

Final Proposal:

Video recording tool for a vehicle's infotainment and navigation system

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Executive summary

This system, which is being developed for Bosch's automotive department, is being developed to record videos during a vehicle's driving test, without disturbing the driver's attention. It is not a simple machine; but a system that combines a video recorder, a computer processor, and a data storage device. The goal of this system is to provide a safe and reliable error recording system, ensure all entertainment and navigation functions operate successfully, and record any bugs that do occur in the vehicle while testing. The system must properly work in various situations; such as short and long drives. It needs to have enough storage capacity to save hours and hours of video recording which can be accessed at a later time.

In this project, the design team will improve the original design that was prepared by the past design team.

The possible solution that has been considered is to combine 4 video cameras, and plug them into a central processing unit. The CPU will store all the video recording into a temporary data store card. When an error occurs, the driver testing the vehicle will press a single button, which will start the video recording from x number of minutes prior to when the button was pressed. Driver can oversee the operation of all four cameras while the video is being recorded.

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Introduction

Project 9 for ECE 480 Spring 2014 is sponsored by Robert Bosch LLC. It requires the design group to build a video recording tool for a vehicle's infotainment and navigation system.

This project was originally assigned to a group in Fall 2013. The specifications were met; however Bosch wants some improvements done on the tool to make it more user-friendly.

The requirements we were given are as follows:

- Have the ability to connect four video cameras to the device and record the video.
- Add a better record and stop trigger. The previous group used a key pad; however Bosch wants something smaller and simpler.
- Add a display approximately 6-7 inches wide with an HDMI port. This display would show the screens of all four video cameras cascaded together. This display would mainly be used to make sure the cameras are aligned properly. It should have high enough video quality to read what is written on the display as well. It should also show time stamp and GPS position logging.
 - o The four cameras should be positioned to show:
 - center stacked display
 - instrument cluster
 - front view of road
 - right side view of road
- Start recording the video with the push of a button from (t-2) minutes, where t is the time at which the button is pressed.
- Add a true DVR feature so that it is possible to live record and be able to rewind a certain number of seconds. Previous group only recorded 30 second blocks.
- Notification on screen telling user when to change flash drive.
- A push button to save the video recording into long term memory (USB flash drive).

The past group has a device with many different USB ports, an HDMI output, and a micro SD card with lynx. Our customer at Bosch, Marty, said that we can use this device and just improve it (to be more cost effective). Or we can completely scratch what the previous group did.

Background

To begin, we attempted to look for the right size display with an HDMI port. After finding one with good reviews, we approved it with our customer and subsequently placed an order for it. We also found a DC/DC step down converter in order to connect the device to the car battery. The converter we selected, which steps down from 12 V to 5 V, was also approved by our customer. With the above all set in place, we placed an order.

Currently, we are in the process of finding a camera with quality higher than 720P, as well as finding a switch that would work to turn the recording on and off. The switch would replace the key pad used by the previous design team.

Further, we are also in the process of figuring out an effective way of storing all the video recordings in an efficient manner. The design needs to have sufficient capacity to record and store simultaneously, which is proving to be difficult. One option, suggested by the customer, is to use multiple flash drives. This option is being considered while we continue to research other viable methods.

Objectives and Design Specification:

The recording system needs to be able to handle these specifications:

- DVR: Being able to record the previous x minutes of video.
- Integration of four video sources into one file.
- GPS coordinates and time stamp label on video.
- Quality of footage must be able to record details on the monitor of the infotainment screen as well as the environment around the car.
- As this is a continuation of an older project, it is advised that the team uses the old microcomputer module, Odroid-XU.

The main objective is to improve on the framework already set by the previous team. Areas that need improvement specifically include but are not limited to:

- Implementing true DVR.
- Improving the video quality.
- Allowing storage to be hot swappable so that the user will be able to transfer files to a computer.
- Adding a more compact controls system, adding a monitor that will allow the end user to adjust camera positioning on the fly.
- Integrating all of the hardware to be able to run off of one power source.

