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MARKET ANALYSIS AND POTENTIAL OF UAV SYSTEMS FOR MONITORING &CARTOGRAPHY IN ECOLOGY, AGRICULTURE & FORESTRY

This paper describes recent research into Aerial Photography, Cartography and Monitoring Capabilities and Technologies of UAV products currently available into the market. It reviews advancement of small electric powered unmanned air vehicle (UAV) capabilities. Specifically, topics under consideration were Aerial photography and its two uses, Cartography and Monitoring within the context of proposed exploitation of UAV for Planning, control and management in Agriculture, Forestry and Ecology. In the end a design and development of a new micro-UAV "Sparrow-S" is projected.

INTRODUCTION

To effectively tackle the contemporary ecological and environmental hazardous it is important to understand its proper dimensions and dynamism, which are specifically the damages and rapid change over time, to judge the best means of prevention or compensation of changes. For the solution of these ecological and environmental problems a proper monitoring and data generation should be impose to initiate research for ecological and environmental operation. The basic important source of cartography and monitoring are Satellite photography and Aerial photography. Satellite remote sensing mainly consist of capturing aerial photographs on desired surface using wide range of wavelength and modalities. But access to satellite services is straightforward for government use and in more cases prohibited; more ever it is very costly and time consuming process. Also images are of not high resolution and in case of bad weather not effective e.g. clouding etc. Also satellites may not pass over a region at the right time, and there is difficulty in capturing 3D structure. We conclude that a mini-Unmanned Aerial Vehicle (UAV) with high resolution image capturing capability would be beneficial. So we proposed professional, low cost mini-UAV system "Sparrow-S" for the function of ecological, forestry and agricultural monitoring and management. It's a report on "work in progress" and the focus is on producing a sustainable innovation, UAV product providing professional UAV system for the use of global customer need. The basic requirement and platform required for the mini-UAV for different function of monitoring are discussed in Section **UAV DESIDERATA**, in Section **Market Analysis** we had compared current Mini UAV systems which are in use, and on the bases of their characteristic we had set tactical technical requirements (TTR) for our proposed project "Sparrow-S" And in Section **Characteristic of Sparrow-S** a brief description and information is given about proposed mini UAV "Sparrow-S" Section **Application** consists of the operation can be performed by our proposed mini UAV system "Sparrow-S" for different ecological, Agricultural and disaster management tasks. This leads us to the Section **Conclusion** of our research and proposed "Sparrow-S" UAV project.

UAV DESIDERATA

As indicated above, the aim of this work is to produce an airborne platform, sensors and associated processing. The target applications are principally in the general area of ecological monitoring. Many ecological monitoring applications involve data capture that is regular and frequent over extended periods of time. Furthermore, ecological monitoring involves only one or two people, so the UAV needs to be able to be used by an individual, including launching to meet the CAA guidelines. Having outlined the *Desiderata* for a UAV, let us now consider the Cartography & monitoring work employing aerial photos in the preparation of maps, capturing aerial pictures is the work mission of the UAV. Later these aerial pictures are utilized by trained interpreters to determine land-use and environmental conditions. In global market there are numerous software for Photogrammetry and Photomapping: Eg: ERDAS IMAGINE by ERDAS Inc; products include Leica Photogrammetry Suite, ERDAS ER Mapper, and ERDAS ECW JPEG2000 SDK (ECW (file format)) are used throughout the entire mapping community (GIS, Remote Sensing, Photogrammetry and image compression). Delta – Digital Photogrammetric Station (DPS) from GeoSystems, Ukraine.

"It is quite reasonable to conclude that some form of digital photomap will become the standard general map of the future" go on to suggest that "photomapping would appear to be the only way to take reasonable advantage" **of future data sources**

likehigh resolution UAV imagery. In the last years, more and more applications of UAV-systems in real Photography became common. This development can be explained by the spreading of low cost combined GPS/INS systems, which are necessary to navigate the UAV with high precision to the predicted acquisition points. Some systems are used without GPS/INS-systems, especially for the capture of roofs for the combination with terrestrial measurements. In the context of the work profile of the UAV "Sparrow-S" Technical backgrounds for realization of assertive possibilities: **Miniature Unmanned Aerial Vehicle (UAV):**

A very popular contemporary aerospace, electronics and information technology product:

- On bored core consists of automatic control system with inertial navigation systems (INS);
- High precision GPS navigation systems with differential correction.

H**b. Compact digital camera**:

- Sensor with physical dimensions >1/1.7 inch and low noise level;
- High aperture wide angular optic + possibilities of Photogrammetry calibration;
- Possibilities to receive the images in near IR range.

d. Software for Photogrammetric and Photo mapping.

Sparrow-S Application: The intention is that Sparrow-S can be adapted quickly for a variety of application:

- Flood mapping / monitoring;
- Man-made chemical release / oil spill;
- Fire (wildfire / urban/wild land interface);
- Agriculture.

