Infrared Cameras for IR LED Tracking

Introduction

Infrared imaging is used to analyze light at wavelengths longer than those of the visible spectrum and provide analogous displays for interpretation. It has applications in industry, law enforcement, military, medical, and consumer electronics [1]. Infrared cameras use IR filters to detect sources of light invisible to the human eye and record changes in infrared light, position, and movement. Some common uses of IR cameras include night vision, thermography, and video game controllers. This paper seeks to examine commercially available camera options for real-time detection and tracking of infrared LED sources, as well as address necessary complements (i.e. IR LEDs, IR filters) and ease of integration with circuit boards for further image tracking processing.

Current Products

Most military, medical, and industry applications of infrared imaging deal with "far" infrared rays: longer wavelengths of light that are observed as infrared radiation, or heat. Infrared LEDs emit "near" infrared rays, typically at wavelengths between 800-1000 nm [2]. Due to this discrepancy, most IR cameras do not inherently perform well for tracking of IR LED sources. More applicable options combine a camera with tracking capabilities with an IR filter specified for a range of IR LEDs.

Nintendo Wii Remote

The Nintendo Wii has sold over 20 million units worldwide since its introduction in 2006 and is currently the most popular home gaming console available on the market. As a result of the high accessibility, engineers and hackers have become quite familiar with the device and have taken particular interest in the infrared camera tracker inherent to the Wii remote. Each remote contains a PixArt Imaging IR camera sensor capable of tracking up to four independent IR light sources. Its image processing provides location data at 1024x768 resolution with 100 Hz refresh rate [3]. At $39.99, the Wii Remote outperforms comparably priced webcams, while requiring less CPU power and incorporating LED tracking functionality [3], [4].

OptiTrack

OptiTrack produces technology for tracking and motion capture. The OptiTrack SLIM: V100 is the smallest and least expensive camera available from OptiTrack, at a price of $249. It operates at 100 Hz with 640x480 resolution. OptiTrack cameras are intended for use with "markers" (IR LEDs also sold by OptiTrack) and a $799 "Real-time Optical 3D Tracking" software package that tracks position and orientation of multiple objects using multiple cameras. Cameras and software packages from OptiTrack

are typically used for biometric analyses, interactive games, motion capture, and animation control by companies like Microsoft, EA, Disney, and John Deere [5].

CMUcam

The CMUcam and subsequent CMUcam2 and CMUcam3 were designed at the Robotics Institute at Carnegie Mellon University. The CMUcam was originally intended to operate as a low cost, low power sensor for mobile robots. The most recent iteration, the CMUcam3, has 352x288 resolution with image processing at 26 Hz. It was not designed as an IR camera and does not have an IR filter, but can be adapted. It resides on a circuit board with a variety a ports for later integration into a robotic device. The CMUcam3 also provides an open source development environment, creating flexibility in use of its image processing and tracking features [6]. The CMUcam3 retails for $239, while the previous versions, CMUcam and CMUcam2, retail for $179 and $109, respectively [7].

Implementation of the Technology

Hardware/Software Integration

Of the Wii, OptiTrack, and CMUcam options currently on the market, each has its challenges in implementation. The Wii Remote contains a version of Bluetooth that allows it to wirelessly integrate with Bluetooth-capable computers [3]; however, if a wired connection is desired, it is possible to read from the PixArt camera via I2C, as described at [8]. Due to the widespread distribution of the Wii Remote, hackers and hobbyists have developed a number of software libraries for use in various areas, including tracking applications [9]. The OptiTrack cameras connect to computers via USB. Once connected, applications can be developed through a free SDK or a purchased software package, both of which include APIs for common languages [5]. The CMUcam3 was designed for easy integration and resides on a circuit board with a microcontroller and serial and servo ports for communication with other devices [10]. Because the CMUcam3 does not have an IR filter, it can be optimized for IR LED tracking by purchasing and installing an IR pass filter for under $20 [11].

Infrared LED Selection

Common infrared LEDs generate light at wavelengths between 800-1000 nm. They can be purchased for under $1 from most electronic component suppliers [2], [12]. Such LEDs could be powered and used for tracking by any of the cameras aforementioned. For premade IR LED devices, Nintendo sells a Wii Sensor Bar for $7.50 that contains two IR LED clusters and is designed for detection by the Wii Remote [13]. Also, OptiTrack sells wired, shaped sets of IR LEDs, for use in specific applications of their technology; prices start at $29 with the sets meant for hand tracking [5].

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