Ranking of Conceptual Design:

Design Aspect	Priority	Comments	Rank
Optimization of Keyboard	Low	While this is not the most important detail, a proper user interface and controls system does improve the user experience.	4
Addition of Screen	Medium	Without a monitor to check camera positioning, data collection may become useless.	2
Integrating Power Supply	Medium	Multiple power supplies creates more points of failure, as well as more of hassle switching from car to car. Having a consistent compact single supply is important for usability.	3
USB Storage (True DVR)	High	Without true DVR, or proper lossless storage, this whole project becomes pointless as bugs cannot be recorded without an effective system.	1

Conceptual Design Descriptions

In this project, our basic concept is to improve and modify the car camera tool system that has been created by the previous team. The system had originally been designed for having four video capturing cameras, each pointed in a different direction. The system was also designed to set up a GPS for debugging error, a keypad to start or stop recording images, USB storage stick that put all memory together to import in computers, an Odroid chip that is running as computing unit with power input at 5V/4 A, and a MicroSD slot.

The main goal of our design team is looking for ways that can optimize and improve the system described above.

The first aspect is the optimization of the keyboard. The keyboard is not necessary when all we need is a small and simple device with a few basic functions. Instead of using a keyboard, our team is going to replace the board by an efficient and user-friendly record and stop switch. That arrangement could be just two buttons, one of them is used to ask car camera to record the images, and another one is to stop the recording process. Having less buttons than a keyboard will make this system a bit more user-friendly. This will also make the debugging process a little bit easier.

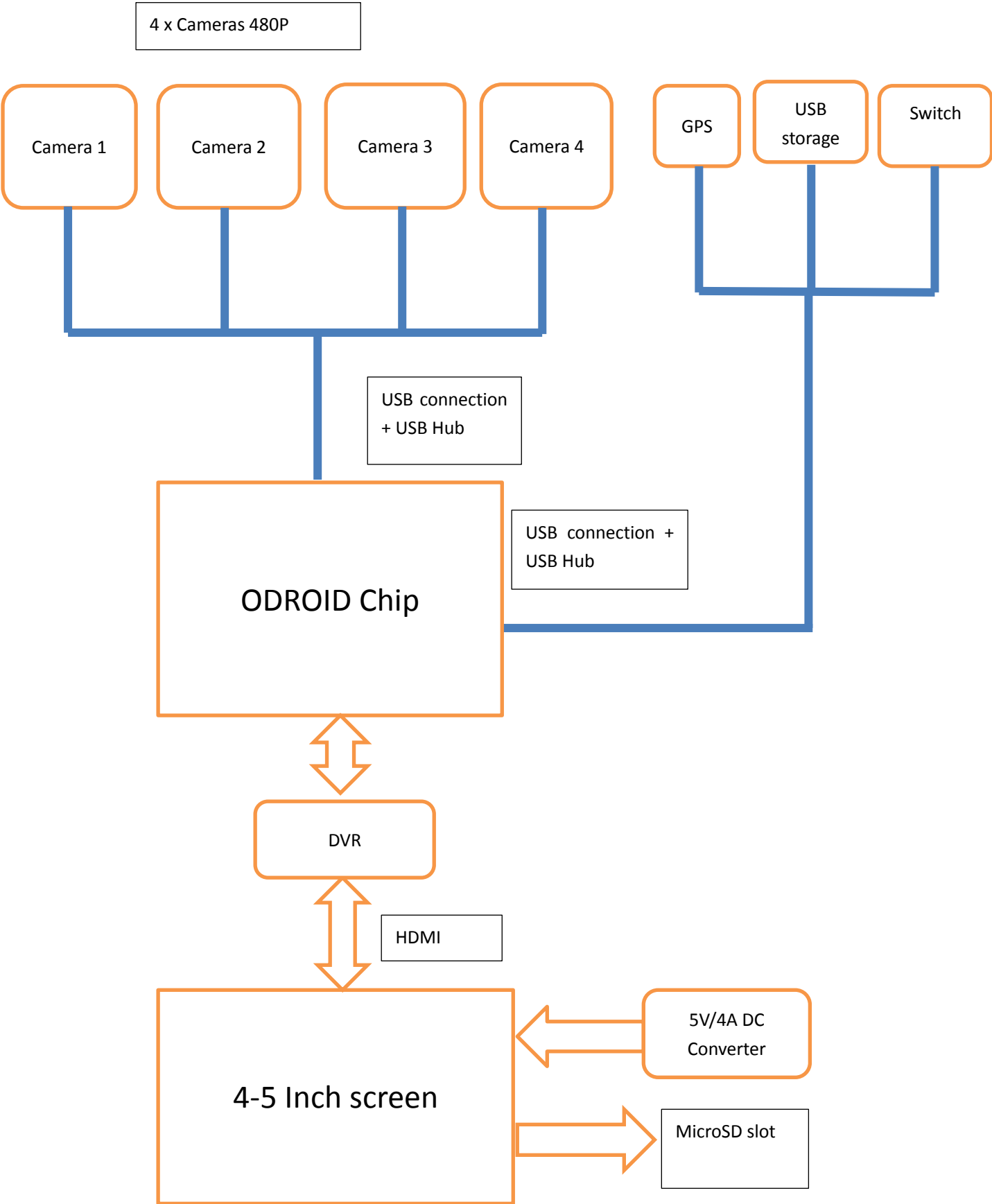
Another aspect of our design is to add a screen for monitoring the camera views in the vehicle. This is an important requirement from Bosch, especially considering that the past design team did not provide a display. The team must find a display approximately 6-7 inches big with an HDMI port. By observing the screen, the user will be able to know that the four cameras are working and pointed in the correct direction. The display will also show the video file name, current recording status, as well as how much of percentage of memory is remaining in terms of total storage. Besides that, a small color HDMI port should be available for users to plug in and display. In addition, the screen should include appropriate setup of adjustment for four cameras, a setting menu for user to manipulate device, and a single video file that can compile the four different video files into one. The video should be recorded in 4 different sections and merges on the same screen concurrently.

