Image Processing for a Camera Type Device

IP4Cam

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PROJECT MOTIVATION

The motivation for this project is to improve upon the current lottery terminal playslip reading technology. The current readers have done tasks at the same level of quality and efficiency for several years. IGT's camera readers can have trouble when sunlight is overexposing a portion of the playslip or when playslips are crinkled and bent. IGT would like a camera reader that can scan playslips in more varied lighting, using High Dynamic Range technology. IGT would also like to upgrade the scanner's ability to process uneven and obstructed images, possibly by stitching together several partial images. Image processing software using the Java programming language will be implemented to demonstrate the effectiveness of developed algorithms. Data will be received from the camera through raw image files, allowing for more control over the raw sensor data being collected by the camera. These raw image files will be processed and the image's pixel data will be extracted through the application.

KEY ACCOMPLISHMENTS

Hardware Setup: The hardware is composed of an inverted tripod, two 12-Watt LED strips, a Flashair wireless photo transfer SD card, and a Canon Powershot S110 digital camera located 11 inches above a 6x9 inch platen. **(Figure 1)**

Figure 1: Inverted Tripod Camera Display used to collect RAW images

Software Tool: A software tool was developed in Java that allows us to test team IGT's algorithms. Images are loaded from the user's local file system to be used for further image processing applications such as HDR. Additionally, our software is capable of communicating with the team's hardware through the use of a Wi-Fi chip, any pictures taken from the hardware can be transferred directly into software for image processing. All the components of our software are fully proprietary as they were developed from scratch by the IGT Capstone team, all of the software is developed using Java's native library and without the usage of any third-party libraries.

User Interface: The software contains a graphical user interface where the user can select a raw image file to be processed by algorithms developed by the IGT Capstone team. The user is able to save any processed images to their local file system. Image data such as RGB values are displayed in the form of histograms inside the interface. The graphics are made to look modern to allow a clean and intuitive user experience. **(Figure 2)**
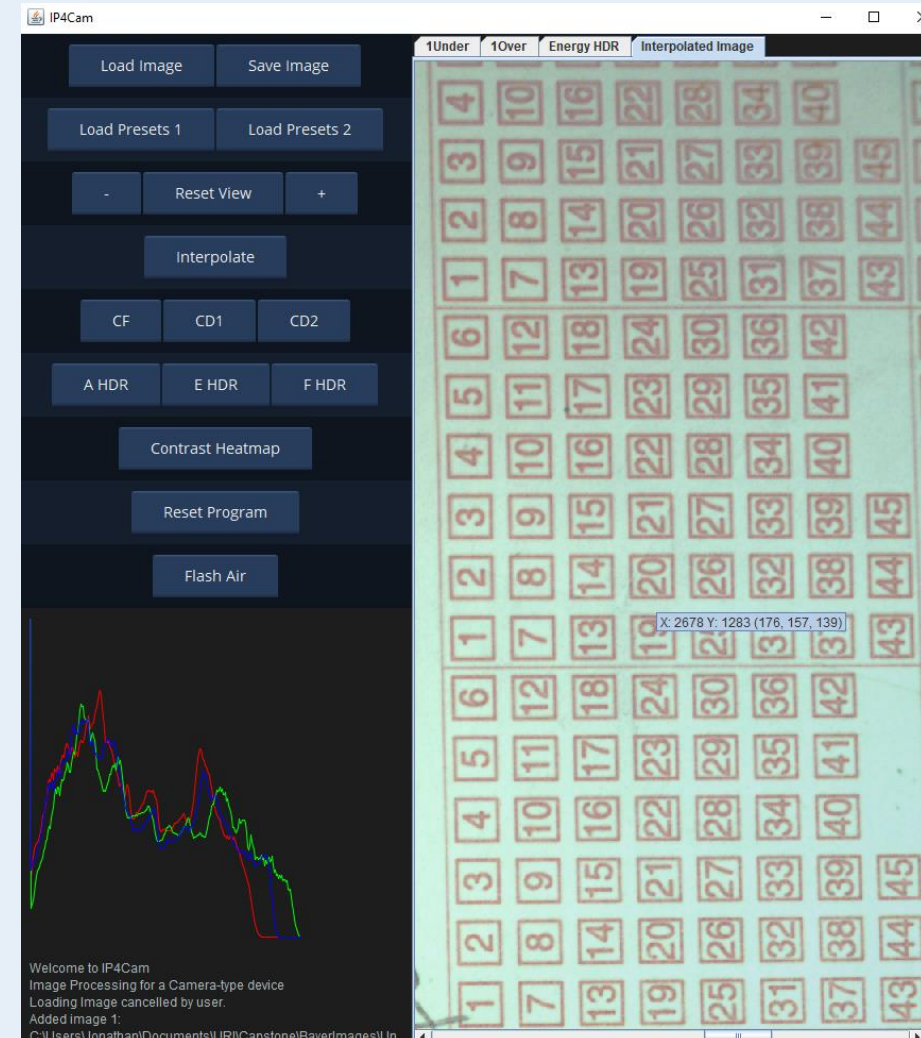

