Sprint 3 - Writeup

Behnam Saeedi, Margaux Masson, Kamilla Aslami, Nghi Duong, Dhruv Jawalkar
CS561: Software Engineering Methods
Due Dec 2nd 11:59pm
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Repository: https://github.com/BeNsAeI/PADSR

CONTENTS

1 INTRODUCTION

Through out the course of this class our team dedicated its time to creating an interesting programming application that each member could proudly include in their resumes and show it as something they have done or achieved. Team faced many challenges and problems that they had to solve and overcome. This documentation is a brief description of what the group managed to produce in the third sprint of our scrum procedure. Please join as as we describe this exciting engineering procedure through the course of this documentation.

2 GITHUB REPOSITORY INSTRUCTIONS

This section has been covered in previous sprint documentations as well. All of our code is available online and in you can try them yourself by following the following instructions.

The repository is located at "https://github.com/BeNsAeI/PADSR" and contains many different folders. The files that we developed for the purpose of this project are all located in the Integration folder. Furthermore, We can find all of our documentation in the Documentation folder. We also have few other folders in the repository that are meant for testing, development and figuring out what is achievable. Likewise, in the documentation folder we have a folder for user stories. The User stories for this sprint and potential user stories for any future development are located in "Documentation/User stories/ PAD".

3 MEET THE TEAM

Through the past two sprint documentations we have already introduced our dedicated team who put effort in order to produce, test and maintain this tool set. As a revision we have included the list of the group members and their expertise in this documentation.

The following is the list of our group members and their expertise and background.

- **Behnam Saeedi:** Behnam Saeedi is a master student with AI and computer graphics options. His skills are mainly in embedded programming, machine learning, image processing and computer graphics.
- **Margaux Masson:** Margaux Masson is an exchange Computer Science's student at OSU from France. Her school back in France is CPE Lyon Engineering school. Her major is Computer Vision, so all the fields related to image processing and computer graphics. In OSU, she is taking the Computer Graphics, Cyber Security and Software Development Methods' courses.
- **Nghi Duong (Scrum Master):** Nghi is a new master student concentrating computer vision and 3D modeling. His background is in mathematics and computer vision. He joined the team later than other members. (He first met the team on Oct 3rd.)
- **Kamilla Aslami:** Kamilla is a first year Master's student participating in the Software Innovation Track. She is interested in Machine Learning and has used Python for 3 years in a professional setting.
- **Dhruv Jawalkar (Product Owner):** Dhruv is a master's student at OSU with an interest in Computer Vision, has experience in programming in Python, training neural nets to do simple vision tasks like Classification, Localization and Object Detection.

4 USER STORIES

For the third sprint, we introduced 4 new user stories. The purpose of these user stories are to provide an alternative method of computing the depth, integrate the new method, test it and integrate it. These new user

stories were outside of our area of expertise and all of the members needed to learn many new skills and setup several new tools in order to create the final product.

These user stories could be viewed on the "PAD-SR GitHub: Documentation/User stories/ PAD/" path. In this write up, texts that are written in **bold** are the texts that are in our user story 5×3 cards.

4.1 Spike (Process requirement):

Take time as a team to set everything up

This step was added to make all of our team members learn about CNN and PyTorch.

4.1.1 Priority

High: Next User stories depend on this task. This task is especially important this sprint because non of the members have used PyTorch API before and we needed to install, learn and understand the basic concepts present in this API.

4.1.2 Estimated time

50 hrs: Pytorch in particular caused a wide range of issues on several different systems. It did not perform well on Linux system that had ROS installed, it corrupted the path variable on Linux and macs, it crashed into a segmentation fault screen on Linux and it flat out does not support windows for python 2.7x. To make matters worse, we could not even manage to install and compile it from source code due to library requirements more convoluted than Tensor Flow, OpenCV and SKLearn combined.

4.1.3 Details

Learn how CNN's work and implement them using a NN framework, PyTorch

4.1.4 Tasks

- Learn CNN (10)
- Set up PyTorch (5)
- Learn PyTorch - Tutorials on pytorch.org (10)
- Learn and train a simple CNN (10)
- Look at writing custom model, loss fn, transforms (15)

4.2 Neural Network

Using CNN to extract a depth map from an image

4.2.1 Priority

Medium: Not many of our tools actually depend on this particular feature, However, this was one of our stretch goals and we are extremely excited to work on this. Some of the members have been anticipating this for over 3 weeks now.