Moreover, it is team's duty to research on a sustainable and reliable power supply converter. Due to the instability and malfunction pertaining with the power portion of the chip, the device cannot operate safely with just a 12V power supply. Therefore, a DC buck step-down converter is required to output 5V/4 Ampere with 10 Watts. Regardless of the bundle of ports the odroid chip has, it is preferable to have one single plug in port for power supply, and the 12 V car cigarette lighter plug would be the most desirable source to power our entire device. Therefore, the team is going to find a converter to step down input voltage from 12 V to 5V drawing 4 A as a steady output to meet the Odroid chip requirement.

Lastly, in order to store all video recordings efficiently in a USB drive, the team decided to add a true DVR feature that can always record the video in the background. The display will also show how many minutes and seconds of the video have been recorded until the user press the stop button. The DVR will have access to

the USB port and in turn, a USB flash drive. It should be able to convert all video files into USB output. And then those files can be opened in a personal computer or laptop. Despite the vibration and shaking that will occur in the car during the test drive, the cameras must obtain a high enough resolution to clearly see and read street signs while watching the video recordings.

The team is looking to develop the prototype described as following:



Proposed Design Solution

Software

Components:

- FFMPEG: An open source Linux software that can screen capture as well as record from other hardware (i.e. Webcam).
- VLC (Or some other webcam software): Any software that can access video recording hardware and provide a live view. This is in order to be able to position the cameras.
- Team Written Code: A combination of C++ and batch scripts to utilize the software.

Description:

Ideally, the system will boot up and bring up a live view of the four cameras connected to the microcomputer. Additionally, a terminal will be called in the background to run the DVR function, which will save the last n minutes of recording. FFMPEG will not be recording from the video cameras directly. Rather, it will be capturing the screen that the live view of the four cameras. This is less computationally commanding and the microcomputer will be under less strain while running.

DVR Function:

FFMPEG, unfortunately, does not natively have a DVR function. Thusly, the team will be using this method.

1. FFMPEG will be running continuously, recording one minute chunks of video.
 - a. There will be n total clips depending on how long the save video must be.
 - b. The batch script will continuously overwrite the video clips labeled 1 through n.
2. When the appropriate switch is pressed, another batch script will run in a different thread concatenating the video into an n minute clip.

