Week 1

What has been done this week

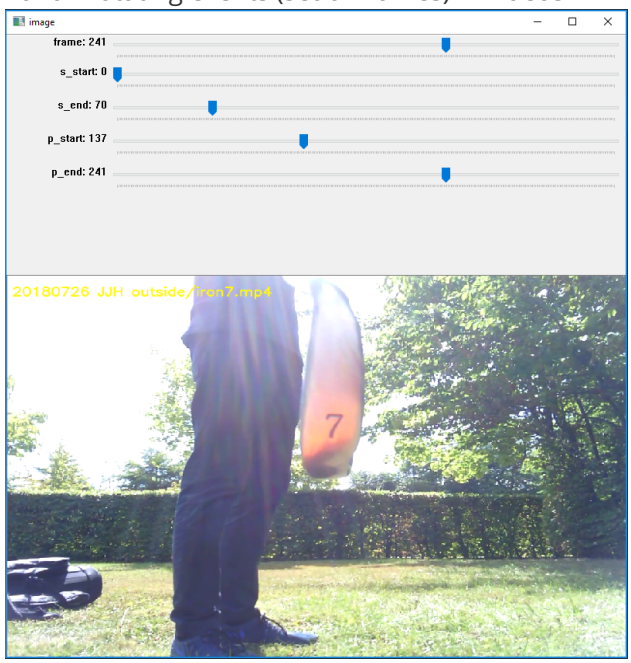
Currently we have 142 videos, with a total duration of 19 mins

```
Subtypes:
driver          6
hybrid          5
hybrid3         2
iron5           21
iron6           9
iron7           23
iron8           10
iron9           19
pitchingwedge   10
putter          5
sandwedge       10
wedge54         2
wedge58         1
wood            16
wood1           1
wood2           1
wood3           1

Main types:
driver          6
hybrid          7
iron            82
wedge           23
putter          5
wood            19

Number of videos: 142
Duration (HH:MM:SS): 00:19:09
Frames: 51773
```

More videos are set to come in from the sellers during the next two weeks. I have created scripts for renaming the video files and collecting stats. A script for extracting frames has been made but need to be customized to choose specific part of frames.

It took a bit of time to get set up in the new space. Much of the time this week has been spent on creating and exploring tools for managing and annotating the incoming data. Especially BeaverDam took some time but seems like some really promising software for creating annotation and deploying a HIT to MTurk.

- [x] Get set up with the new space
- [x] script for renaming videos
- [x] script to collect stats about videos
- [x] Updated data collection guide and youtube video https://www.youtube.com/watch?v=1Ltk6quUXYg&vq=hd1080
- [x] Finish data recording guide and sent out to sellers so that we can collect data.
- [x] Create an annotation tool for annotating events (set of frames) in videos



