NEW APPLICATIONS OF INTEGRATED SURVEY ON UAV PLATFORM FOR ARCHITECTURE AND ENVIRONMENT.

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ABSTRACT

The aim of the project is to test the application of aerial drone technology in the documentation and survey of built structures against traditional methods of architectural investigation.
The research project proposes a thorough analysis of the potentials of the Survey System using platform UAV (Unmanned Aerial Vehicle) related to the built and environmental system. It is necessary to ponder the pros and cons of UAV method survey in the following fields of application: Urban and Architectural Survey, Structural Survey and Environmental Survey.
At the moment the use of UAV technology , is primarily aimed at military purposes, and as a possible alternative to the major instruments aimed at knowledge , preservation and intervention in the territory in all those cases where places are inaccessible, in hydrogeological , seismic and structural risk.
In the face of an initial financial investiment , this detection technique falls into a category of low economic impact and high safety of use of the same , which means to avoid the man inquires directly on places at risk and encourages the use highly scientific technology in order to verify the advantages related to: lower costs than traditional surveying techniques and aero, high speed of implementation and centimetric precision mapping .
KEY WORDS: Systems Laser Scanner; Thermographic; Photogrammetric; UAV platform; Survey.

INTRODUCTION

The goal of the research is the testing of the latest equipment available on the market , which is currently used mainly to face situations of risk , in order to develop a methodology for vertical axis survey at high altitude. Are provided through direct tests measurement campaigns in order to compare the current and well-established instruments of territorial-urban and architectural survey with the unexplored potentials of the Survey by Drones.
It is necessary to try "Advanced Survey" with advanced telematics survey solutions such as: - Laser Scanner , Thermal sensor and Digital camera on board UAV DRONE in order to produce not only the traditional graphic-analytical representation

from the urban scale to that of architectural details but also Infographic Modeling of the survey and analysis of the historical and architectural heritage in integrated procedures for the conservation, safeguard and evaluation: 3D Rendering - Augmented Reality and GIS Cultural database.
The basis materials purchase is laser scanner multicopter drone with UAV monitoring system:
n. 1 Multicopter to 8 arms with two opposing helices and UAV Integrated System with Laser, GPS and IMU;
n. 1 Thermo Camera (which allows to perform a complete thermal mapping for the object to be investigated);
n. 1 Compact camera digital high resolution;
n. 1 Software for the management and processing of image data from a digital camera;
n, 1 Software processing of the thermal images
n. 1 Software for image processing and laser scanner data
Because of the multidisciplinary nature of the research is deemed necessary scientific and technical advice in the following disciplines: Geology, Engineering, Restoration.

OBJECTIVES AND EXPECTED RESULTS

State of the art

The origins of multicopter are likely to be identified in the experiments of "flying platform" and "Flying Jeep" conducted by U.S. forces in World War II. The history of the development of micro-UAVs is a recent history that began in the early 2000s with the creation, of the first prototypes , but the first aircraft to 4 rotors put on the market was the X-UFO in 2005.
Four small motors with brushes and counter-rotating propellers, light carbon-fiber chassis with protective EPP, control electronics. The horizontal stabilization is effected by a mechanical gyroscope.
From this background arise the micro-UAV (Unmanned Aerial Vehicle acronym weighing less than two kilograms in flight attitude) that represents the last frontier for the high-resolution recovery of the area, with low-altitude flight. These objects are in a band of altitude up to now occupied by some balloons or ultralights, but without presenting issues related to the use of gas (balloon) or necessitated to have aviation take-off surfaces.
Actually the major uses of Aerial Search & Rescue UAV are :
Traffic Accident Analysis, Work Documentation, Real Estate Photography, Police Applications, Fire Scene Inspection, Environmental Monitoring, Critical Infrastructure Inspection, Wind Turbine Blade Inspection, Railway Track Bed

Inspection, Wildlife Census, Anti-terrorist operations, Disaster Site Monitoring & Mapping , Natural Disaster Monitoring, Post-Disaster Relief Operations.

Methods

The research project will be developed through a comparison of traditional terrestrial survey methods (laser-scanner-terrestrial photogrammetry – digital photo-ractification) and survey UAV platform.
A drone equipped with integrated laser scanner is fundamental to experience this technology aerial survey to capture metric data (horizontal axis and vertical axis) aimed at the graphic representation of the object of study. The multicopter can replace the laser scanner alternately with thermal camera or a digital camera to use the aerial drones to take geo-referenced HD geo-referenced digital photographs in order to develop a Photogrammetric 3D point cloud model or to acquire data thermography for the detection and diagnosis of degradation of the facades, the state of the painted decorations and of any critical conditions of the structures.
UAVs can provide a more accurate survey of a working quarry than a traditional survey with an RTK GPS or robotic total station. The UAV can cover the whole area, including benching and other inaccessible areas at a markedly increased grid pattern when compared to a typical 15-20m grid pattern obtained with the RTK GPS. Traditional surveying methods require a large amount of interpolation, which leads to large inaccuracies in DEMs and subsequent volumetric calculations.
This option allows to test three types of survey: Laser Scanner System integrated onboard the UAV drone for Urban and Architectural Survey - System with integrated thermal sensor on board the UAV drone for Structural Survey - System with integrated camera on board the UAV drone not only for Environmental Survey, but for this research of facades details, expecially in the historical city centers.
The methods involves:

a- Study of current uses of drones as far as Survey and Drawing Representation of Architecture and Environment is concerned
b- Choice of 3 case studies related to the three types of drone system (Lase Scanner - Thermal sensor – Digital Camera)

