Person Following Robot using Selected Online Ada-Boosting with a Stereo Camera

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Introduction

- The robot follows the target (human) in real time in a dynamic environment. Problems addressed: Tracking and following behavior.
- Problem of Person Following: dynamic environments (target might be occluded, lighting variations, appearance changes, etc. see Figure 3)
- A novel algorithm Selected Online Ada-Boosting (SOAB) is proposed. On top of Online Ada-Boosting approach, depth is used as an additional tool in SOAB.
- The robot follows the target (human) in real time in a dynamic environment. Problems addressed: Tracking and following behavior.
- Problem of Person Following: dynamic environments (target might

Fig. 1. Robot being used for person following behavior

Approach

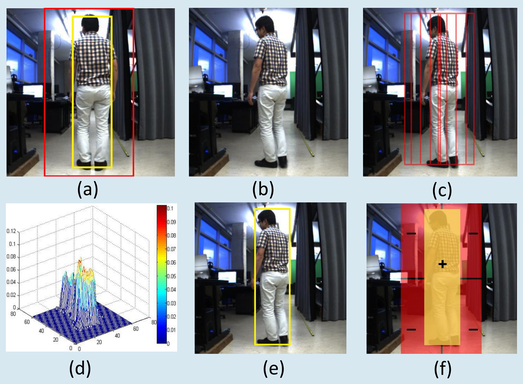

Fig. 2. OAB update process: (a) yellow box is the target region, the red box is the search region. (b) is the next frame. (c) is searching and evaluating the patches in the search region. (d) is the confidence map of the evaluation. (e) is the best matching with minimum error. (f) update the classifier with positive and negative patches. After (f) go back to (a) to search in the next frame. Similar to [2],[3].

- Robot can track target in 2 ways: *user defined* or *pre-defined* bounding box.
- *user defined*: user selects the target to be tracked in the former.
- *pre-defined*: person stands at a pre-specified distance for the later.

Approach

Data: CameraStream
fetch left and right image from CameraStream;
select target to track;
calculate $curDisp$;
$preDisp \leftarrow curDisp$;
pre-train OAB;
while *true* **do**
  fetch left and right image from CameraStream;
  run OAB to extract a positive patch I_p;
  $curDisp \leftarrow Mean(I_p[I_p \in preDisp \pm \beta])$;
  $R \leftarrow \frac{\sum[I_p \in preDisp \pm \beta]}{w*h}$;
  if $R \geq \gamma$ **then**
    update the classifier;
  end
  $preDisp \leftarrow curDisp$;
end

Algorithm 1: SOAB

Navigation Module

- Linear and Angular Velocities are proportional to the disparity and the *x-coordinate* of the centroid.
- The robot always keeps the centroid of the target in the center of the image.
- Robot could run up-to speeds of 1.0 m/s.

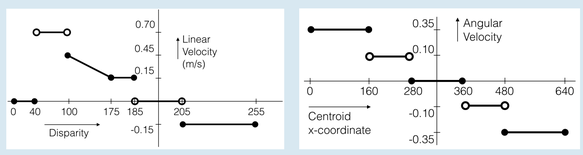

Fig. 1. Linear and Angular Velocities as functions of disparity and *x-coordinate* of the centroid.

Stereo Dataset and Experimental Results

- Indoor Dataset (4 places)built at Lassonde Building at York University.
- Frame rate: 15fps, Resolution: 640 x 480
- Dataset covers different challenging situations as shown in Fig 3.

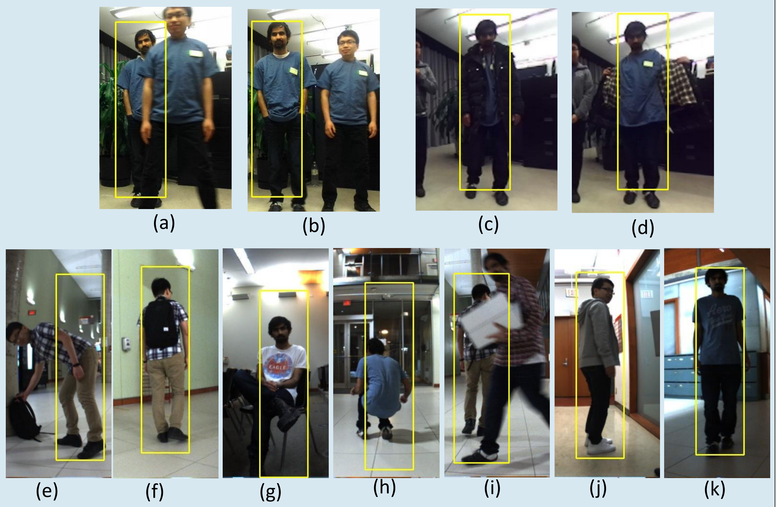

Fig. 3. Different Cases our approach (Selected Online Ada-Boosting) can handle. (a) standing side-by-side with same clothes. (b). Front crossing with same clothes. (c,d) appearance changed (e) picking a bag. (f) wearing a bag. (g) sitting. (h) squatting. (i) occlusions. (j) side facing. (k) illumination changes.

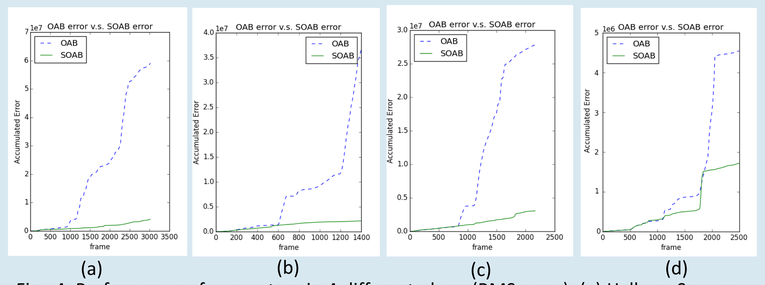

Fig. 4. Performance of our system in 4 different places(RMS error). (a) Hallway Sequence. (b) Multiple Crossings Sequence. (c) Same Clothes Crossing Sequence. (d) Lecture Hall Sequence.