Figure 2:
The User Interface of the IP4Cam software tool. Through the interface, users can load and save images, view images each under their own tab, apply a variety of algorithms, and view the RGB histograms of an image.

Raw Data Extraction: Raw image data can be extracted from raw image files or from a custom .bayer image format. This raw image data is displayed as the images bayer pattern output. These patterns can then be interpolated using a bilinear interpolation algorithm developed by the IGT Capstone team to emulate how the image is perceived by the human eye.

High Dynamic Range (HDR) Imaging: Solutions were implemented for the task of producing HDR images, which reduces shadows and light glares from the input images while retaining all relevant information. Given raw underexposed and overexposed images of the same subject, various HDR algorithms were developed from scratch that combine aspects from both exposures to create an output image with better details and greater range of luminance. **(Figure 5)**

Color Balance Algorithm: An algorithm was developed with the function of removing the colored tint that can appear in images under various lighting setups. By assuming that all tickets would have a white background, each pixel in a given image is color balanced so that its local region has a white background. This color balancing technique results in images that are primarily white. Pixels in the image that stand out from their local background, such as ticket boxes, are emphasized and stand out more. **(Figure 4)**

Image Stitching Algorithm: Often times it may require two or three shots to capture the entirety of one lottery playslip, which is tedious and could lead to errors in processing. In an attempt to solve this problem, we implemented a very basic stitching algorithm was implemented that takes these images as inputs and stitches them together either vertically or horizontally to create one single image.

ANTICIPATED BEST OUTCOME

The best outcome of this capstone Design Project is to produce an image of significant quality to support the reading of numbers and text from IGT lottery slips. The playslip scanned can be of varied quality, whether wrinkled, shadowed, or angled. The code designed will use the High Dynamic Range (HDR) technique, taking multiple photos of a playslip and combining the images for the highest quality processed result. In addition to this, the process of Illumination Normalization will be used to help clearly define and remove any unintentional lighting, shadows, and blurs.

PROJECT OUTCOME

The Anticipated Best Outcome was achieved: the ability to use High Dynamic Range technology to produce high quality readable images.