4.2.2 Estimated time

40 hrs: a NN model has many components, will take time to hand code overall network and loss function

4.2.3 Details

Read existing papers on the topic and implement the nn model to extract a depth map from an image

4.2.4 Tasks

- Evaluate options (5)
- Dataset and preprocessing (10)
- Architecture design (10)
- Train our own model (5)
- Evaluate our trained model (10)

4.3 Integration:

Integrate the depth map generation using CNN

4.3.1 Priority

Low: The neural Network User story is not that crucial to the functionality of our tool set. In fact our software can function with no problem what so ever if this particular component fails. This gives this component a very low priority.

4.3.2 Estimated time

10 hrs: Would need to integrate the model as an API into the existing application. This task could get very time consuming very quickly.

4.3.3 Details

Integrate the function which generate depth maps using the CNN and update the user interface with this new feature

4.3.4 Tasks

- Integrate neural net into API (3)
- Integration testing (5)
- Command line interface (2)

4.4 Testing:

Test the whole system

4.4.1 *Priority*

Low: We are predicting that our user would not be particularly interested in Neural Network feature of our tool set given that we already have a very efficient algorithm that takes care of converting image to depth-map.

4.4.2 *Estimated time*

10 hrs: The breakdown of the time needed is in the Tasks section.

4.4.3 *Details*

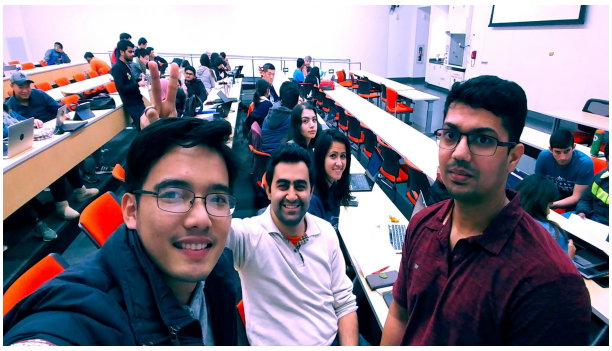
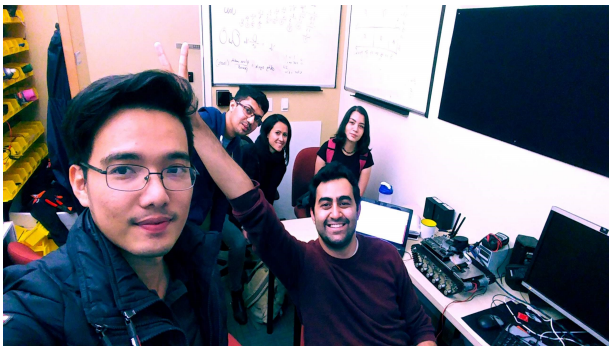
Unit test and manually test the system now that is uses CNN

4.4.4 *Tasks*

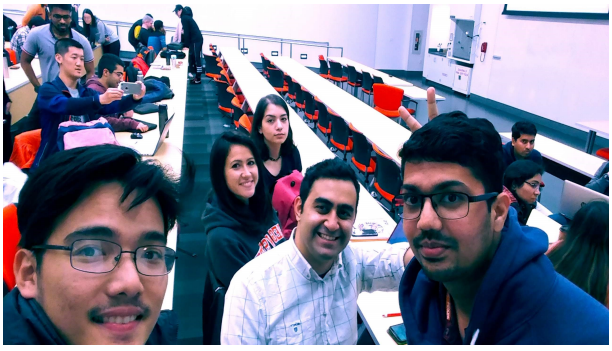
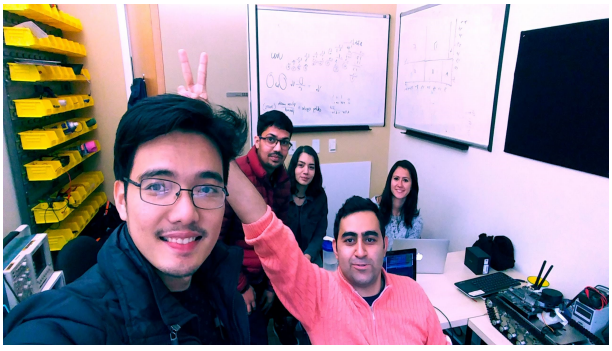
- Test plan (2)
- Automated testing (5)
- Manual testing (3)

