



## Image Processing from a Camera Type Device

[igt.com](http://igt.com)

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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.

### ANTICIPATED BEST OUTCOME:

The best outcome of this capstone Design Project is to produce an image of significant 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.

### IMPLICATIONS FOR COMPANY AND INDUSTRY:

Currently, camera-based playslip reading technology is greatly hindered by factors such as topography asymmetries and lighting aberrations. If we are successful at developing an HDR algorithm, the algorithm can be integrated into a new image processing library currently under development at IGT to combat the aforementioned obstacles. This breakthrough will grant new image processing capabilities to IGT and revolutionizes the way images are processed in the lottery industry. The data and experience gained from the project will get IGT closer to using improved image taking in unstable lighting, and processing data from combining multiple partial images.

## PROJECT OUTCOME:

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

## KEY ACCOMPLISHMENTS:

**Power Hardware Setup:** inverted tripod, two 12-W LED strips, Flashair wireless photo transfer SD card, Canon Powershot S110 digital camera, 11 inches above a 6x9 inch platen. (Fig. 1)

**Software Tool** was developed in Java; allows to test team IGT's algorithms. Images are loaded from the user's local file system, for further image processing applications such as HDR. Additionally, software communicates with the hardware with a WiFi 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; developed from scratch by the team; all the software is developed using Java's native library, without the usage of any third-party libraries.

**User Interface:** Software contains a GUI: user can select a raw image file to be processed by algorithms developed by the team. The user is able to save any processed images to their local file system. Image data such as RGB values are displayed as histograms inside the interface. The graphics are made to look modern to allow a clean and intuitive user experience.

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

**High Dynamic Range (HDR) Imaging:** Solutions implemented for 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. (Fig. 4)

**Color Balance Algorithm** was developed with the function of removing the colored tint that can appear in images under various lighting setups. Assuming 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. (Fig. 3)

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

Presenting Project at Student Poster Session at:



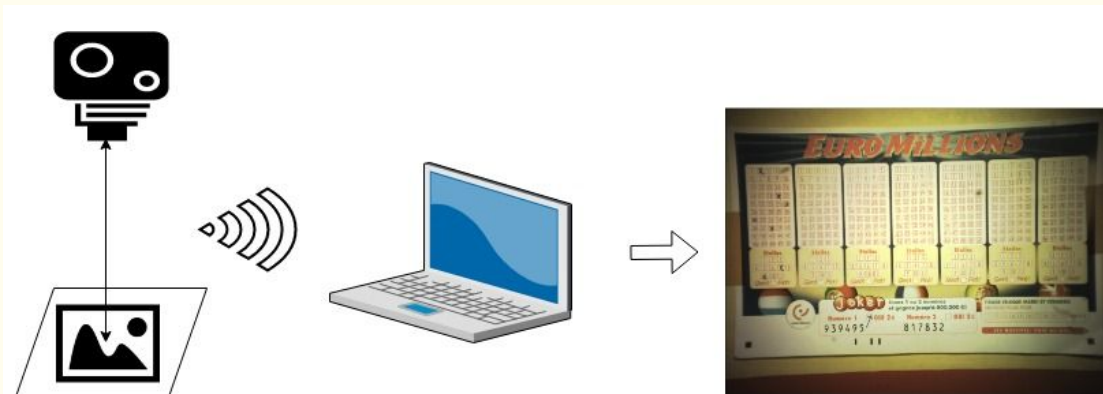
**Capstone Design**  
CONFERENCE 2018

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<http://www.capstoneconf.org>