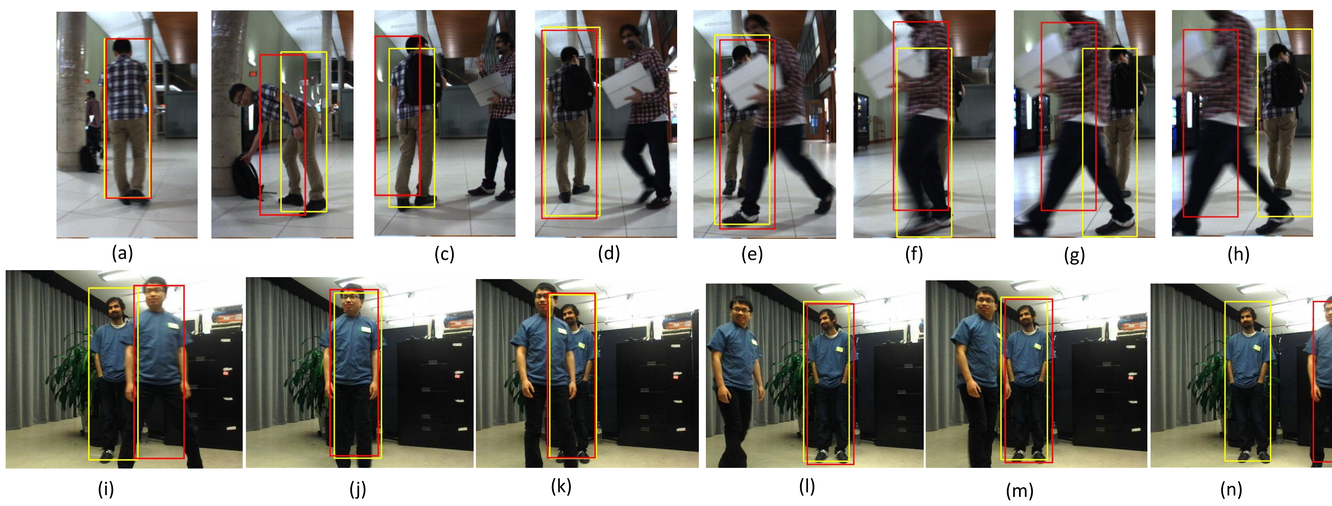

Fig. 5. Red Box is tracking using original OAB algorithm. Yellow box is tracking using SOAB with depth ratio threshold $\gamma = 0.6$. (a-h) are sequences from a university hallway. (i-n) are sequences showing crossings with same clothes.

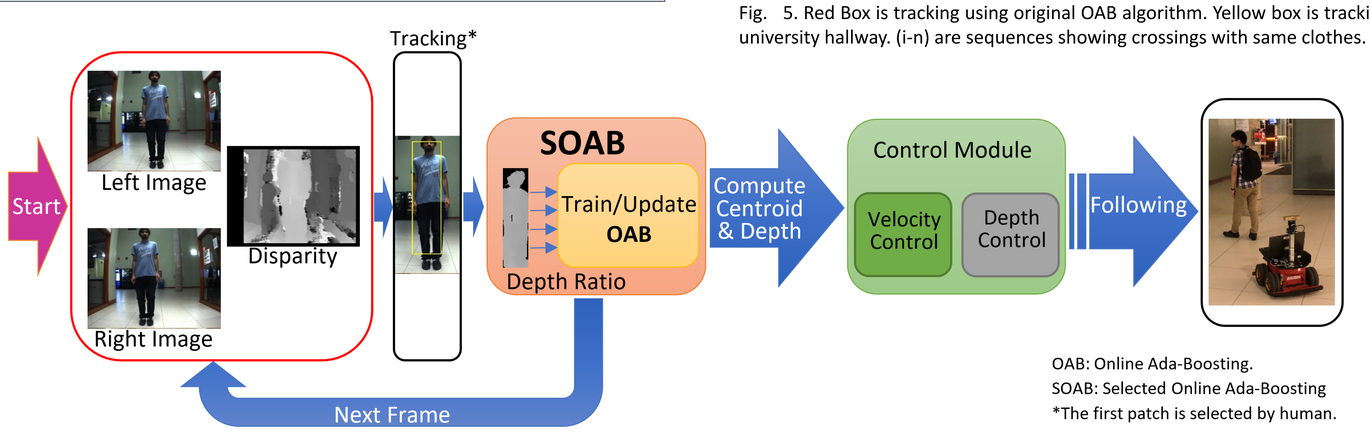

Fig. 6. System design for our approach using (a) Selected Online Ada-Boosting [1], (b) Convolutional Neural Network

References

[1] B.X. Chen, R. Sahdev, and J.K. Tsotsos (2017) Person Following Using Selected Online Ada-Boosting using a Stereo Camera. *IEEE Conference on Computer and Robot Vision, Edmonton, Canada.*

[2] H. Grabner and H. Bischof, "Online Boosting and vision".In *Computer Vision and Pattern Recognition, 2006 IEEE Computer Society Conference on, vol. 1, IEEE, 2006, pp 260 - 267.*

[3] H. Grabner, M. Grabner and H. Bischof, "Real-time tracking via on-line boosting", in BMVC, vol 1. no. 5, 2006, p. 6