SURVICE ENGINEERING COMPANY

HAWKEYE™

OVERVIEW

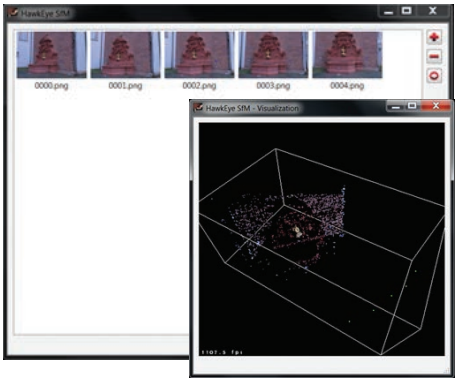
SURVICE's HawkEye high-performance computer-vision software leverages the latest in optics, photogrammetry, and three-dimensional (3D) reconstruction techniques to provide a low-cost means to scan, capture, and analyze 3D data. With an embedded library that can automatically identify coded targets, the software provides "visual anchors" from multiple images to allow camera positions to be precisely determined.

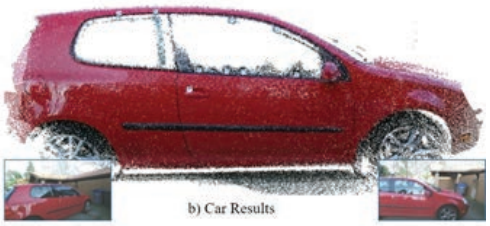
HAWKEYE COMBINES:

- **Structure-from-motion (SfM) technology,** which supports image analysis, either from the device or in a secure computing environment.
- **Photogrammetric technology,** which employs a hybrid approach to substantially improve accuracy of SfM from imagery alone.
- **Low-cost structured-light technology,** which increases 3D point-cloud data and accuracy, especially for large featureless surfaces.

BACKGROUND

Numerous applications—from aligning mirrors on the latest telescopes to providing accurate body analysis of burn patients to estimating damage and structural integrity after improvised explosive devices (IED) events—depend on easy and accurate measurements. Accordingly, the field of metrology specializes in various approaches to precisely capture these measurements. Photogrammetry, in particular, uses targets (either noncoded or coded) placed on or around an object to compute the target positions in 3D space from 2D photographs. This time-intensive process, although accurate,





b) Car Results

traditionally generates only 3D geometry for target positions.

Other metrology techniques, such as light detection and ranging (LIDAR), provide dense 3D geometry of the imaged scene. LIDAR creates distance measurements by illuminating a target with laser light and timing the return. Unfortunately, such systems are expensive, cumbersome, and time-consuming to use. Moreover, globally stitching LIDAR scans together is a semi-manual process that relies on accurate user-selected matches or careful calibration of equipment, or that employs high-precision motorized controls to set device poses.

THE HAWKEYE SOLUTION

To combat the issues and costs associated with current approaches and processes, HawkEye was developed to be a hand-held, consumer-grade optical scanner and supporting application suite. This system employs recent advancements in hybrid photogrammetry/SfM technologies to provide a fully automated stitching process that is inexpensive and provides an accurate and dense 3D reconstruction.

HawkEye's scanner hardware is based on the Microsoft Kinect v2, a consumer-grade optical sensor package. In combination with hybrid photogrammetry/SfM software, the scanner provides a fast, accurate solution to global alignment of individual snapshots. Specifically, the reconstruction software uses the a-contrario SfM pipeline along with photogrammetry target information to first perform a relative 3D reconstruction. Ultimately, photogrammetry targets provide metric distances and globally align the 3D scanner data.

The HawkEye pipeline was tested for its accuracy and behavior in both indoor and outdoor scenes. Initial results demonstrate accuracy to within the underlying hardware limits, and HawkEye clearly generates visually accurate results. Moreover, iterative closest point (ICP) refinement increases accuracy by rectifying minor misalignments in the initial 3D reconstruction.

Going forward, the HawkEye pipeline will integrate different—and more accurate—data acquisition devices to further increase reconstruction accuracy. Additionally, the SfM and ICP algorithms on which HawkEye is based can be further enhanced by optimizing their implementation for particular computing architectures—for example, a heterogeneous platform with both multicore central processing units (CPUs) and one or more many-core graphics processing units (GPUs).

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