"Sparrow" UAV system while mission to detect oil spill can captures the aerial images with onboard IR camera can allow us to determine thermal analog. Such imaginary missions of the UAV could also employed for mapping, forest fire screening of smoke cloud with using GPS data

Physical Principle of Anaysing the Man made Accidents damaging Ecology: As we know Physical principle of remote detecting carbonates on the water surface and thermal anamolous from fire are connected with peculiarities of oil slicks reflection in UV and IR spectrum region, especially in second transparency window. As far as fire detection and mapping IR camera is able to see through the smoke on the base infrared remote sensing. (Binenko V. I. Dyachenko, L.N. Kondratyev.K.Ya., Chemenko A.P. 1972). Visible and near IR/ including and at 1700 and 2350 nm length waves/ may are used for detecting heavy spills also. Oil products reflect better than water in microwave region (3.4 and 12.5 GHz), that is why to detect oil spills on the base microwave polarization radiometry

MARKET ANALYSIS

So as to tackle current market of mini UAV and to bring our proposed mini-UAV System "Sparrow-S" to success we did a detailed market research.The first UAV system used for monitoring application which we studied is **CropCAM**by CropCam Ltd, Canada. The CropCam is a mini UAV which helps in managing and monitoring fields, specific area for ecological and agricultural operation, by providing high resolution GPS based digital images for proper data generation.

3.1. Advantages and disadvantages of CropCam:

– + Less cost,+ More payload options,Can't fly at wind speed more than 8 m/s. Temperature requirement +5°C to +30°C (Not certified)Airframe is a borrowed one form RC-Models;

– Required 30 min to setup.Skid landing needs: landing on sand and grass. Otherwise airframe could be damaged. Airframe is made of wood so have deep impact of humidity and temperature on flight.

The second product, we studied is PersonalAerial Mapping System (**PAMS**) by Smart Planes AB Ltd, Sweden. PAMS is a complete package of hardware and software that makes it possible for a single operator to do aerial survey, monitoring and mapping over small areas on-demand.

3.2. Advantages and disadvantages of PAMS:

+ Fully ready system for application in ecological, agriculture and forestry + photogrammetry services. + easy operate, +easy setup. + A typical mission covers 25-50 ha at 5 cm resolution from 200m altitude and individual flights, can be combined into larger blocks. Can't fly at wind speed more than 7 m/s, Need -5 'C to 30' C temps. to work. (Not certified), Unstable wooden Airframe. Less option of additional payloads. Improper orientation of camera. Skid landing- chance of airframe damage.

Third UAV System **PTERO -E4** from AFM Services, Russia. UAV Complex **Ptero -E4**, is designed for aerial photography during the day and night in a fully automatic mode for power line diagnosis, has both an emergency and prophylactic use.

3.3. Ptero -E4: Disadvantages

High cost, Complex operation. Need special training for groundcrew. Required special transportation for the mobility. In final phase of our Market research we had compared all the specification and characteristic of above mentioned UAV Systems and decided the Tactic Technical Requirements.

SPECIFICATIONS

	CropCam	PAMS	PTERO-E4
Span	2.44 m	1.2 m	3.03 m
T/W	3.63 kg	1.1 kg	20 kg
Flight Speed	Cruise speed 60 km/h	Cruising speed 50.4 km/h	Cursing 85...115 km/h Max. speed 170 km/h
Recovery	Landing on fuselage	Landing on fuselage	Parachute
Price	**19500 $(minimal pack, in Russia)**	**45 000 $ (full pack in Russia)**	**116 000 $ (Full Pack)**

GENERAL CHARASTERSTIC OF SPARROW-S

At the end if the market study we felt the market need of a commercial products, a Professional High-End UAV system for monitoring and cartography in Ecological, Agricultural and other Applications. As our UAV has maximum ceiling up to 800 m and comes under mini-UAV category so Sparrow-S don't need any special license or permission (CAA).It is quite simple system so no special training is required to fly and operate. On current market trend we had chosen DELTA from GeoSytem, Ukraine, for our GIS operations. Semi and fully automatic control means flight plan cab be either fully programmed or can be controlled by ground station.

Sparrow-S projected version span 75 cm

Ground station

Sparrow-S Specification:

Air Frame	Fully composite
Weather conditions	+5 'C to + 35 'C
Flight Speed	80 km/h …… 90 km/h cruise.
Take-off weight	1.2 Kg max
Landing	Automatic hand Landing (Patented), Landing speed < 40 km/h
Endurance	30 min, 45 min optional
Payload	Photo with High Spatial resolution, nIR, etc.

CONCLUDING REMARKS

Aim is to build a low-cost high end professional mini UAV system, easy to operateoperational in conditions like of natural disasters, chemical hazardous etc.a revolutionary Hand recovery system.It eliminates any landing impact, guarantees high life span of UAV system Sparrow-S. The Research and Development cost will be $ 200,000.

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Referances

1. *Civil* Avation Authority United kingdom.
2. *DPS* «Delta» Software.

Scientific supervisor – Smolyakov A. V.