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Characterization of Unpaved Road Condition Through the Use of Remote Sensing

Deliverable 5-A: Candidate and Recommended Remote Sensing Platforms for Unpaved Road Condition Assessment

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www.mtri.org/unpaved

Purpose of this document

This document describes the process of selecting the platform(s) that will carry the sensors during data collections for unpaved road assessment. As described in the project's statement of work, chosen platforms will need to be economical, easy to use with minimal training, and able to make the needed measurements as conveniently as possible.

Motivation

Unpaved road condition can be measured by the selected sensor that was described in Deliverable 4-A, "Candidate and Recommended Remote Sensors for Unpaved Road Condition Assessment" (to be posted to http://www.mtri.org/unpaved/ one approved by the Program Manager). In this report, the selected sensor was the 36.3 megapixel Nikon D800 (7360 x 4912 pixels), with a full-sized (FX) sensor, 4 fps (frames per second) image collection rate, 1.5 kg weight with lens, $3,000 cost, and remote trigger capability, This sensor has size, weight, and power (SWAP) requirements. In this document, the project team will be discussing the process of platform selection, and the platform(s) that have been identified as candidates for our subsequent system design. As also described in the original project statement of work, two types of platforms will be considered: small, unmanned systems, and standard manned fixed-wing aircraft.

Summary of platform requirements

Altitude

The Federal Aviation Administration (FAA) requires that unmanned systems stay out of the national airspace, and must remain below 400ft. For the FAA factsheet that summarizes current regulations on unmanned aerial systems (UAS), please see http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=6287. For manned systems, for safety reasons, the aircraft should never fly below 500ft (navigable airspace includes all airspace 500 feet above ground level, see http://www.faa.gov/air_traffic/publications/atpubs/AIR/air0603.html).

Speed

The maximum speed considered is 60mph (for a manned aircraft). This is above the stall speed of a small manned fixed wing aircraft but slow enough to enable effective data collection.

Payload

The platform must be able to carry 5kg of payload, which consists of the camera, lens, battery, and control-system.

Range

The UAS is required to remain within line-of-sight under current FAA regulations, so the range is limited to several miles. A manned system has unlimited range, for the purposes of this program.

Additional Requirements

There are several other requirements on the platform:

1. It should be reliable
2. If a UAS, it should have an autopilot
3. It should be cost-effective

Platform Types

For unmanned systems, there are fixed-wind, rotary-wing, and aerostat aircraft. For manned systems, there are fixed-wing and rotary-wing platforms. These will be discussed separately.

UAS
The speed/altitude combination restricts us to either rotary-wing or aerostat types (the fixed-wing UAS cannot fly slowly enough to get the image overlap required to calculate critical indicators of unpaved road condition). For the payload required, the aerostat is extremely large (>10m), and would present serious problems in storage and deployment. For this reason, we will only be considering rotary-wing UASs.

Manned
Any manned platform, ranging from ultra-light aircraft to typical single-engine aircraft, will satisfy the requirements. The only factor we will consider is cost.

Candidate UAS Platforms

Table 1, below contains a subset of the information which we used to indicate which platform might be appropriate. All the platforms meet the basic requirements.

Table 1: Comparison of rotary-wing UASs

Manufacturer	Cost	Service location	Comments
Rotomotion SR2	**>$30k**	**France**	**Parent company located in North Carolina. Michigan Tech has purchased from them before, and had unpleasant problems with them.**
Viking Aerospace Wolverine III	**>$50k**	**Oregon**	**Good interactions with company, and good customer reviews.**
Bergen R/C Tazer 800	**<$15k**	**Michigan**	**Excellent service and customer reviews.**
Bergen eObserver	**<$20k**	**Michigan**	**Has gimbaled camera mount.**

Based on Michigan Technological University's previous experience with aquisition of a Rotomotion platform, they were excluded. Based on cost and reliability, the Viking platform was rejected. The platform chosen was the Tazer 800 (see Figure 1), over the eObserver, since a pointable camera mount was not needed. We were able to obtain two of the aircraft , with fixed camera mounts, for under $20k, one with an autopilot, and one without (which is the backup aircraft in case of mechanical problems with the first UAS). Details specifications are shown below (see Figures 1 and 2).