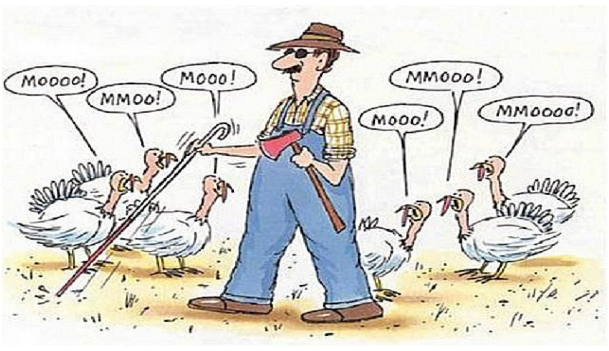
5 Daily Scrum Photo Gallery

5.1 Week 1

5.2 Week 2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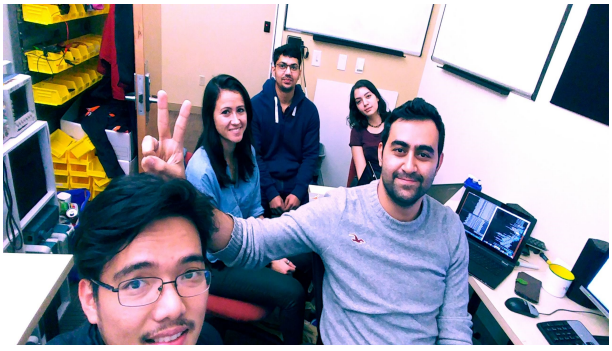
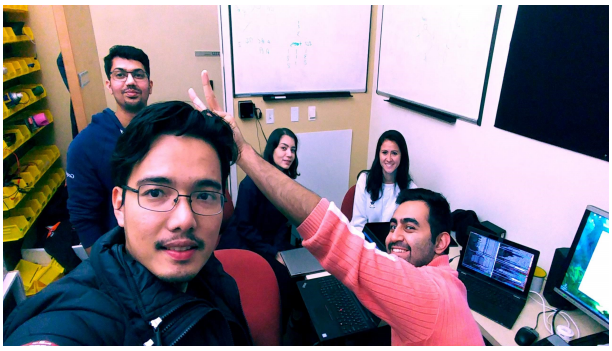
THE DAY AFTER THANKSGIVING

5.3 Week 3





Please note this is the same image as the evidence for our sprint retrospective, because we did this on the same day after our scrum

6 Integration Test Plan

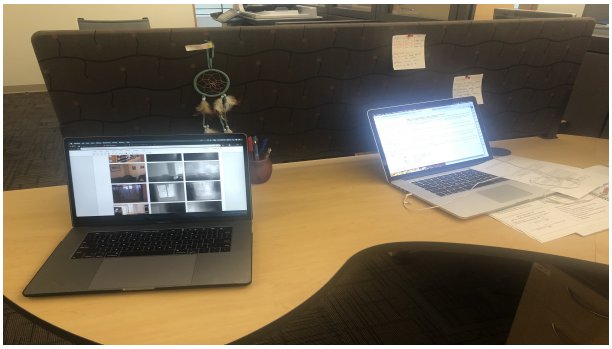
We choose to test our system manually because of the complexity of written end-to-end tests with CNN. So, in order to test our system end-to-end manually, we followed these steps: - Take a video (.mp4) filmed with a smartphone. - Upload the video on the computer - Run the integration file cli.py (both creating depth map video showing the 3D video) and putting the path where the video was uploaded. - Choose the step between two frames. We executed these tests with step=1, 10 and 30.

