

Virtual drum kit using stereo imaging

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Background

AirDrums is our concluding project in the Digital Image Processing (DIP) course in the Dept. of Electrical and Computer Engineering at Ben Gurion University. We have created a virtual drum kit, in which a player uses a pair of sticks with colored tips to hit virtual drums, while matching drum kit sounds are played. We use a pair of cameras located above the player facing downwards, capturing stereo images which are used for estimating the sticks' spatial location and motion.

Requirements

Detecting the spatial location of a tips of drum-sticks requires three complementary procedures:

1. **Detecting and Tracking** the locations of the tips in the image plane (multiple object tracking).
2. Calculating the distance to the tip from the cameras using **passive Stereo Vision**.
3. **Estimating** the sticks' motion and deciding if, and which, a hit was made.

Technical challenges

Maximizing Frames per Second to allow Live play.

The Frames per Second ratio (FPS) is bounded by three major constraints:

1. Rectification of the image pair – the process of projecting the images into a common image plane so that the shift can be measured.
2. Conversion of the RGB acquired image pairs to a chosen color-space in which the sticks tip are easily detected.
3. Hardware constraints – Image acquisition rate constrained by the cameras, and image processing rate constrained by the computer and chosen implementation.

Solutions

We chose to tackle some of the challenges by the following optimizations:

1. Taking use of **Epipolar Geometry**, the detection of a tip of the stick in a matching stereo image can be restricted to an horizontal line corresponding to the height of the tip located in the first image.
2. Using the **YCBCR color space** for comparable and robust color separation and feature detection.
3. Efficient code implementation for real-time performance with minimal delay.

The System