Laser Scanner integrated on-board multicopter of the drone, UAV Lidar, IMU and GPS in just two kilograms of payload. The multi-target integrated system (up to 3 echoes) ensures a high signal penetration into the vegetation. The full system security is ensured by the use of a laser class 1. The storage of data is on-board. The system is compatible with other mobile platforms (cars, boats, trains).
Infrared thermography: a versatile technique for non-destructive thermal surveys, the predictive maintenance analysis of structural deterioration. IR thermography is a diagnostic technique that absolutely not destructive, measuring the infrared radiation emitted by a body, is able to determine the surface temperature. Maps are generated, in false colors, representative of the zones investigated and are

associated with a color temperature measured. The mapping of the surface temperature is essential in order to assess the conservation status of the materials. Anomalies on the temperature distribution denounce going issues on the building or plant technological analyzed.
System for photogrammetric camera (or SLR) integrated on board the drone and software for the management and processing of the frames. The system allows to perform a survey by drone ensuring a high level of accuracy metric also of painted decorations of façades.

c- Experimentation with instrumentation platform UAV
d- Management of the data collected
e- Comparison with the traditional tools of Surveying Instrumental
f- Critical Summary of the results
g- Future Application

Expected results

The actual research activities have been conducted on the use of this technology but the actual limits and the real potential has not yet been defined. The applications of the drone are many and the analysis obtained are quantitative, qualitative and multi-temporal , in response to the needs of documentation , measurement, monitoring and control. The speed control , guidance and placement ensures the distinctive advantages of precision in handling the camera exactly as planned during the flights scheduling . The management of such precision coverage is a key factor for achieving maximum quality , which is crucial for geomatics and 3D modeling of land. This project wants to test the same precision for architecture survey .
The aim is the definition of a project for the development of controlled aerial platforms UAV (Unmanned Aerial Vehicle) capable of acquiring , using different instruments placed on board platforms themselves , high-resolution images of geometric areas of interest, historical town,
The growing interest in these systems is also due to the advantages they have compared to conventional aircraft :
-flight performance : UAVs can operate in a wide range of operational altitude and have a high range of autonomies hour.). It follows the possibility to set up monitoring operations to small, medium and large scale;
- adaptability to different types of missions : these systems can be used for monitoring missions in remote areas , even under conditions of high risk to human life ;
- the cheapness : perform operations flight at a lower cost than those required by a conventional aircraft .
State of the art : there are still very few systems designed for purely civilian use .
The most important aircraft were designed by NASA. The most significant model is the ' " Aerosonde " HALE UAV : the aircraft is equipped with an IR system for

measuring the temperature of the water of seas , and other instruments for the measurement of gas concentrations in the atmosphere. This research stems from the need to achieve 3D representations architectural structures overcoming the limitations associated with the use of traditional techniques that typically require time-consuming acquisition and representation level (using contour lines) the third dimension with severe loss of information. The introduction of the laser scanner about a decade ago has only partially solved the problem , but there are problems with long periods of scanning and occlusions . Because of this the laser scanner onboard will be test in order to solve the problem of long time acquisition of data .Therefore, the field Application of this technique is limited to contexts rather elementary and especially where it is not request a standardization of the process. A further reason that makes the use of this type of platform under architectonic-structural and degradation surveys is the possibility to investigate multitemporal ; flight , in fact, is repeatable , with identical parameters , at any time. Therefore is developing a methodology for automating aerial proximity, Photogrammetric image acquisition and processing through the platform UAV (Unmanned Aerial Vehicle) . The methodology involves the identification of the first phase of the study, the assumption necessary for the planning phase of the flight , to run on a cartographic basis , in a GIS environment . First of all, define the boundaries of the site and determine the extent to detect, is characterized the survey area to the fullest extent in order to proceed to the planning stage of the flight : morphological study of the soil, vegetation cover , presence of natural barriers or building structures that could interfeere with the flight altitude deviations , and any other special features . Furthermore , all the information to altitude, at any resolution are computed to generate a DEM the area. The phase of "Scheduling automatic flight " will be also performed on the basis of mapping in a GIS environment through a flight planning software that has a number of advantages:

• maximize the number of shots to cover the full area , depending on the overlap and sidelap (overlap between frames and between strips)
• to minimize the response time and precision shooting program with complexn shooting and zenith angle, on a flat surface , on the slope and in a circular route around a Fixed Lens (buildings, historical architectures…)
• maintain a constant footprint in terms of steepness (slope of filming)
• investigate multitemporal .
• It is possible to immediately switch image quality is not optimal (due to , for example, unexpected intrusion of other subjects, sudden changes of light , etc.).
• perform a flight more precise than manual , in case of unfavorable weather conditions , in particularly with the presence of wind of a certain intensity . And it’s possible to make an expeditious Georeferencing of images captured with sufficient accuracy to have a mapping and visual contextualization of the entities represented in a GIS environment .

Once captured images of adequate quality and scale wil be calculated with a photogrammetric processing to extract orthophotos, digital terrain models , 3D models , themes, vector , etc. .. , different details .
It presents the need to use and to test software to perform this type of processing future applications include the development of UAV equipped with a camera and laser scanner for small or medium sized , and consider it in effect a means of performing photogrammetric surveys from short or medium distances , can provide noticeable results quickly and cost containing a valid alternative to traditional measurement tools.

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