LOW COST HIGH-RESOLUTION AERIAL PHOTOGRAMMETRIC TECHNIQUES FOR PRECISION AGRICULTURE IN LATIN AMERICAN COUNTRIES

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ABSTRACT

One of the first steps in precision agriculture is to obtain aerial images of an area of interest to determine soil units and management zones. Aerial and remote sensing information, digital elevation models and other spatial data are often inexistent in planning offices in Latin American countries and, up to now, enhancement and modifications have not been integrated into smaller scaled planning operation such as farming.

This paper presents two inexpensive solutions to obtain high resolution aerial color photographs using a small urethane hydrogen balloon (volume of 5.1 m^3 for a lifting power of 3.2kg) and a powered paraglider equipped with consumer-level digital cameras(12.1 and 15.2 megapixels). The aerial surveys are carrying out at an altitude of 600 to 1,500 m selecting days when cloud cover is nil and when crop and soil are in desired conditions. The high resolution shots are taken at given time intervals and angles to allow identification of management areas and reconstruction of accurate 3-D ground models during post processing.

Keywords: aerial survey, photogrametry, remote sensing

INTRODUCTION

Precision Agriculture (PA) is based on the potential to increase profits by utilizing precise information about agricultural resources. Fertilizer and lime, for instance, can be applied only where needed and in quantities that do not exceed nor fall short of the crop requirements. Plant population can be chosen to optimize soil nutrients, and plant variety selection can be chosen to take advantage of the field conditions.

It is well established in the scientific community that one of the first steps of PA is to obtain an aerial photograph of area of interest to determine soil units and management zones. However, high resolution remote sensing images from scanning satellites like Quickbird, Ikonos or others are very expensive. One of the ordering requirements from satellite image distributors is to purchase images

for large area (i.e., minimum of 500 km^2 for satellite Ikonos) at an average price of USD $ 27/km^2. In addition, these aerial images are not always available for the area of interest or for a given period. If that is the case, the remote sensing images will be acquired during the next passage of the satellite over the area, occasioning delays of up to several weeks (depending on the region). There is no guaranty that the satellite image at that time will have clear ground visibility. In the humid tropics, this can be a major constrain as cloud cover is often a limiting factor. As a consequence remote sensing information, DEM and other spatial data are often inexistent in planning offices in developing countries and, up to now, enhancement and modifications have not been integrated into smaller scaled planning operation such as farming.

This project proposes an inexpensive solution for the acquisition of up to date aerial color photos of high pixel resolution. This technique uses a urethane plastic balloon inflated with hydrogen gas (volume of 5.1 m^3 for a lifting power of 3.2kg). The balloon is equipped with a consumer-level digital camera mounted on a ring and is launched to an altitude of about 1000m to take digital aerial photos of area of interest. The camera (Canon PowerShot SD950) has been preprogrammed to take high resolution shots at given time intervals and at given angles. The rectified, merged and geo-referenced aerial balloon-photos with surface resolution per pixel of approx. 0.4m (depending on altitude of the platform) are enlargeable up to a scale of 1:1.000 without any loss in optical and spatial quality. This technique offers a unique opportunity to generate low cost high resolution aerial images and promote precision agriculture in developing countries.

Figure 1:
Aerial photogrammetric system – a) Urethane balloon, b) rotating camera base and c) aerial photo taken at an altitude of 400 m.