AMSERP–Adaptable Multi-Sensor Emplacement & Recovery Payload

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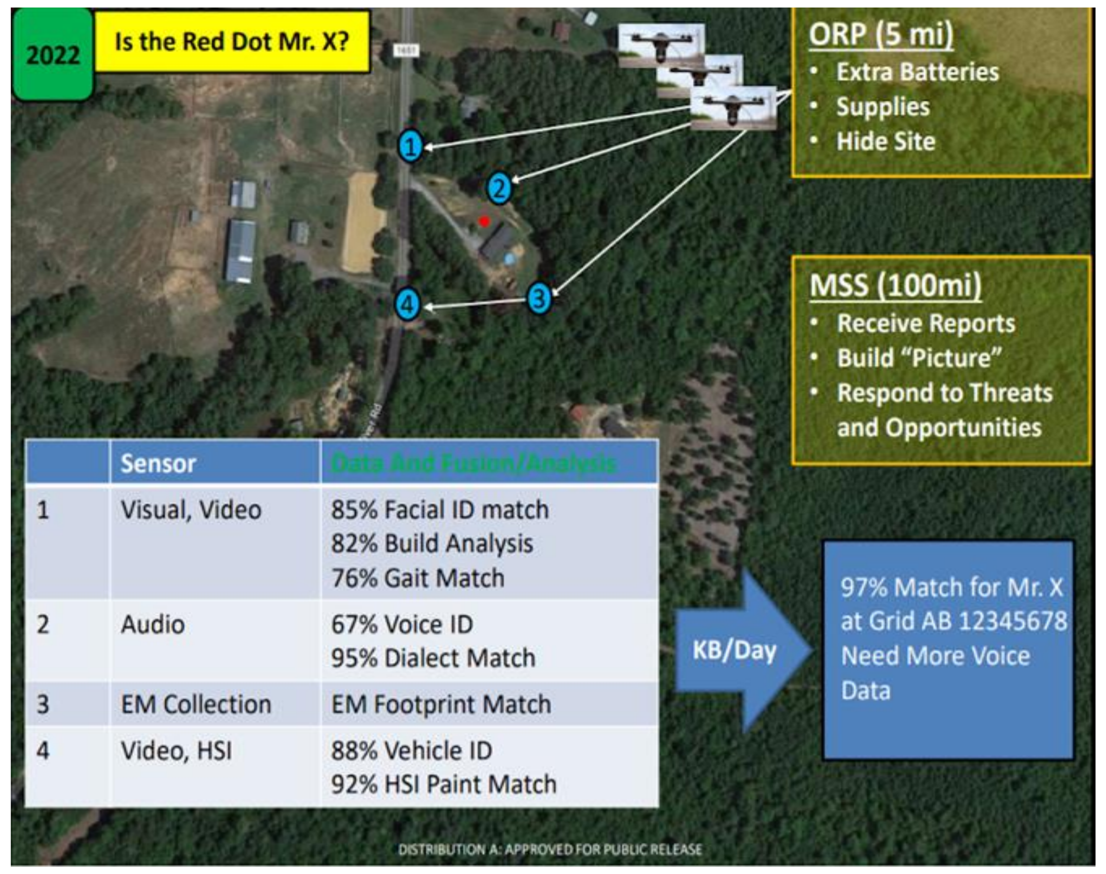
Introduction

In an effort to gain information on strategic targets the customer utilizes small teams of well-trained individuals to place sensors and observe the target area. This process has several risks to both the personnel and the mission itself; therefore, it is desired that the task be accomplished autonomously or semi-autonomously. The customer has requested a demonstration of a proof of concept (PoC) by utilizing an unmanned aerial system (UAS) to place four sensors within 300-500 m of the target area. The target area has been defined as an isolated building with concealment with a theoretical Mr. X being the target as shown in Figure 1 below.



Aim

The customer has set for the following constraints:

- Range of 2 km, threshold of 1.5 km
- Horizontal accuracy of +/- 1 m, threshold of +/- 1.5 m
- Payload of 4.5 kg, threshold of 3.2 kg
- Budget of $5,000
- Operable by single user
- Deploy and recover 4 sensors

Additionally, the PoC will be evaluated on its level of autonomy, acoustic signature, adaptability, and scalability.

Conceptual designs considered include:

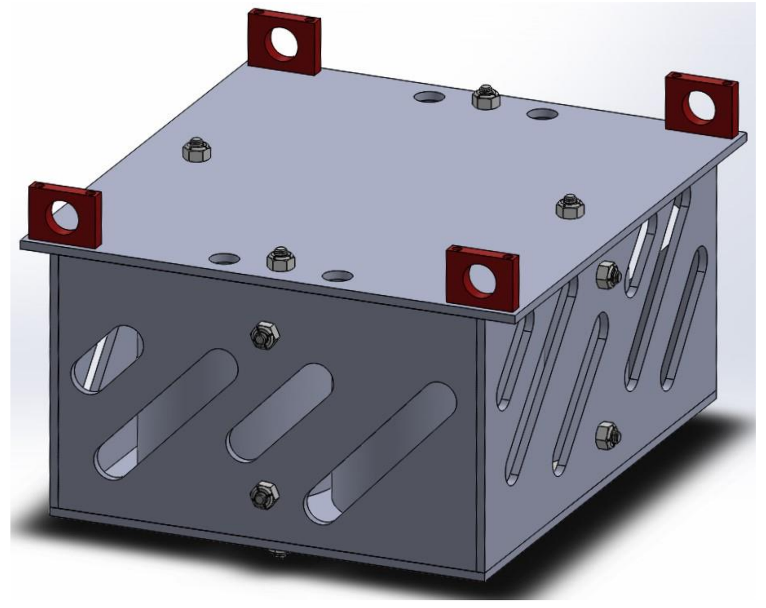
Concept 1, Cantilever Arm
Concept 2, Fixed Wing UAV
Concept 3, Fulton Recovery
Concept 4, Transforming UAV
Concept 5, Single Use UAV
Concept 6, SSE Recovery
Concept 7, AMSERP