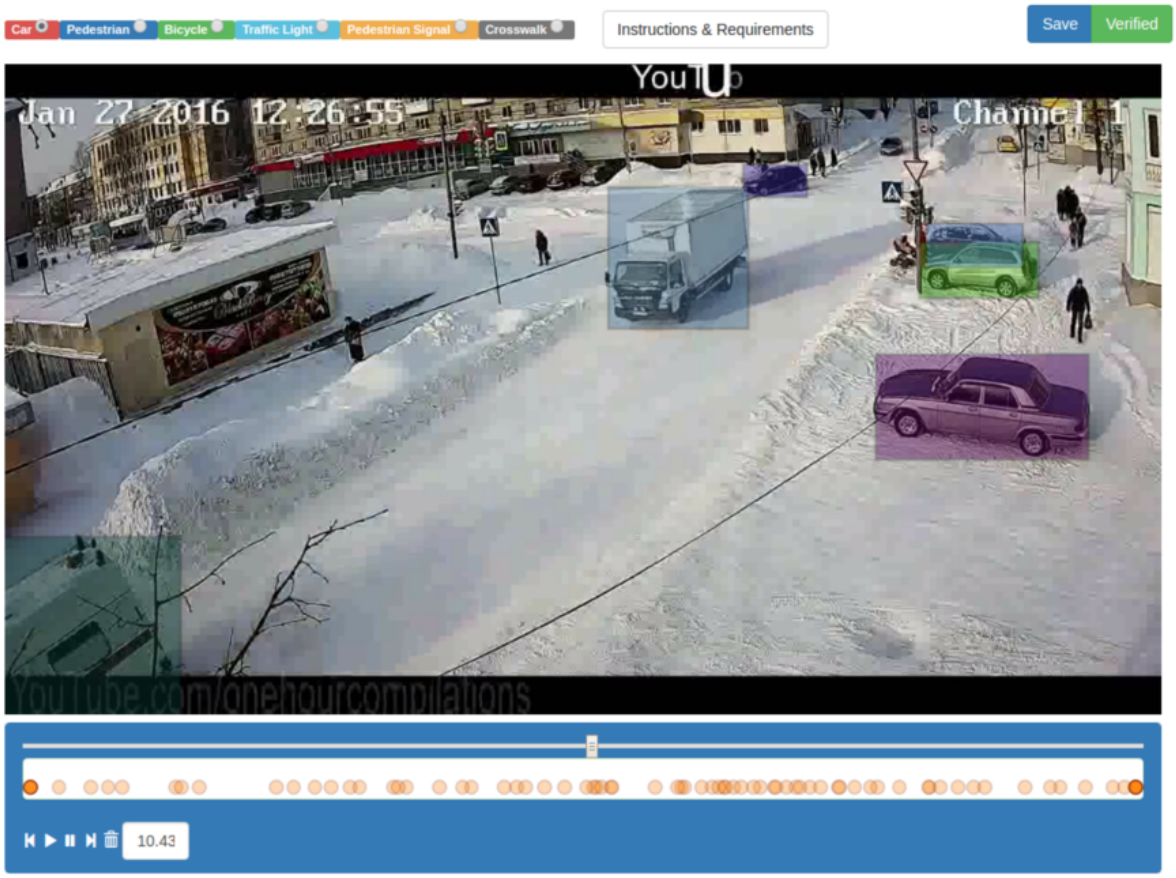
- [x] Setup Citation / References environment (**Zotero**)
- [x] Read Trackman Intro Documents
- [x] Setup Microsoft Teams
- [x] Find title for project
    - [x] Golf club detection and identification using deep learning on embedded devices
- [x] Try out BeaverDam annotation software
- [x] Load club data into beaverdam and setup scripts locally
- [x] USB-C Dock and Screens
- [x] literature review

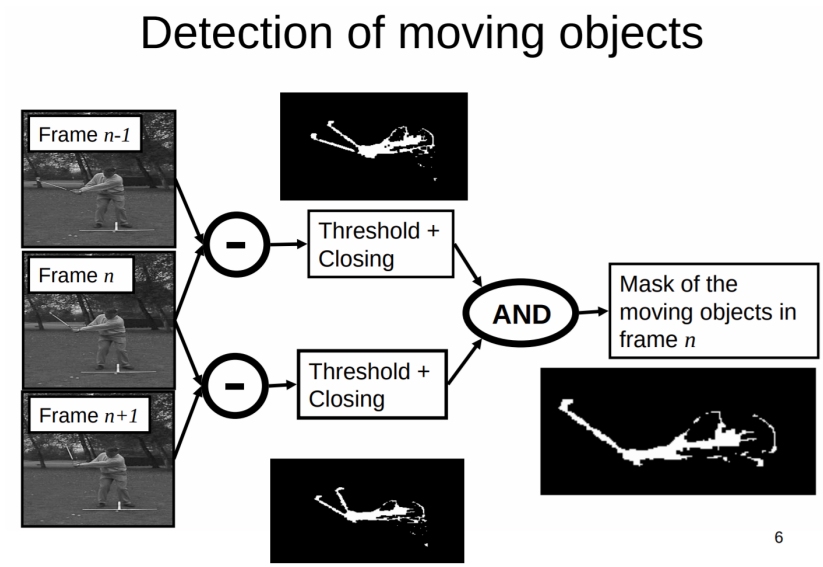
Status according to project plan

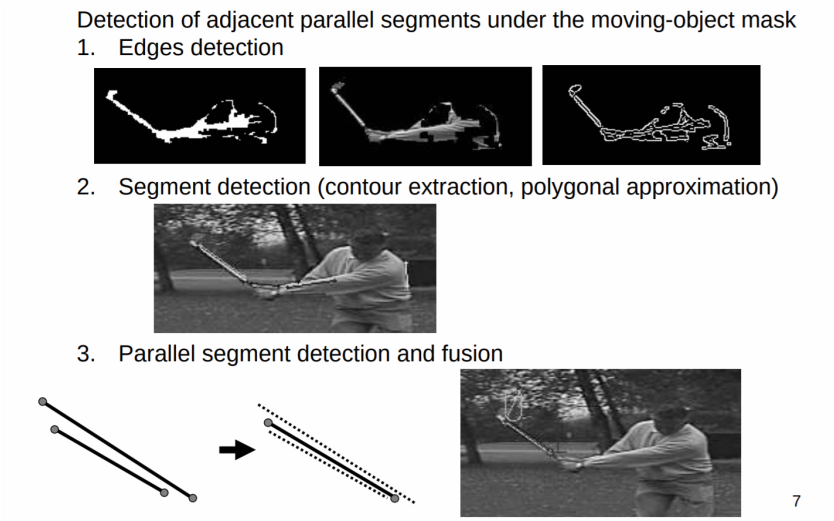
Done initial data exploration, created some tools and thought a bit more about the problem and what needs to be done moving forward which was the goal for this week. Next week is more intense literature study and enhancing the project plan, essentially deciding how I will go about doing this project.