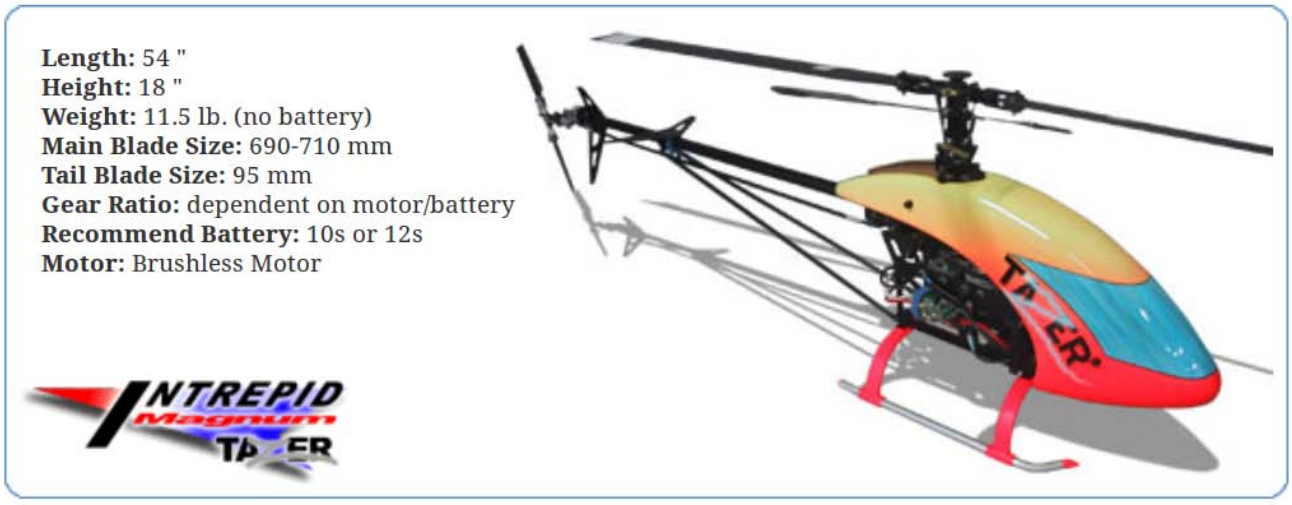

Figure 1: Overview of the selected Tazer 800 UAS platform.

