



The Robographer: Progress Review #7

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Team: G (The Robographers)

Teammates:

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ILR No.: # 6

Submission Date: Jan 27, 2016



1. Individual Progress

Responsibilities: Project management
Mechanical design & development

Softwares/tools Used: Google Drive, Google Calendar, Microsoft Excel

Task Description:

Following tasks were assigned to me and completed before the progress review 7:

- Conducting team meeting and deciding goals for PR#7
- Trade studies for the required hardware
- Budget preparation and parts ordering
- Single robot system integration & working video demonstration

a. Setting the goals for PR#7:

Conducting team meeting and deciding goals for PR#7

- Upgrade the turtlebot workstation computers to ROS Indigo and Ubuntu 14.04.
- Merge the mechanical and detection subsystem with the planning and navigation subsystem for a single turtlebot.
- Implement the photo clicking algorithm.
- Finalize and order the required parts for the project.

b. Trade studies for the required hardware:

I was assigned to carry out the trade studies for the present hardware requirement for the spring semester. We decided to make upgradations for the current laptop hardware as well as the camera used for AprilTag detection and photo capturing purposes. The present hardware being used for controlling the Turtlebots & the IntraFace software are Asus netbook EeePC 1025C laptops. Being very old laptops with insufficient specifications, they have become obsolete and hence perform slowly, reducing the overall system efficiency. Hence, their replacement was a necessary measure to be taken. Considering the requirement of multiple (3) such laptops along with the finite budget of 4000\$, I decided to opt for inexpensive laptops with decent specifications. Moreover, overall laptop dimension was another huge constraint, as it is necessary to keep them over the turtlebots surface. After discussing these prime constraints with the team guide Sasanka Nagavelli, I decided to review the Chromebook series laptops. I further conducted a trade study for all the Chromebooks. The criteria for the study conducted were compatibility with Ubuntu 14.04, price, RAM, Memory, processor specifications, weight, and screen size and battery life, in the order of the weight factors assigned to them. Following table summarizes the trade study performed for the selection of the Chromebooks:

Table 1: Trade Study: Chromebooks

Parameters	Trade Study: Chrome-books											
	Asus netbook Eee_PC_1025Ce	Asus Chromebook C201		Chromebook pixel		hp chromebook 11G4	hp chromebook 14 G3	Toshiba chromebook 2	Acer Chromebook 11	Acer Chromebook 13	Asus Chromebook C300	Asus Chromebook C200
Price (Lesser the better)	5	8	9	0	0	8	8	6	9	5	6	7
Weight	10	10	10	7.5	7.5	10	2.5	7.5	10	7.5	7.5	10
Memory	8.75	1.25	1.25	2.5	3.75	1.25	1.25	1.25	2.5	1.25	1.25	2.5
RAM	5	5	5	10	10	7.5	5	7.5	5	7.5	7.5	5
Ubuntu compatibility (proc)	10	0	0	10	10	10	0	10	10	10	10	10
Battery life	8.75	10	10	8.75	8.75	2	1.25	3.75	3.75	3.75	5	7.5
Display size	10	8	8	6	6	8	5	6	8	6	6	8
Processor spec	2	2	2	8	8	2	2	2	6	2	2	2
TOTAL	8.02	5.45	5.62	7.33	7.51	6.92	3.52	6.35	6.87	7.21	6.35	6.66



In addition, table 2 summarizes the metrics used for evaluating every criteria of the trade study:

Table 2: Metrics used for Chromebook trades evaluation

Wt factor			Price		Weight		Speed		Memory	
1	1.75	1.75	100-150	10	1kg<X<1.5 kg	10	<1.5Gz	1.25	16GB	1.25
2	1.5	1.5	150-200	9	1.5kg<X<2 kg	7.5	1.5Ghz	2.5	32GB	2.5
3	1.25	1.25	200-250	8	2kg<X<2.5 kg	5	1.6Ghz	3.75	32<X<100GB	3.75
4	1	1	250-300	7	2.5kg<X<3 kg	2.5	1.7Ghz	5	100<X<200	5
5	0.75	0.75	300-350	6			1.8Ghz	6.25	200<X<300	6.25
			350-400	5			2.16Gz	7.5	300<X<400	7.5
			400-450	4			2.2Ghz	8.75	400<X<500	8.75
			451-500	3			>2.2Ghz	10	>500	10
			501-550	2						
			551-600	1						
			600>	0						
Battery Life	Display size		Processor		RAM		Ubuntu compatibility			
6	1.25	10.1	10	Celeron	2.5	1GB	2.5	Intel	10	
8	2	11.6	8	Dual corei3	5	2 GB	5	Non-intel	0	
8.5	2.5	13.3	6	Quad corei5	7.5	4GB	7.5			
9	3.75	15	4	Octa corei7	10	8GB	10			
9.5	4.5	>15	2							
10	5									
10.5	6.25									
11	7.5									
12	8.75									
13	10									