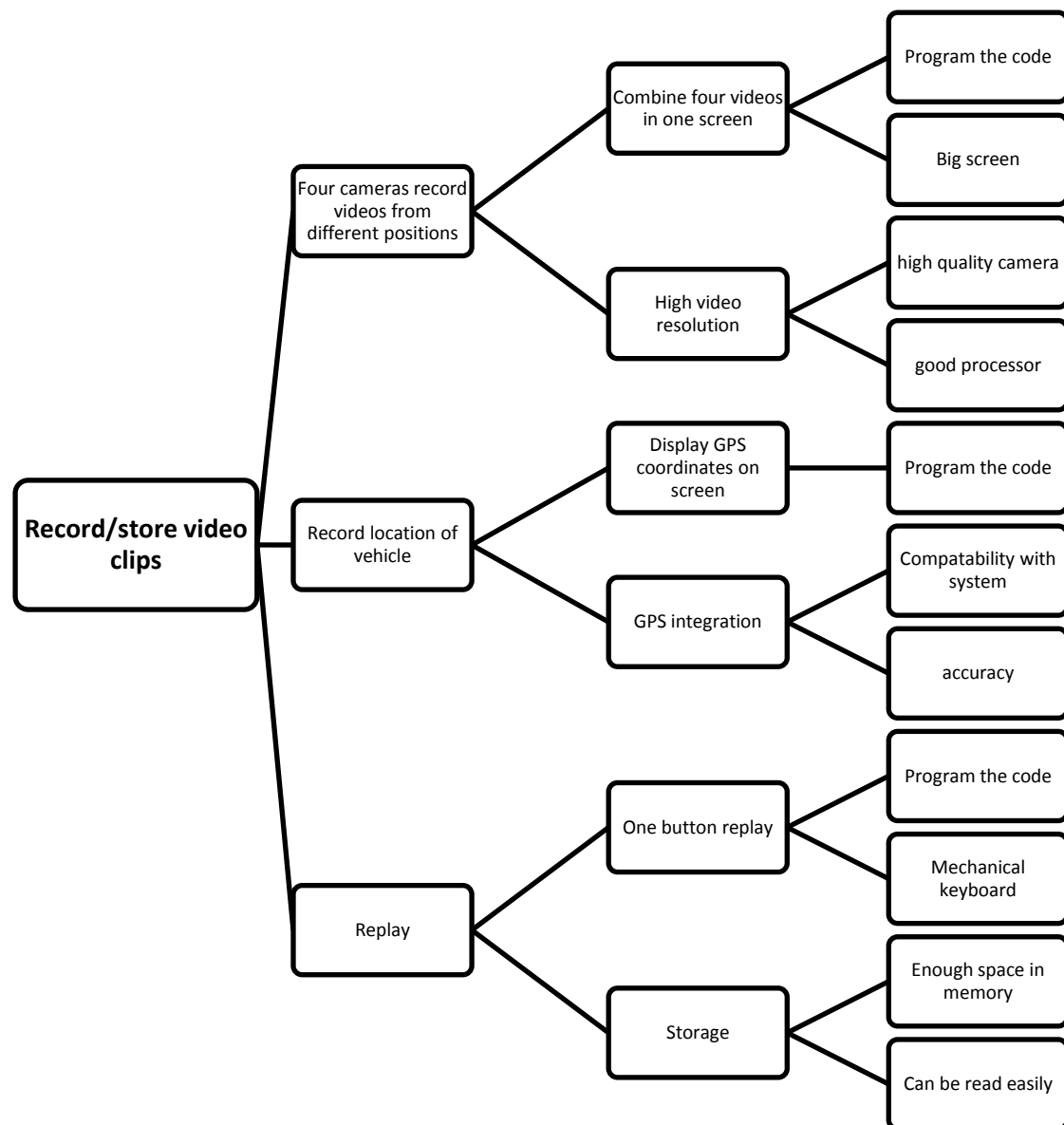
Hardware

Our project is based on the previous project, so initially, we have the ODROID – XU, which has 1.6 GHz quad core CPU with 2 GB RAM, 1 USB 3.0, 1 USB 3.0 OTG, 4 USB 2.0, micro HDMI output, Micro SD port, with 5v and 4A power. This is run on Linux system inside of the micro SD card. This is our control unit. As Bosch request, we need to modify their work. As the part of the hardware, they require we add a screen for the unit, so they can view the image and video from the display, but also the GPS coordinates. The ODROID has a HDMI output, so it is easy for us to add a screen.

The monitor that we choose is the Koolertron 7 inch HD TFT LCD display. One nice thing about this display is it come with the 12v DC power supply with the car outlet, and it does have a HDMI input no further modify needed. Currently the power is driven by the wall outlet, they use a 12V to 110 converter and transfer back to 5v to support the ODROID. One of the requirements is to drive all the devices from the car outlet with 12V supply. The design that we will make is to check the power supply of the display and maximum current that the power supply can reach. ODROID require a 5V and 4A power supply. The car outlet is 12V with up to 10A fuse.

The step down convert is a good choice; the one that we chose is DROK SR Waterproof DC Buck Converter 12V/24V to 5V 5A/25W Car Regulator Power Supply. This power supply can support up to 5A and 25W that meets all the requirements of ODROID and it is also waterproof. We will use this step down convert to connect the DC power 12V and the ODROID to support the power. The ODROID use a 5.5mm*2.1mm adapter. So the step down converter needs to connect to ODROID.