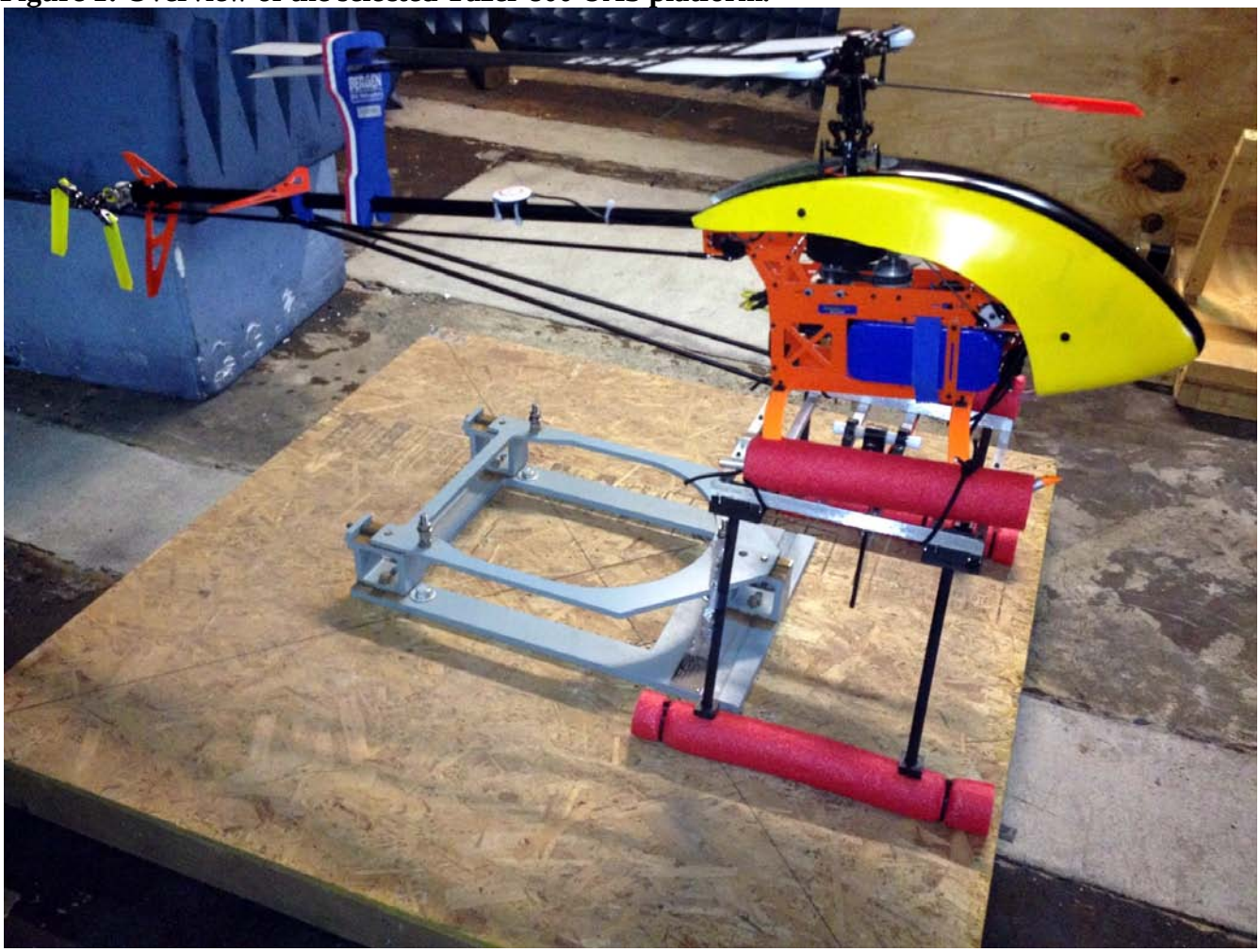

Figure 2: Tazer 800 with fixed camera mount slung underneath.

Candidate Manned Aircraft

The choice a manned aircraft is going to be based solely on availability, which will vary by region, as well as the ability to mount the camera system in a way to look down. This will vary by aircraft, but any typical fixed-wing aircraft will suffice.

Costs to charter an aircraft vary by region, and aircraft type. A typical Cessna 206 rental has been found to cost between $600 - $2000 per hour, depending on the location. Typical mission profiles will last at least 1 hour, and as long as 2 hours. As we get closer to testing the system, we will obtain quotes from local agencies, to determine the cost more closely.

Summary

This deliverable report, 5-A, has described the platforms evaluated and selected for carrying the project's selected digital camera sensor so that the critical indicators of unpaved road condition can be

assessed with the requirements described in Deliverable 1-A (see http://geodjango.mtri.org/unpaved/media/doc/deliverable_Del1-A_RequirementsDocument_MichiganTechUnpavedRoadsr1.pdf). Both manned and unmanned platforms are capable of meeting the data collection requirements. For an unmanned aerial system platform, the Tazer 800 helicopter was selected as meeting data collection needs whereas unmanned fixed wing and aerostat platforms do not meet them. For manned systems, any typical manned fixed wing aircraft will be capable and the exact platform will depend on availability and cost. Upcoming deliverables will describe the software and algorithms needed to support processing of the collected imagery data into useful information, how these data will be made available through a Decision Support System, field deployment plans, and an overall performance evaluation.