# MM 803 Project Proposal

Nov 6, 2017
Professor: Amirhossein Firouzmanesh
Student: Chenrui Lei, Lin Tong, Anni Dai
Student ID: 1366324, 1296836, 1264320
Student CCID: chenrui, ltong2, adai1

1. Motivation

The task is coming from RoboMaster Competition, a largest and most complex student robotic competition. The details of the competition itself could be found from their website: https://www.robomaster.com/en-US

In short, the competition is a robot shooting game. Two teams of robots shoot against each other to win the game. The thing that related to this project is, during the competition, there is a ground rune on the competition's battle field. This ground rune is like a magic energy for the robots. The team that could successfully activate the rune will gain 3 times of shooting power for all the robots in their team.

A ground rune have been shown in Graph 1. There are 4 components to form the ground rune: grid area, cells, digit tube, and prompt lights. The grid area is a 3 by 3 grid that contains 9 cells. Each cell contains a handwritten number range from 1 to 9 without replicated numbers (each number will only display in one cell at a time, e.g, not two "3" displayed in two cells at a time). The digit tube contains the 5 number digit code which the robot will need to use for ground rune activation.
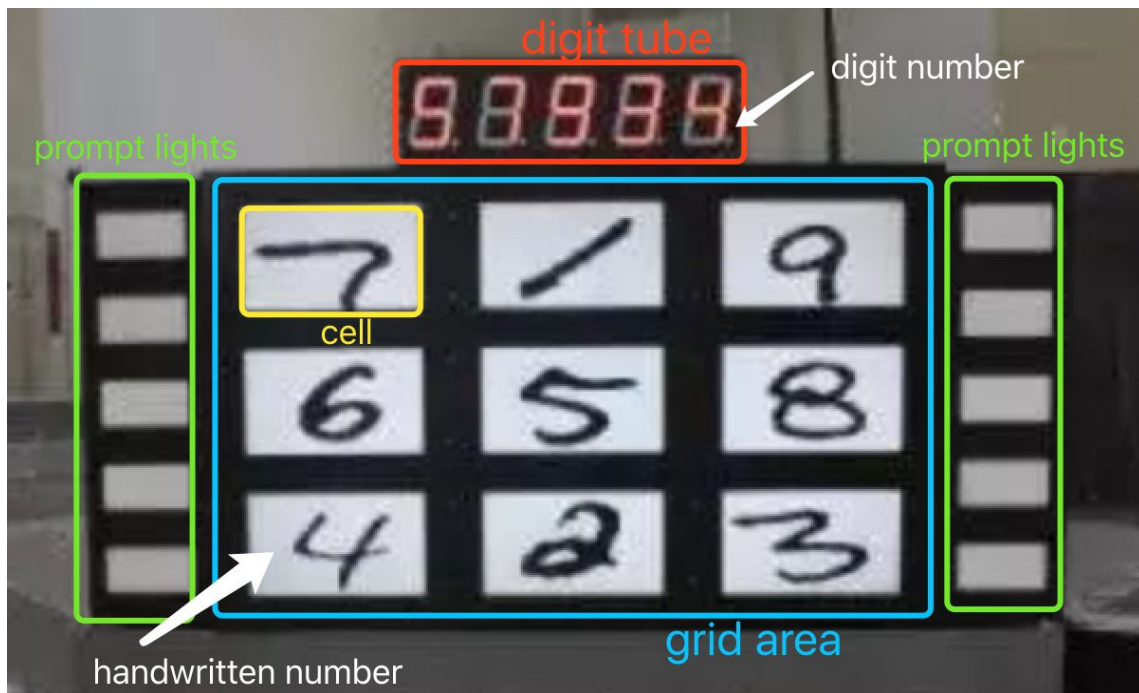
Graph 1

The Rune Auto-activation System is a system that could activate this ground rune automatically. In order to activate the ground rune, a robot needs to read the digit code and shoot the handwritten number cell with that digit code order. To solve this task, it require image processing technologies. First, the system will need to find the place of digit tude, then apply number recognition method to read the digit code. Secondly, the system will need to locate the cells individually and apply handwritten number recognition method to identify which cell contains the number it wants. Finally sent the command with location of the cell to hardware control board and let the robot shoot the target cell. Those steps will need to be completed under 1.5 second, otherwise the rune will be reset (digit code and the place of handwritten number will change). If 5 handwritten number have been shooted correctly in digit code order the ground rune will be activated.

