Measuring Parking Lot Occupancy using Image Processing

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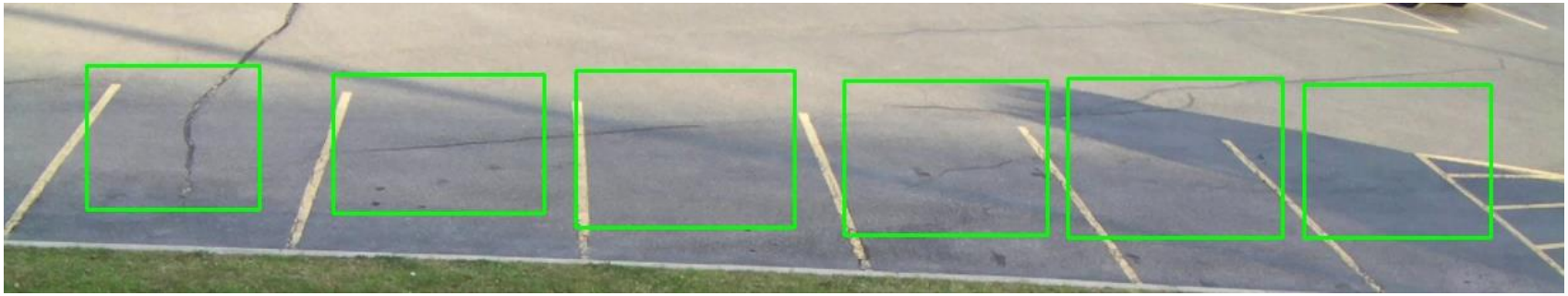
Project Goals

- Given only images and video of a parking lot:
  - Determine the number and location of occupied spots
  - Determine the number and location of unoccupied spots



Development Environment

- Set up Raspberry Pi
- Install SSH server - remote CLI
  - *apt-get install ssh*
- Install VNC server – remote GUI
  - *apt-get install tightvncserver*
- Install Git – source control
  - *apt-get install git-core*
  - *git clone https://github.com/haidark/N02062147.git*
- Install OpenCV-Python libraries
  - *apt-get install python-opencv*

Approach

- Problem as stated is vast; The following restrictions are made:
  - Static camera (simulating surveillance footage)
  - User inputs spot locations
  - Image of empty lot required
- Now the problem lends itself to template matching

Template Matching

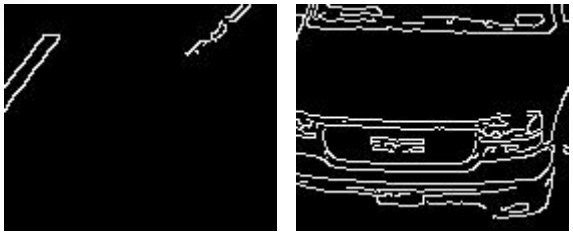
- Each spot is defined as a region of interest, or ROI
- Templates are defined as unoccupied spots
- Each ROI from subsequent frames will be compared to its template

Comparison Technique

- It is unadvisable to use the raw images to compare the template and the newly extracted ROI
- Instead use Canny Edge detection to extract edges








Canny Edge Detection

Thresholding

- The absolute difference between the template edges and new ROI edges is calculated and normalized:

