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On-board computational efficiency in real time UAV embedded terrain reconstruction

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In the last few years, there is a surge of applications for object recognition, interpretation and mapping using unmanned aerial vehicles (UAV). Specifications in constructing those UAVs are highly diverse with contradictory characteristics including cost-efficiency, carrying weight, flight time, mapping precision, real time processing capabilities, etc.

In this work, a hexacopter UAV is employed for near real time terrain mapping. The main challenge addressed is to retain a low cost flying platform with real time processing capabilities. The UAV weight limitation affecting the overall flight time, makes the selection of the on-board processing components particularly critical. On the other hand, surface reconstruction, as a computational demanding task, calls for a highly demanding processing unit on board. To merge these two contradicting aspects along with customized development, a System on a Chip (SoC) integrated circuit is proposed as a low-power, low-cost processor, which natively supports camera sensors and positioning and navigation systems.

Modern SoCs, such as Omap3530 or Zynq, are classified as heterogeneous devices and provide a versatile platform, allowing access to both general purpose processors, such as the ARM11, as well as specialized processors, such as a digital signal processor and floating field-programmable gate array. A UAV equipped with the proposed embedded processors, allows on-board terrain reconstruction using stereo vision in near real time. Furthermore, according to the frame rate required, additional image processing may concurrently take place, such as image rectification andobject detection. Lastly, the onboard positioning and navigation (e.g., GNSS) chip may further improve the quality of the generated map.

The resulting terrain maps are compared to ground truth geodetic measurements in order to access the accuracy limitations of the overall process. It is shown that with our proposed novel system,there is much potential in computational efficiency on board and in optimized time constraints.