Note :
- After each correct shooting, the place of handwritten number will be randomly shuffled but the digit code will remain the same.
- If there is any mistake made by the algorithm (not able to find the correct number under 1.5 second, or find a wrong cell to shoot, or reads the digit code wrong), the ground rune will be reset. So, the system have to solve the problem from the beginning again.

2. Scope of the project

Due to the limit time on this project, we won't able to develop a fully functional Rune Auto-activation System. We will focus on the grid searching task and handwritten number recognition task. Ideally, our algorithm should be able to find the 3*3 grid area in a frame (if there is a complete grid captured in that frame) and recognize the handwritten number in each grid cell.

Input

This is a project related to the image processing so all the input are the video files that recorded from the camera mounted on top of robots. There are 2600 frames in those input videos. Those frame are raw frame without labels so we need to do the labeling ourselves.

Output

The output of our algorithm is the central position coordinator of a specific grid cell that contains the target number.

Overall Evaluation

Since we won't develop an algorithm to extract the target number from digit bar and the prompt lights. We will feed the target number to our system to do the test.

Once our system got a output from a frame, we compare this output with the ground truth. We consider a success round if the output coordinator is located within the bounding box of the ground truth for that target number. Otherwise, it is a fail round. The error will be the distance between the predicted coordinator and the ground truth central coordinator.

3. Related papers

- Jung, Claudio Rosito, and Rodrigo Schramm. "Rectangle detection based on a windowed Hough transform." Computer Graphics and Image Processing, 2004. Proceedings. 17th Brazilian Symposium on. IEEE, 2004.

- Viola, Paul, and Michael Jones. "Rapid object detection using a boosted cascade of simple features." Computer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on. Vol. 1. IEEE, 2001.

- Jain, Nimisha, et al. "Hand Written Digit Recognition using Convolutional Neural Network (CNN)." (2017).

4. Plan

- Week 1
    - Create a script to help us label the testing data
    - Labeling testing data
    - Explore basic image processing techniques for noise removal, etc.

- Week 2
    - Explore techniques to detect object
    - Explore techniques to detect rectangle
    - Explore techniques to recognize handwritten numbers
    - Develop algorithm to find the grid area
    - Implement handwritten numbers recognizer
    - Tuning grid area detector
    - Tuning handwritten numbers recognizer

- Week 3
    - Tuning and optimize grid area detector
    - Tuning and optimize handwritten numbers recognizer
    - Combine grid area detector and handwritten numbers recognizer to form a system
    - Tuning and optimize the overall system

- Week 4
    - Final tuning
    - Perform experiments and gathering result data

- Week 5
    - Write final report

Reference

1. Competition web: https://www.robomaster.com/en-US

2. Competition rules 2017 v1.9 (Ground rune on page 33~34):
   https://cdn-hz.robomasters.com/robomasters/public/document/RM2017CompetitionRulesV1.9.pdf
3. Video explanation of general competition rudes 2017:
   https://www.youtube.com/watch?v=5Xy6flWkJQQ
4. RoboMaster2017 Final SCUT VS SDUST recoding 2017 (ground rune activated by blue team on 3'16'', 6'10''~15'', 16'02'', 19'57''~20'02'', 32'51''~54'', 34'41''~49'', 43'34''~40'', and 45'10''. red team tried to activate ground rune at 41'28''~37'')
   https://www.youtube.com/watch?v=q1o3wda4Gl8
5. Competition video documentary 2016:
   https://www.youtube.com/watch?v=ECr4zgK6cPA