FAST Diagram



Risk analysis

This system is a combination of several mature devices, such as cameras, ODROID chip, and screen. However, there are still many risks. One of the biggest risks we have is hardware/software compatibility.

According to the preliminary testing, several problems were detected. These problems could become bigger and bigger if they are not taken care of in the early stages of the project. Below is a risk analysis chart which shows how problematic the risk could potentially be if not taken care of right away.

item	Risk level	comment
Video Quality Improvement	Low	After testing, the camera itself should be ok, the input quality is good.
Screen	High-risk	Adding the Screen is team's main goal, but considering the ODROID's capability, the screen may overload the processor. Other problem is power supply. However, further information still needed.
ODROID	High-risk	The capability of ODROID is a problem. Further testing needed.
Power supply	Low	Many options exist; team can choose the best one easily.
Software design	High-risk	challenge
Control Button	Low	
Data store	Moderate	Software challenge

ODROID is the main hardware problem for now, but further testing is needed. Software design may become other problem. Each problem may cause whole project to fail, team will focus on each and every risk to avoid failures.

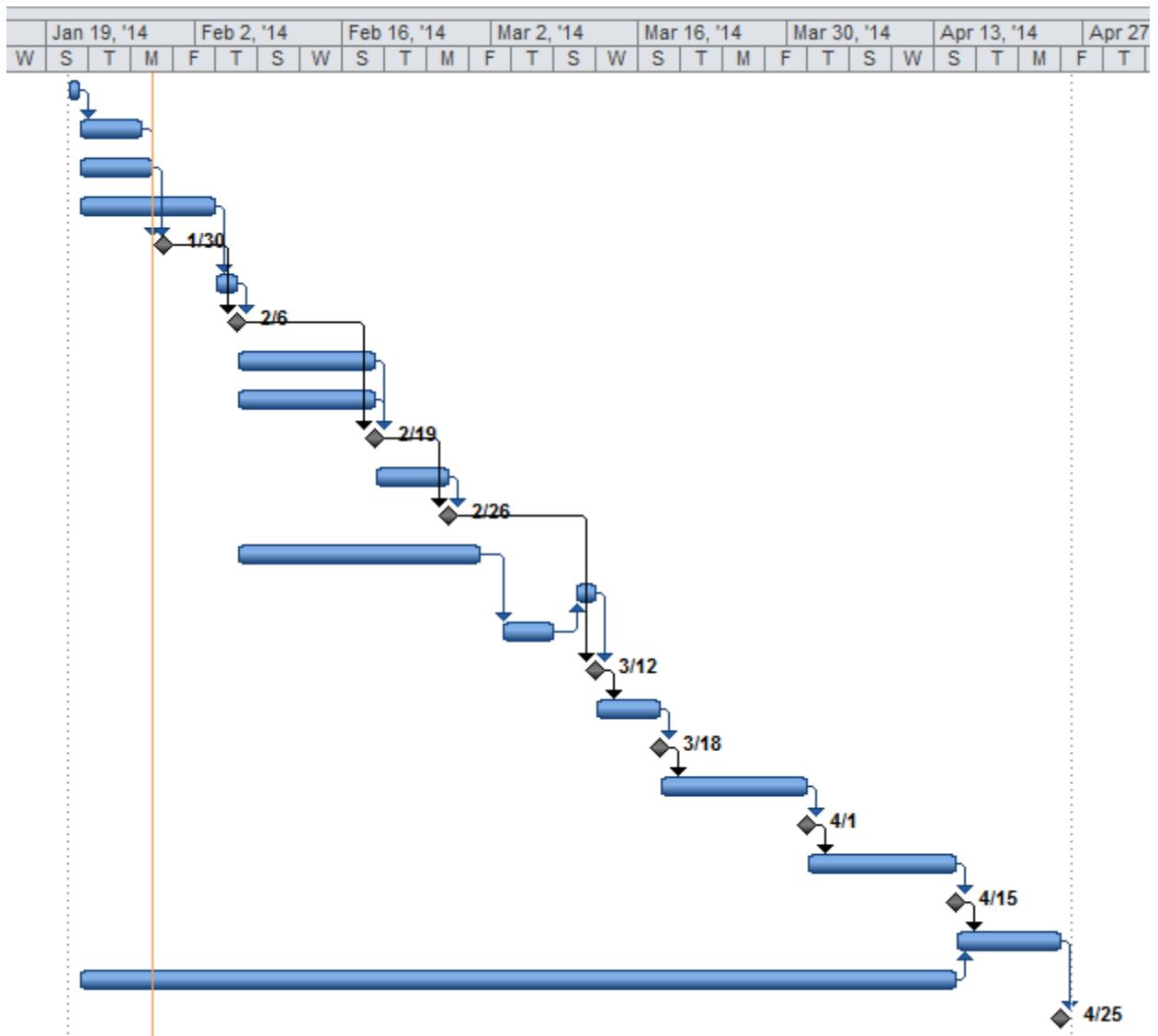
Project Management Plan

Meet with the manager of Bosch every Thursday 3:00-4:00pm through WebEx.

Meet with Professor McGough every Thursday 4:00-5:00pm in Engineering library.

Gantt Chart

		Task Mode	Task Name	Duration	Start	Finish	Predecessors
1			Project Introduction	1 day	Tue 1/21/14	Tue 1/21/14	
2			Hardware Purchase	4 days	Wed 1/22/14	Mon 1/27/14	1
3			Test Software	5 days	Wed 1/22/14	Tue 1/28/14	
4			Hardware Seachering	9 days	Wed 1/22/14	Mon 2/3/14	