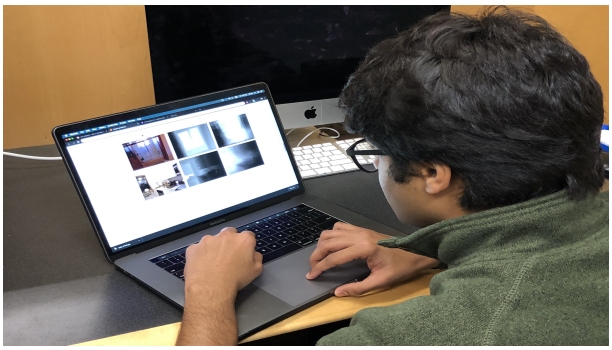
7 GitHub Integration evidence

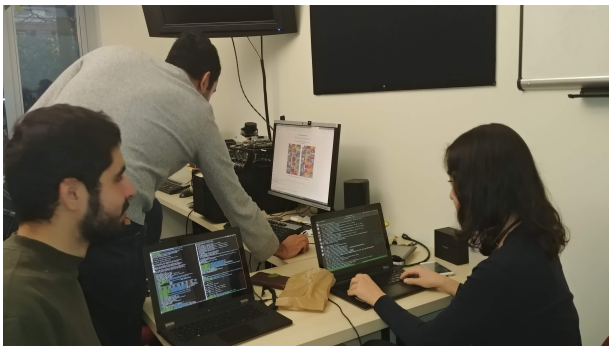
```
* b3950d0 - (18 minutes ago) Added unit tests for NN option in video converter - Kamilla
* ca858f5 - (60 minutes ago) Updated cli and cli_helpers docs - Kamilla
* 1e6a4d0 - (73 minutes ago) Fixed broken unit tests - Kamilla
* 78f2d24 - (8 hours ago) updated DIW model to run on gpu if avaiable - Dhruv
* 2ae9f0b - (31 hours ago) fixed python3 division. - Nghi Duong
* 4a2976d - (17 hours ago) python3 compatible version - Kamilla
* ce91243 - (17 hours ago) Neural network depthmap version integrated to CLI - Kamilla
```

```
* 371bd2d - (29 hours ago) Integrate the function to create the depth maps using CNN - Margaux
* ccd6a59 - (29 hours ago) [WIP] Add Neural Network code in the Integration folder - Margaux
* 2507594 - (2 days ago) updated depth-prediction model to run on cpu, gitignore for ds, weight
* b8a99ec - (3 days ago) updated the DIW model state_dict(), now works with pytorch=0.4 as well
* d609a81 - (4 days ago) aded depth preception in the wild model - Dhruv
* 35263b2 - (4 days ago) Update README.md - BeNsAeI
* fa96cab - (5 days ago) trained model, updated notebook with results - Dhruv
* 5eef898 - (8 days ago) added neural net model from the paper - Dhruv
* afe2f7a - (9 days ago) added loss function, minor mode utils - Dhruv
* 49e7c54 - (10 days ago) added dataset, transforms for the nn model - Dhruv
* e57441b - (10 days ago) Data set folder added please add gitignore before pushing - BeNsAeI
* 5d8925d - (12 days ago) C++ neural net is implemented and working - BeNsAeI
* 8612c45 - (2 weeks ago) C Nueral Network example unit tested - BeNsAeI
* 3518f21 - (2 weeks ago) added c nueral net example -> this is for Ben's book keeping in case
* 9b417af - (2 weeks ago) pytorch install script added - BeNsAeI
```

8 Sprint Review Logs and Notes










For this sprint we mannaged to find 11 new users in to test our tool and give us their feedback on the performance of the tool. Our users were mostly with computer science background in various fields from software engineering to AI. This gave us a unique opportunity to consider feedbacks from a wide range of backgrounds and from a wide range of different perspectives. The feeds-backs varied from usability and aesthetics of our system to performances and quality of outcome.

8.1 User Tests

We came up with a streamlined user test in order to evaluate claims for our product on usability, reliability, performance and simplicity. The following User test procedure was used in order to conduct this test:

1) Ask the user to stand still so we can film them for the demo purpose
2) Ask the user to start up the tool
3) Use the tips and navigation instructions on the screen to produce the scene
4) ask for their feedback on:
    - Ease of use
    - Effectiveness of onscreen instructions
    - Quality of output
    - Suggestions

Users gave us a wide range of feed-backs. The following is a refined list of some of such feed-backs given to us.