$$normDiff = \frac{abs(templateEdges - newEdges)}{255}$$

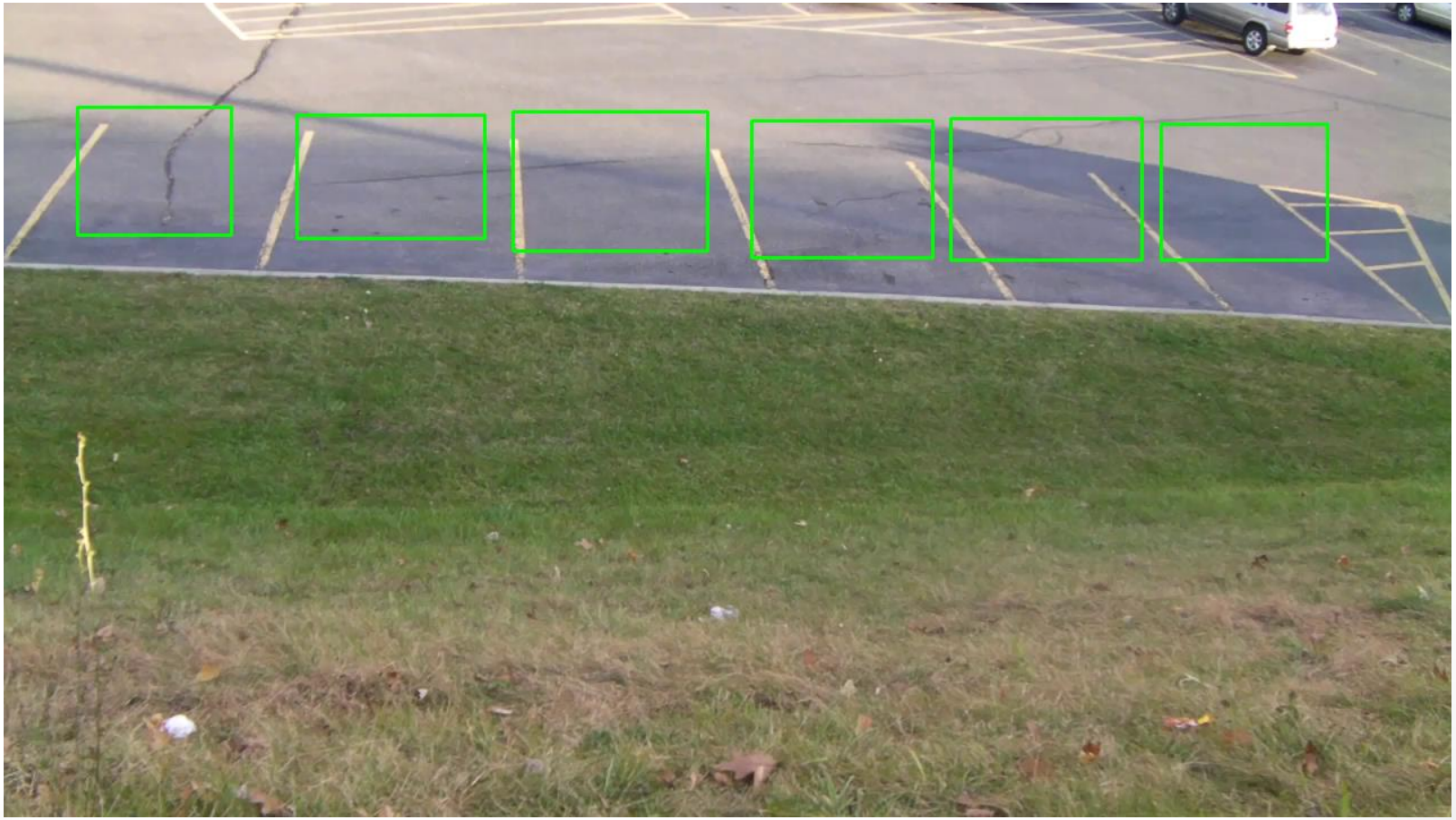
- User defines the percent difference, *tP*, at which a spot is considered occupied and the threshold, *t*, is calculated:

$$t = size(normDiff) * \frac{tP}{100}$$

- If *diff*, the number of TRUE pixels, is greater than *t* the spot is occupied.

$$diff = sum(sum(normDiff))$$

Results



What I Learned

- Familiarity with CLI
- Setting up development environment
- Using OpenCV framework in Python
- Image processing techniques
- Limitations of embedded environments

Issues Faced

- Template matching problems
  - feature extraction
- Problems with thresholding techniques
- Video processing on Raspberry Pi
  - ffmpeg

Future Work

- Automatically extracting ROIs from an empty parking lot image
- Combined with bird's eye view will allow non-static camera
- Improve technique to decide whether occupied or not

Questions?