FIGURES

Figure 3: The process of producing HDR images: one or more over- and under- exposed photos are taken from the camera, and transferred wirelessly to the laptop for image processing applications; hence one high quality HDR image is produced.
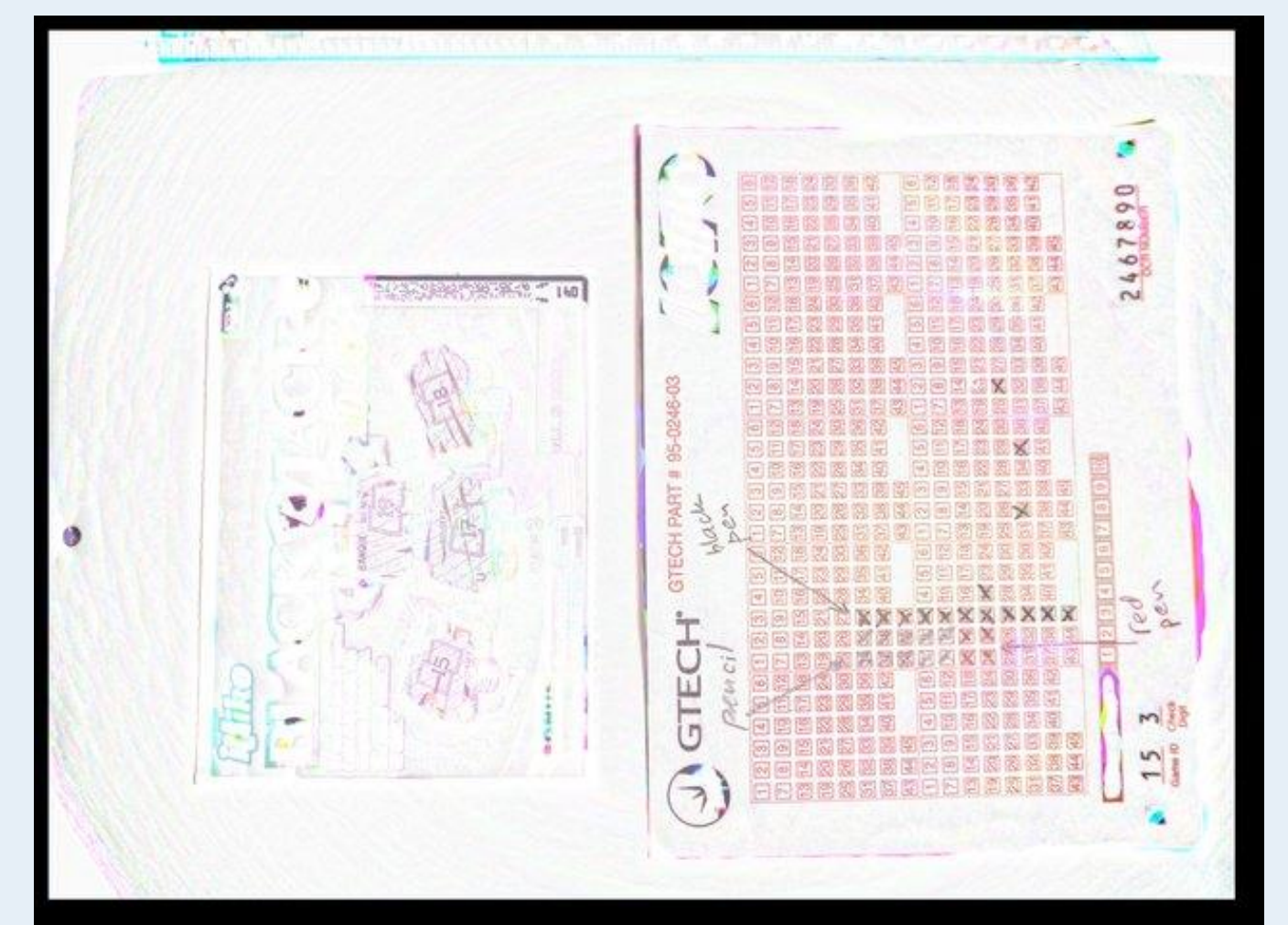

Figure 4: A color balancing technique is used to alter the original coloring of an image so that the image has a consistent white background. Outliers in the coloring of the image, such as the ticket boxes, then stand out.

Figure 5: Underexposed(top left) and overexposed(bottom left) images combined using a contrast based HDR algorithm to produce an optimal quality HDR output image(right).