Methods

- Airframe

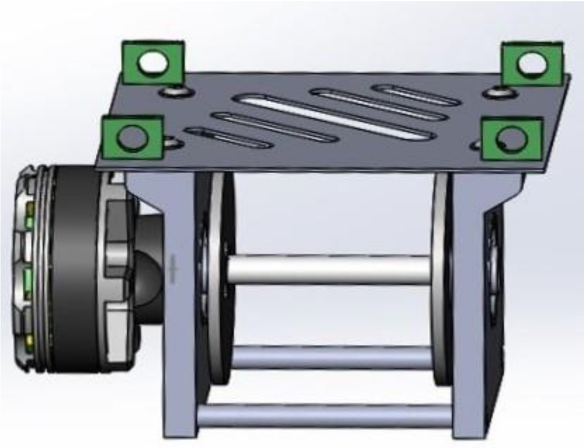
To reduce costs and increase modularity, the team utilized a Commercial Off the Shelf (COTS) DJI M600 that was provided at no charge by Oklahoma State University's (OSU) Unmanned Systems Research Institute (USRI). This allowed a stable platform from which to deploy and recover the sensors, while meeting all customer requirements.

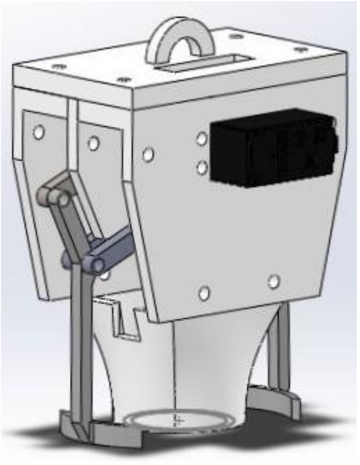
- Emplacement Mechanism



To deploy the required four sensors and allow mission adaptability, a set of four polymer tubes in a carbon fiber housing were fitted with analog servos. The servos are positioned in such a way to facilitate individual deployment of the user selected servo, allowing different types of sensors to be placed during the same sortie.

- Recovery Mechanism





Recovery is to be accomplished by the use of an electromagnet based "claw" that is attached to a winch assembly via high strength braided cordage. The "claw" will be lowered to approximately 2 m below the aircraft and the electromagnet engaged. The pilot flies a grid over the sensor which eliminates the need for precision guidance. Once the sensor and magnet mate up, the arms of the claw engage, gripping the sensor. The winch then reels in the claw and sensor to the base of the aircraft before returning to the launch site.

- Controls

Streamlining of the user interface was accomplished by utilizing the commercially available DJI controller "backpack" and the built-in auxiliary channels on the M600. These were used to control the servos, winch motor, and electromagnet.

Results

Having tested the system, there are apparent challenges that must be better addressed in future development; however, AMSERP was successful in deploying four sensors varying in weight from 320 g to 570 g, meeting the customer's requirements. Additionally, recovery of the sensors was successful.

Some pros of AMSERP noted during testing included:

- Simplicity of controls and user interface
- Successful deployment and recovery
- Quick swap from deployment to recovery payload
- Tool-less, one-person payload swap
- User control of sensor deployment order
- Portability and low system weight

While the issues experienced with the system were:

- Repeated compass errors, possibly due to magnets
- Weak electromagnet requiring reduced sensor weight
- Snagging of the power and control cords for the "claw"
- Pilot induced oscillation due to swinging of the "claw"
- Obstructed view due to seven segment display
- Faulty sonar readings caused by sonar placement
- High pilot work load requiring experience and skill
- Motor shutter of winch at low RPM (fixed)

These issues should be investigated by future teams during further development of this concept. Future researchers should also test the run time of the aircraft to insure that it matches the marketed run time while carrying a payload as well as the communications range. If electromagnetic interference due to the magnets is an issue, a simple shielding element would solve this issue.

Conclusions

Through testing and evaluation of AMSERP, the concept of a portable, unmanned aerial vehicle, capable of semi-autonomously placing and recovering multiple small sensors has been proven viable. There are issues that must be addressed during further development; however, the mission parameters have been met. With continuing efforts, a field-ready system could be produced that would reduce the workload and, more importantly, the risks associated with the covert emplacement and recovery of intelligence collection sensors near strategic targets. Additionally, this technology could reduce mission costs and increase end user capabilities significantly.

Acknowledgments

Many thanks to everyone at the Richmond Hills facility, especially Dane Johnson and Taylor Mitchell for their expert guidance.

Also, a very special thank you to our customers, Harry Looney, Robert Weinraub and the Systems Engineering Research Center Capstone Marketplace

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