Tracking Bubbles for Outdoor Flow Characterization

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I. CONTEXT

Research into Micro Air Vehicles (MAVs) and other small, dynamic robots often involves quantification of the dynamic behavior of these vehicles. While the most interesting behavior occurs in unconstrained environments, the behavior which is easiest to analyze occurs in constrained, laboratory environments. In either case, video analysis is common for many of the same reasons it is commonly used in biological research applications - low disturbance to the system, potentially high spatial resolution, and easily adaptable to laboratory scales [1]. Tools like those developed by [1] are often used for image analysis, but these tools have some limitations and are designed for more general objectives. For any given analysis, a great deal of time is often spent with a human operator manually identifying points in each frame of interest. Figure 1 shows typical trajectory and velocity information extracted using this manual method. While crucial to the underlying research in terms of both final results and iterative feedback during development, the high time commitment creates a barrier to its use.

Fig. 1: Typical data sets for a jumping/gliding robot showing repeatability of trajectory (top) and comparison with model predictions for trajectories with varying initial conditions (second from top) and with extracted velocity and energy data (bottom)

II. OBJECTIVES

We propose to create an image processing system which is powerful because it is tailored specifically to the needs of small (usually rigid) robotic platforms predominantly moving in directions parallel to the plane of the camera being used. The system will identify moving objects in a video, characterize these objects by shape and, if possible, by consistent discovered fiducials, and output velocity and trajectory information, along with angular velocity information where possible. If resources allow, the system will also perform some basic distortion compensation.

III. METHODS

We propose using a knowledge of rigid body kinematics to help us identify moving robots over the course of a video using motion tracking techniques like those used in [2], and will use keypoint analysis to extract potential fiducial markers. By using the full information available in the video, we hope to construct an estimate for the basic shape of the robot being observed, using a simpler approach informed by the work in [3]. We can use the centroid of this shape for velocity and trajectory estimation, and the orientation of the shape for angular velocity estimation. We can also potentially use this shape to constrain our search for fiducials and re-insert obscured data. We hope to also present the end user with options for automatic fiducials from which they can then select the most useful.

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REFERENCES


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