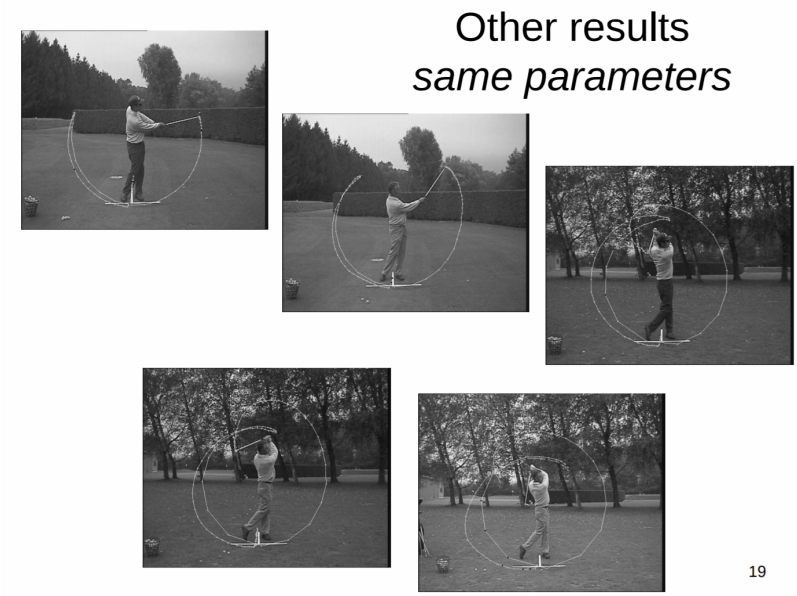
Literature

- BeaverDam: Video Annotation Tool for Computer Vision Training Labels: https://www2.eecs.berkeley.edu/Pubs/TechRpts/2016/EECS-2016-193.pdf
    - Seems to be best in class for video annotation. Better than VATIC system which was previous best in class. Essentially taking VATIC and removing all the pain points for direct access to MTurk labeling



    - Ability to mark an object, let the video play and then move the annotation when the object moves, greatly increasing the number of covered frames as compared to annotating individual frames
    - Push-to-play integration of MTurk
- **Visual Golf Club Tracking**, Nicholas Gehrig et. al
    - 

- 

  - Uses motion estimation (predict where the club will go) and check this with the prev and next frame to remove mis-detections.
- 

  - Hard to apply to our result because the angle of the camera is very different.
- **Golf video tracking based on recognition with HOG and spatial–temporal vector**: http://journals.sagepub.com/doi/full/10.1177/1729881417704544, Li Weixian et. al
  - Good performance for a low number of videos. Has a quite different angle than the videos in our project and is more focues on the swing rather than the presentaton of the club.
  - Algorithm:
    1. Body detection (bounding box using Dollar et al)
    2. Get *Rect* for hand and club in initial position from body position (estimated from experience)
    3. Run object detetion in this frame:
       1. Estimate possible postions from last frame
       2. Run Object detection here
       3. Features: [$[HOG_i, HOG_i-HOG_{i-1}, X_i-X_0]$ where HOG_i is the HOG vector in frame *i* and $X_i = [x_i ,y_i]$ is the position coordinates of the object in frame *i*
  - Training is using adaptive boosting algorithm in OpenCV
  -

Table 1. Configuration of the training database.

Properties	Hand	Club
Number of videos	99	99
Number of positive sample	13,287	13,287
Number of negative sample	147,671	147,671
Patch size (pixel)	63 × 63	48 × 48
HOG dimension of a patch	1296	900
Proposed descriptor dimension of a patch	2594	1802

HOG: histograms of oriented gradients.