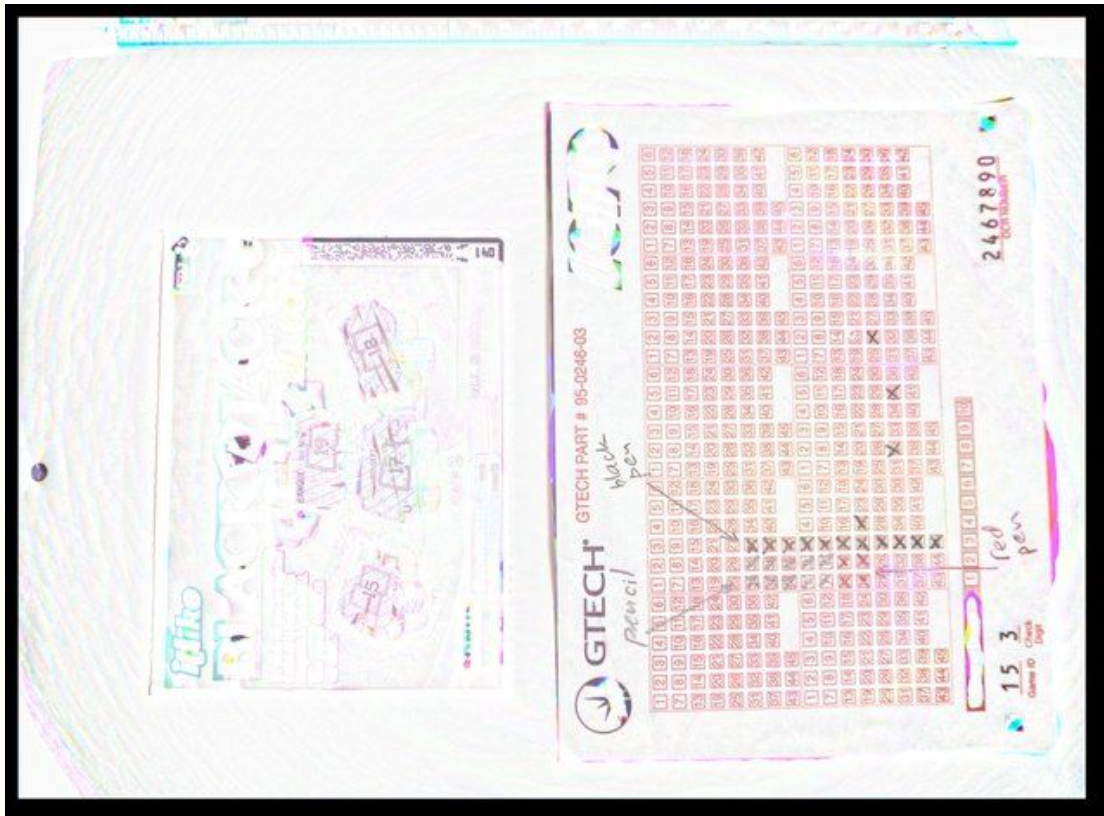


**Fig 1:** Inverted Tripod Camera Display used to collect RAW images.

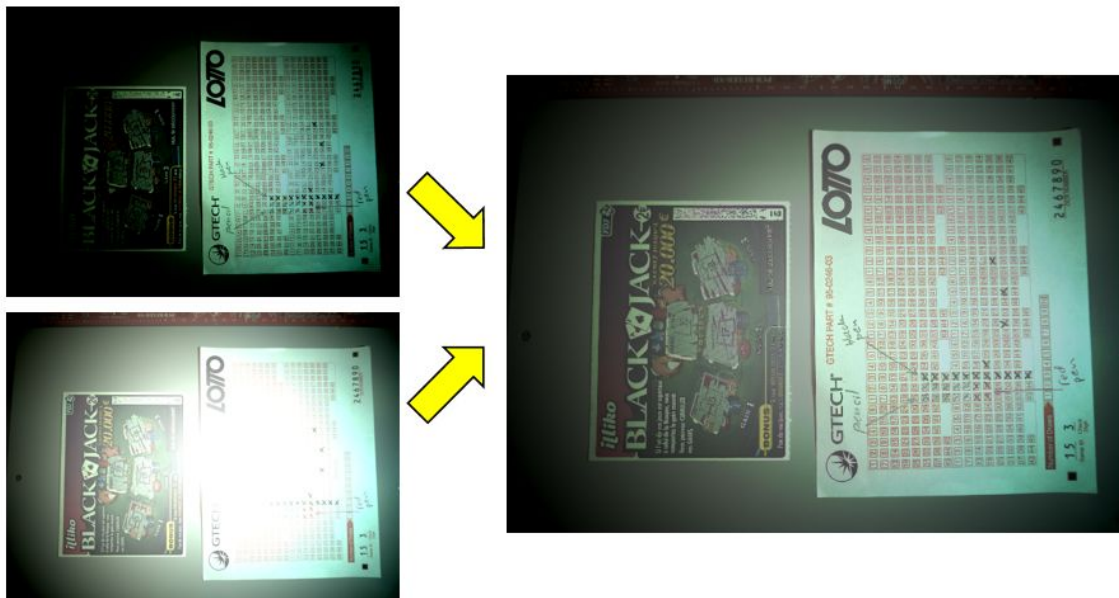


**Fig 2:** The process of producing HDR images: one or more over- and under- exposed photos are taken from the camera, and transferred wirelessly to the laptop for image processing applications; hence one high quality HDR image is produced.





**Fig 3:** 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.



**Fig 4:** Underexposed(top left) and overexposed(bottom left) images combined using a contrast based HDR algorithm to produce an optimal quality HDR output image(right).