of the site to controlled airspace requires UAV pilots to receive a special FAA airspace wavier to operate in restricted airspace and FAA approval can take much longer than expected. Site elevation, weather conditions, avian activity, and radio communication interference can also present challenges to UAV operations at particular sites. Post-processing and hardware requirements to process the 1000 individual images in each data collect can also present technological issues.