5			Assemble & 1st Test	0 days	Thu 1/30/14	Thu 1/30/14	2,3
6			Hardware Purches	2 days	Tue 2/4/14	Wed 2/5/14	4
7			Assemble & 2nd Test	0 days	Thu 2/6/14	Thu 2/6/14	5,6
8			Program for button c	9 days	Thu 2/6/14	Tue 2/18/14	
9			Program For Camera	9 days	Thu 2/6/14	Tue 2/18/14	
10			3rd Test	0 days	Wed 2/19/14	Wed 2/19/14	7,8,9
11			Improve Design	5 days	Wed 2/19/14	Tue 2/25/14	
12			4rd Test	0 days	Wed 2/26/14	Wed 2/26/14	10,11
13			Program For Replay	17 days	Thu 2/6/14	Fri 2/28/14	
14			Program For Replay	2 days	Mon 3/10/14	Tue 3/11/14	15
15			Spring Break	5 days	Mon 3/3/14	Fri 3/7/14	13
16			5th Test	0 days	Wed 3/12/14	Wed 3/12/14	12,14,14
17			Improve Design	4 days	Wed 3/12/14	Mon 3/17/14	16
18			1st Test in Car	0 days	Tue 3/18/14	Tue 3/18/14	17
19			Improve Design	10 days	Tue 3/18/14	Mon 3/31/14	18
20			2nd Test in Car	0 days	Tue 4/1/14	Tue 4/1/14	19
21			Improve Design	10 days	Tue 4/1/14	Mon 4/14/14	20
22			Final Test	0 days	Tue 4/15/14	Tue 4/15/14	21
23			Preparation	8 days	Tue 4/15/14	Thu 4/24/14	22,24
24			Web Design	59 days	Wed 1/22/14	Mon 4/14/14	
25			!!!DESIGN DAY!!!	0 days	Fri 4/25/14	Fri 4/25/14	23



Budget

Ordered Parts	Quantity	Cost	Total
Koolertron® 7 inch 16:9 HD TFT LCD	1	159.99	159.99
DROK SR Waterproof DC Buck Converter	1	15.62	15.62
Total Cost			175.61

Parts from previous team

PART	Quantity	Cost	Total
Odroid-Xu	1	\$169.00	\$169.00
Odroid RTC Battery	1	\$8.00	\$8.00
8GB Micro SD w/ Android Installed	1	\$13.00	\$13.00
Transcend 32 GB microSD HC Class 10 UHS-1	1	\$22.99	\$22.99
Kingston 32 GB microSD card HC class 4	1	\$26.99	\$26.99
Logitech C270 Camera	1	\$24.99	\$24.99
Logitech C270 Camera	1	\$32.23	\$32.23
Logitech C310 Camera	2	\$29.99	\$59.98
Microsoft USB GPS	1	\$47.04	\$47.04
USB Number Pad	1	\$12.56	\$12.56
MicroHDMI - HDMI Cable	1	\$9.00	\$9.00
Belkin USB 2.0 4-Port Hub	1	\$6.99	\$6.99
Total Shipping		\$30.00	\$30.00
Total Cost			\$462.77