Natural-Color 3D Insect Models for Education, Entertainment, Biosecurity and Science

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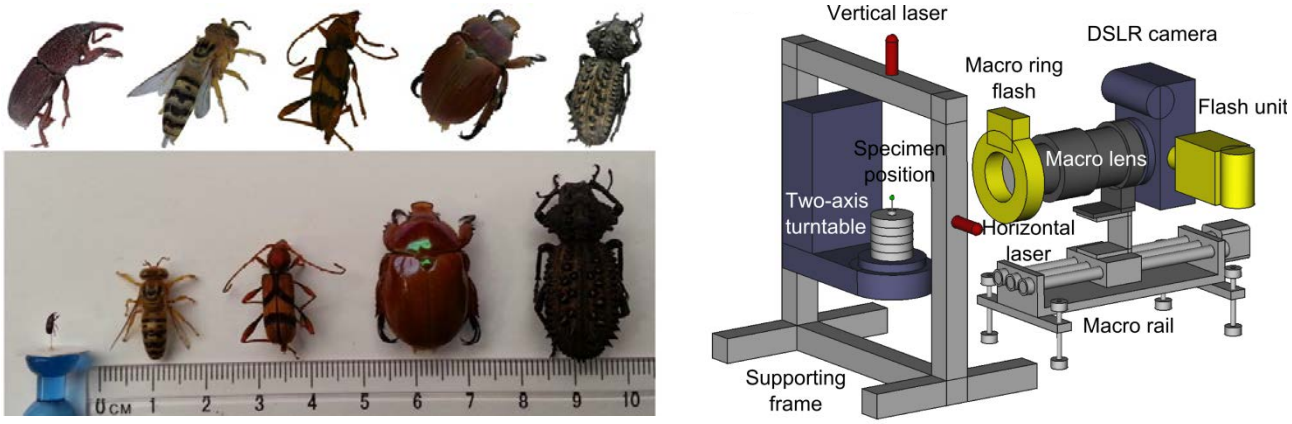

Figure 1. *Left: Various 3D insect models (above) and photos of the respective insects (below). Right: Hardware for macro-mode image acquisition.*

1. Introduction

Capturing high-quality 3D models of insects is challenging - they are usually too small for laser or depth camera based systems, and techniques such as Micro CT scanning do not record color. We have developed a prototype system that generates unprecedentedly high-quality natural-color 3D models of various insects from 3mm to 30 mm in length. Through the use of 3D web standards we are able to use these models to develop novel applications for entomologists and ensure wide accessibility.

2. 3D Model Acquisition

The three main steps of the creating a natural-color 3D model of specimen are (1) mounting the insect onto a pin, (2) capture of high-magnification and depth-extended 2D images of the specimen at different poses, and (3) reconstruction of a single 3D model from those multiple images [Nguyen et al. 2014a]. Our hardware setup can be seen in Figure 1. At each rotation step, the turntable triggers the macro rail to move to a set of predetermined positions. At each position, the control box triggers the camera to capture an image.

3. Processing Pipeline

The camera pose of each image is extracted using a marker placed below the specimen. For the smallest insects, we require an extra step to first stack each set of multi-focus images captured from the same viewing angle (but at different depth distances) into a single in-focus image.

The silhouette is then extracted from each image and combined with the respective pose estimate to perform 3D shape reconstruction. The texture is then applied to the model from the original photographs. Upon viewing the model, some 'hidden' areas might be noticed and additional camera poses can be acquired to improve the reconstruction.

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4. Applications

Using our prototype system we can take many gigabytes of captured images and distil them down into a comparable and highly portable X3D model of around 10MB.

We have begun to populate an online repository of X3D insects (For example: [Nguyen et al. 2014b]) and develop related tools for scientific discovery and reference. We also have started collaborations on applications ranging from education to quarantine [Nguyen et al. 2013]. Using this system a quarantine officer can quickly send a morphologically correct representation to an expert entomologist for identification. Although color 3D printing solutions capable of fabricating objects of sufficient resolution are only just emerging, we have successfully 3D printed our models in titanium in an effort to explore their aesthetics (see Figure 2).

Figure 2. *Insect models, 3D printed in titanium.*

References

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