- **Positive:**
    - User interface has many options that allow to customize the output or use the default configuration.
    - The program execution is fast enough to create a smooth video.
    - All users were satisfied with the accuracy of a depth-map video.
    - A 3d scene can be rotated, and its depth can be adjusted.
- **Negative:**
    - Some users were not comfortable with the command line and asked for additional instructions on how to work with it.
    - The 3D scene has some noise and the scene is not smooth enough.
    - The program does not support videos with a format rather than MP4 or API.
    - It came to our attention that not all phones encode video the same way making it complicated for us to debug the video frame rate issue that happens. This was something that the users.

8.2 Product owner

Dhruv Jawalkar was the product owner for this sprint. He created tasks to explore the possibility of using CNN's to generate a depth map for our 3D video application. This was fairly experimental but we were looking to solve the problem of generating better depths from video frames, different scene videos and not having to tweak with a lot of parameters in OpenCV to see good depths. A NN model could generalize better and need less tweaking.

8.3 Scrum Master

Nghi Duong was the scrum master for this sprint. He was in charge of the daily meetings hours, getting to know if all the members were able to come, take pictures to have evidence of the meetings attendance, make sure that every member of the team had something to work on and was happy about it.

8.4 Attendees

The attendees were limited to the minimum number of people necessary in order to have an effective Sprint review.

- Developers: All the members of the team were present during this meeting.
- Product owner
- Scrum master
- User

8.5 System strengths and weaknesses

8.5.1 Strengths

- The system satisfies our claims, works as expected and has all planned functionality implemented.
- The program execution is fast enough to create a smooth 3D scene and a depth map in a reasonable time.
- The User interface is easy to use for those who are comfortable with terminal and provides many customization options.

8.5.2 Weaknesses

- CNN feature was experimental and it didn't give us considerable improvement: it is slow and computationally expensive.
- Depth map generated by CNN lacks clarity at higher resolution.
- The 3D video can be smoother by removing some noise.

9 Sprint Retrospective Notes

9.1 Notes

What went well:

- Spike time estimation was very accurate, and the spike itself was very efficient - everybody was able to learn and practice with CNN and got to know how to implement CNN using PyTorch.
- Tasks were split and estimated better comparing to previous sprint.
- We implemented a deep CNN model to generate depth maps and integrated it to our project.
- We implemented and trained a research paper model from scratch.

Things to improve:

- Quality of outputs from CNN model is lower than expected.
- Inference time is too high, making it not usable.
- NN model needs too much memory and computationally intensive.
- Time estimations didn't take holidays into consideration.

9.2 Evidence

10 Sprint Retrospective Evidence

11 Contribution Bus

For this sprint, balancing the workload and amount of contributions to the project was particularly difficult due to wide range of technical skill sets among group members. Furthermore, it was hard to determine a reliable time estimation for tasks given the nature of our user stories. Convoluted Neural networks are complicated to design, hard to debug and time consuming to train. Despite these complications we managed to somewhat fairly balance the workload.

11.1 Behnam Saeedi

This sprint Behnam had two main tasks. he was in charge of finding a suitable hardware for the task of training the neural network. For this purpose a full tower with 32 GB of RAM, intel Core i7 8 core processor and two nVidia Geforce GTX 970 graphics cards were selected to process and train the network on Cuda cores. Furthermore, he had the task of training the network.

11.2 Margaux Masson

Margaux worked on the integration part. So, the main goal was to make the CNN code work and integrate it into the current depth map video creator with some condition so the users can choose to use the CNN to generate the depth maps or not. She also worked on the manually testing plan: make sure that the code runs and works for every condition and parameters the user might choose. Tests done using several videos and parameters (differents steps between the steps for example).

11.3 Kamilla Aslami

Kamilla worked on implementing a new option for the command-line interface which allows a user to generate depth map using CNN. She was also responsible for writing and maintaining automated tests. In addition, Kamilla made the project compatible with both Python 2 and Python 3.

11.4 Nghi Duong

Nghi worked with Dhruv on implementing and training the neural network model. He supported with testing and benchmarking the model. Nghi also worked on bug fixing during the code integration.

11.5 Dhruv Jawalkar

Dhruv worked on creating and training the NN model to see if we could obtain good results on the clarity of the depth map. Included data preparation, image transforms and implementing things from the research paper. Dhruv also helped other team members learn CNN and Pytorch basics very fast during spike since he has considerable experience with these.