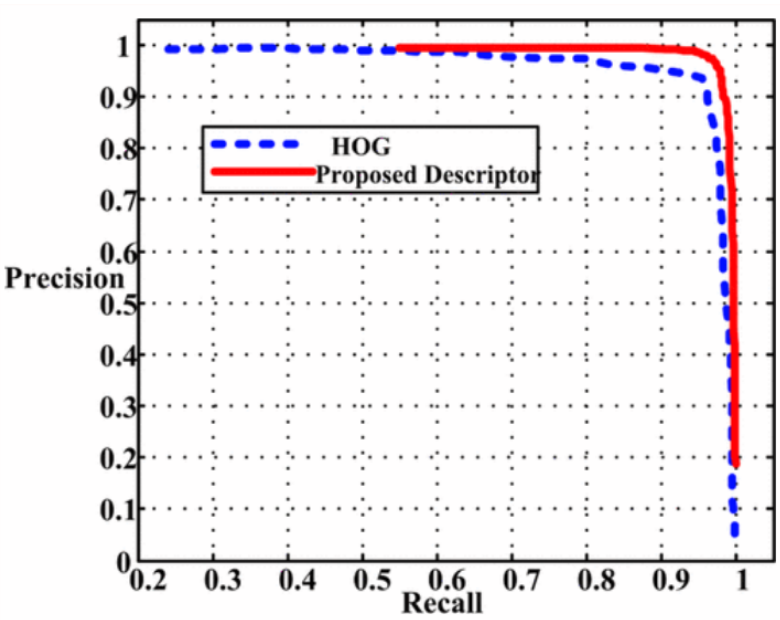


Figure 5. Precision–recall performance.

Figure 6 is the initialization results with the strategy of player's body–object window–object. The black box is the detected player's body using ACF; the blue and red box is the object windows that are defined by Equations (1) and (2); the small white boxes are the hand and club patch recognized by the trained boosted classifier in the above defined object windows. Results show that the initial hand and club can be correctly found.

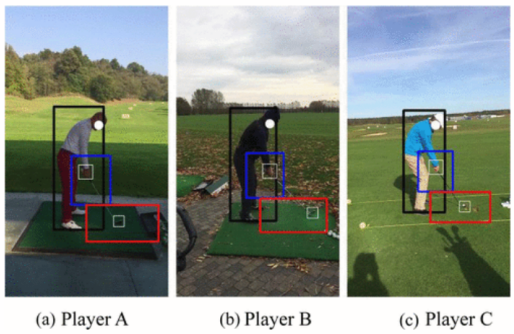


Figure 6. *Initialization* results: player's body, object window, and object.

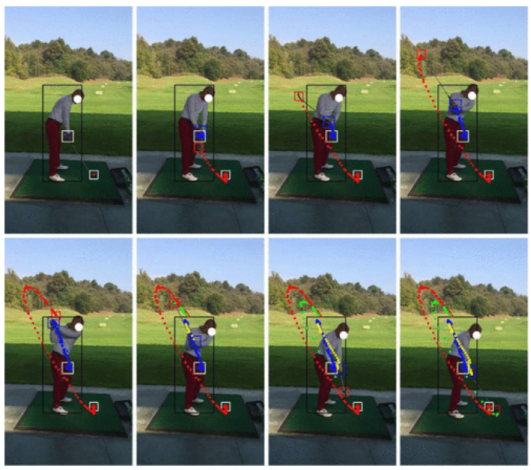


Figure 7. Hand and club tracking of player A. The body position is in black box. The initial hand and club are in white patch, the current hand and club in the current frame are in blue and red patch, respectively. The first row is from backswing: The blue dots and red dots constitute trajectories of the hand and club, respectively. The second row is from downswing: The yellow dots and green dots constitute trajectories of the hand and club, respectively.

- > Since our golf video database is not large enough, the popular deep learning has not been applied in our framework. In the future, as we get more videos, more work can be done to further improve tracking performance with deep learning when videos are shot in the night, in the overcast day, or in other bad situations.

What to do next week

Data should be coming in, so need to set up last part of the framework for processing the incomming data. Also have to get a better overview of literature which will partly be done tomorrow (Friday) when I´m not at trackman.

- [ ] Look into docker
- [ ] Write introduction to the report.
- [ ] Annotate bounding box of the frames
- [ ] Figure out which computer to use for DL applications
- [ ] Sign contract
- [ ] Figure out how to group the clubs into classification categories
- [ ] Script for extracting frames at specific points of the video
- [ ] BeaverDam:
  - [ ] Annotation guide
  - [ ] Fix ID's
  - [ ] Deploy on network?
  - [ ] Get bounding box information