SENSORS & MOTORS LAB

Individual Lab Report 2

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Team G- Robographers

Team Members

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1.0 Introduction

The name of our team is Robographers. The effort of the team is to design a project of group of robots that will click pictures collectively based on the readings of the expressions (smile) of the people in the party or any event. By this project we will be establishing the fact that a group of swarm robots can detect and perform photography with more robustness and effectiveness than a single robot system.

2.0 Individual Progress and Contribution

The development phase of this project is divided in to four sub-systems which are as follows.

1. Mechanical design.
2. Detection and perception.
3. Navigation and planning.
4. Swarm and collaboration.

I am primarily responsible for the fourth subsystem which is design and implementation of the swarm and collaboration. The major and critical tasks which have been outlined in the collaboration subsystem in our work breakdown structure of our project are as follows.

1. Design a swarm algorithm or a strategy which the robots will follow while they are trying to identify person of interest.
2. Design a swarm algorithm or a strategy which the robots will follow in order to approach the identified person of interest in order to capture his expressions effectively and click his photograph within 5 to 10 seconds of detecting the person.
3. Implement a computer vision algorithm by which the robots can collectively and efficiently get the readings of the expression of the person of interest.

The first two tasks require the completion of the navigation and planning part of the navigation subsystem. Since the work on that subsystem is ongoing, I have decided to first tackle the third task. Since this is a collaborative task and taking in to account the noise that each camera

(mounted on each of the four turtle bots), I devised few strategies based on the literature study I did for Progress Review 1. The strategies that suited our requirements are as follows.

Strategy 1- Have Intraface Software installed on each of the turtle bots. Get the smile probability from each of the robots. Calculate the total probability using individual probabilities of each robot. Give the signal to click the picture if the person is smiling.

Pros-

1. Less dependency of the image taken by other robots.
2. System can work even if one robot is operational.
3. Easy to compute total probability

Cons-

1. Too much computation on the turtle bots.
2. Expression analysis will be dependent on noise which is difficult to deal with.
3. Too much dependency on the performance of Intraface [3] especially on how it tackles or eliminates noise.
4. Prone to erroneous readings and dependent on how synchronous they are.

Strategy 2- Send the images or frame of the video containing the person's face from each of the robot to a remote computer nearby. Reconstruct the face of the person using geometry based reconstruction techniques [1] and run the reconstructed image on the Intraface [3] to get a single expression probability which in this case is the total probability.

Pros-

1. Less computation involved as regards to image processing.
2. Less prone to noise as the reconstructed face will be computer generated and noise dependency is minimized.
3. The system is more centralized.
4. Illumination or lighting variance will be eliminated.

Cons-

1. Again synchronization is of key importance in communication especially.
2. There will be a problem if robots send the image of two or more different persons.

Both options have their own pros and cons. Critically, the second strategy has more advantage over the first for its accuracy as noise will be eliminated. There are various algorithms which reconstruct faces from different cameras efficiently by using state of the art feature matching algorithm [2] in unison with warping the images to a common global frame of reference. Based on the requirements of each of the strategies, I have prepared a list of questions to be addressed with a view that helps us in the integration stage. One such example is, if I reconstruct a face using Computer vision techniques mentioned above, will I be able to input the reconstructed image in to the Intraface [3] software for expression analysis?

Besides this I am also keeping records of the progress in other subsystems keeping systems engineering concepts in mind. The reason behind this is to foresee and minimize as many problems as possible for the integration stage and also alert the team members if some task has high risk or if the task is not suited to our requirements.

2.1 Challenges Faced

The challenges that I face majorly is determining the timeline of the strategies I mentioned above. The second strategy of facial reconstruction which I mentioned has not been done before for this kind of application and the problems that I may encounter are not deterministic. This was stated to me by Professor Maja Pantic of Imperial college of London who is one of the leading researchers in the field of facial analysis. We had a brief discussion which did not help answer my concerns but surely opened a few doors.

The other challenges which I currently face but are not highly risky and are deterministic. One such concern is the workings of the Intraface [3] software but that will be clearer once I get used to its workings and API. The understanding of Intraface [3] is very important to the second task which will help me in designing the strategy of approach of turtle bots once the person of interest is identified.

3.0 Team Work

Rohit worked on designing the CAD model for the pan tilt unit. He is nearly final with the design. He made the design as per the requirements of the project i.e. the design was based on our requirements as well as the limitations of the turtle bots which could carry more than 5 kg of payload. Sida and Tiffany developed a computer vision based human detecting algorithm which can identify a human with 50 to 75 percent efficiency depending on the distance of the human from the camera as well as the illumination of the environment. Gauri, with the help of Rohit planned out the schedule for planning and navigation subsystem and will start working right after Progress review 1.

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3.1 Future Work

We plan to move as per our work breakdown structure. Next week's agenda includes the following.

1. Get acquainted with Intraface software.
2. 3D print the pan tilt unit.
3. Calibrate turtle bots and set up communications.
4. Design of power distribution system if required.
5. Order the parts required by the project.

4.0 References

1. 3D Face Reconstruction Using A Single or Multiple Views -Jongmoo Choi, Gerard Medioni, Yuping Lin ´ University of Southern California – USA, 2010 International Conference on Pattern Recognition
2. Distinctive Image Features from Scale-Invariant Key-points - David G. Lowe Computer Science Department University of British Columbia Vancouver, B.C., Canada, International Journal of Computer Vision, 2004.
3. Intraface Software - Fernando De la Torre† , Wen-Sheng Chu† , Xuehan Xiong† , Francisco Vicente† , Xiaoyu Ding† , Jeffrey Cohn†‡ †Robotics Institute, Carnegie Mellon University, (http://www.humansensing.cs.cmu.edu/intraface/)