Finally, there initial conclusion of this trade study was the selection of the Asus netbook EeePC 1025ce which is an upgraded version of the current netbook version being used with the turtlebots. However, I noticed that there was an insufficient stock of this model in the prime distributor partners of Asus. Hence, I chose the 2nd best result of this exercise which happens to be the Acer Chromebook 11 c720-3404, shown in green background in Table 1. With the specifications such as Intel core i-3 4005U processor with 1.7GHz clock speed, good memory for Ubuntu 14.04 installation (32GB SSD), sufficient 4 GB RAM and smaller screen size (11.6 Inches), 8.5 hrs, low self-weight (2.76 pounds) battery life along with the compatibilityⁱ with Ubuntu OS at a decent price of 358\$, this Chromebook seems as a good choice.

Another hardware requirement was to obtain a good camera with sufficient specifications for clicking a good quality photograph. The camera used previously in the fall semester was my own webcam. I had decided to use the same to test out the camera compatibility issues and avoiding wastage of budget due to unnecessary purchases. The criteria for this study were compatibility with Ubuntu 14.04, face tracking ability, face recognition ability, Autofocus, better resolution, low price, good zooming ability and high video speed, in the order of the weight factors assigned to them. Following table summarizes the trade study performed for the selection of the camera for photo capture and human detection:

Table 3: Trade Study: Camera for photo capture & human detection

Parameters	Level	Weight Factor	Logitech HD pro c920	Logitech HD c615	Genius widecam F100	HP HD 4310	Brother NW-1000	Gear Head WC8500H D	Hue HD Camera	Digital Innovations ChatCam HD 1080P	Creative Live! Cam Chat HD	Freemtalk Everyman HD Webcam
Price (Lesser the better)	4	0.75	4	3	6	5	1	9	6	5	9	5
ZOOM (More the better)	4	1	10	0	0	0	7.5	7.5	0	10	10	0
Compatibility with linux	1	1.75	10	10	10	10	0	10	10	0	10	10
Video Speed	4	1	10	5	10	10	10	7.5	7.5	10	7.5	2.5
Resolution pixel (More the better)	3	1.25	10	6	8	8	6	6	2	2	4	2
AutoFocus	3	1.25	10	10	5	10	10	10	5	10	0	10
Face tracking by itself	2	1.5	10	0	0	0	0	0	0	0	10	0
Face recognition by itself	2	1.5	10	0	0	0	0	0	0	0	0	0
TOTAL		10	9.55	4.475	4.825	5.375	3.825	5.925	3.825	3.875	6.175	3.875

In addition, table 4 summarizes the metrics used for evaluating every criteria of the trade study:

Table 4: Metrics used for camera trades evaluation

Wt factor		Price		Range		Zoom		Focus		Resolution		Speed	
1	1.75	0-10	10	0-3 Ft	2	0x	0	Auto	10			30fps at 1080p	10
2	1.5	0-20	9	3-6 Ft	4	1x	2.5	Manual	5	>=2.1	2	30fps at 720p	7.5
3	1.25	21-30	8	6-9 Ft	6	2x	5	Fixed	0	5.7	4	30fps at 480p	5
4	1	31-40	7	9-12 Ft	8	3x	7.5			7.5-8	6	22fps at 720p	2.5
5	0.75	41-50	6	12-15 Ft	10	4x	10			12-13	8		
		51-60	5							15	10		
		61-70	4	Face tracking		Face recognition		Ubuntu compatibility					
		71-80	3	Present	0	Present	0	UVC enabled	10				
		81-90	2	Absent	10	Absent	10	UVC disabled	0				
		91-100	1										

Depending upon the results obtained by this trade study, I chose the Logitech HD pro c920 webcam as the potentially suitable camera for the Robographer system, shown in the yellow background in Table 3. With the specifications such as 4X zoom capability, 30fps video speed in full HD1080p mode, 15MP photo resolution, Autofocus facility, inbuilt face tracking and recognition along with the compatibilityⁱⁱ with Ubuntu OS at a fairly inexpensive price of 62 \$, this camera seems as a good choice.

c. Budget preparation & parts ordering:

After doing the trade analysis for the abovementioned components required for the project, we decided to prepare a budget for the parts to be ordered, differentiating them as immediate orders and future orders. Following table depicts the budget prepared for the spring semester:

Table 5: Budget: Spring Semester

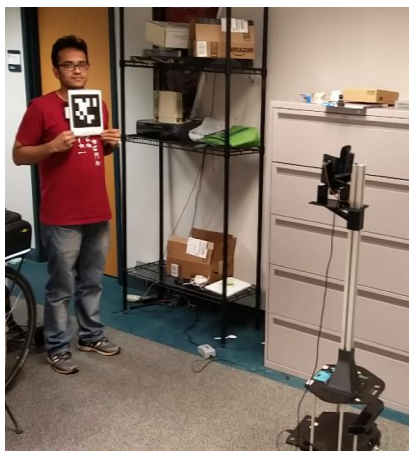
Sr. No	Item	Description	Unit price (USD)	Req. Qty	Backup Qty	Total Qty	Total price (USD)
Immediate requirement							
1	Camera	Logitech HD pro c920	65	1	1	2	130
2	Laptop	Acer Chromebook 11(C720-7404)	358	3	0	3	1074
Future requirements							
3	Battery (For PDB)	To be finalised after PDB redesigning.	-	-	-	-	-
4	Power Distribution Board & components	Redesigning. To be ordered from www.emachineshop.com	-	3	3	-	-
5	PTZ child parts (AI 6061)	Quote awaited from www.emachineshop.com	-	1set	1set	2 sets	-
	Base bkt	140cm x 64.70cm x 95.25cm		1	1	2	
	Tilt Bracket	125cm x 55cm x 100cm		1	1	2	
	Camera mount bracket	112cm x 48cm x 60cm		1	1	2	
						TOTAL	1204

The Chromebook and the camera, as having immediate requirements were immediately ordered before the PR#7. As decided in team meeting, I ordered 1 quantity of each of

them, with the plan of doing successful testing with the system before ordering multiple quantities as part of the risk management.

d. Single robot system integration and working video demonstration:

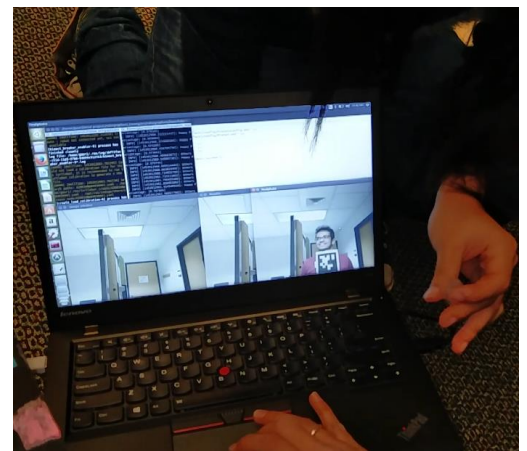
Photo capturing was the only main task remaining in the fall semester which had prevented team G from the complete single robot system integration as promised for the Fall Validation Experiment. Completion of this task for PR#7 allowed me to carry out the full integration. I removed the pan tilt unit mounted on the turtlebot 1 used for facial expression detection as demonstrated in the FVE and remounted it on the turtlebots 2 which was being used for human detection subsystem testing. This was followed by re-establishing the servo and Arduino connections for pan tilt units. Following figure shows the complete single robot system in action:



a. Robographer detects and approaches human



b. Robographer detects face & detects expressions



c. Robographer clicks photo and saves on desktop

Figure 1: The Robographer: Single robot system under work

2. Challenges

I faced the following challenges during the preparation for the PR#7:

- **Too many options for the Chromebook trade study :**

Considering the low price and the small screen size requirements, I decided to go for the Chromebooks. However, there are a large number of (16) Chromebook models available in the market with not much difference in their specifications. Conducting a trade study for these many models was certainly a difficult and time consuming task.

- **Fitment of the pan tilt elevate mechanism over other turtlebot:**

The transfer of the pan tilt elevate mechanism from one turtlebot to other was another time consuming task. The main reason for this was that the base of the first turtlebot was drilled accordingly so as to match with the assembly holes of the pan tilt unit base. Hence, it was required to drill the assembly holes on the other turtlebot as well for the accurate integration to take place. This procedure required a good portion of time.

3. Teamwork

Since the start of the project, I have taken the responsibility for the completion of the mechanical work subsystem which has been completed now. Sida did well to hide all the garbage data output obtained during the expression detection while Tiffany worked hard on operating the Arduino program through ROS environment. Jimit was exceptional in the algorithm development for photo clicking after detection of the smiling face. He also helped Tiffany and Sida to a great extent during their respective work. Gauri was also phenomenal in her work to update whole system and programs to run on the upgraded Ubuntu 14.04 OS and ROS indigo environment. I must mention that Gauri along with Jimit did very well and lead from the start throughout the project work before PR#7.

4. Future Plans

Individual future plans before the PR#8 for the Robographer Project:

1. Order remaining quantities of the components
2. Learn and explore Gazebo
3. Monitoring the completion of the SWARM communication for 3 turtlebots
4. Manufacturing/ordering the multiple quantities of the pan/tilt unit.

References

ⁱ <https://www.linux.com/learn/tutorials/764181-how-to-install-linux-on-an-acer-c720-chromebook>

ⁱⁱ <https://forums.logitech.com/t5/Webcams/C920-driver-for-Ubuntu-VersionX-Fedora-VersionX-or-ArchLinux/td-p/849876>