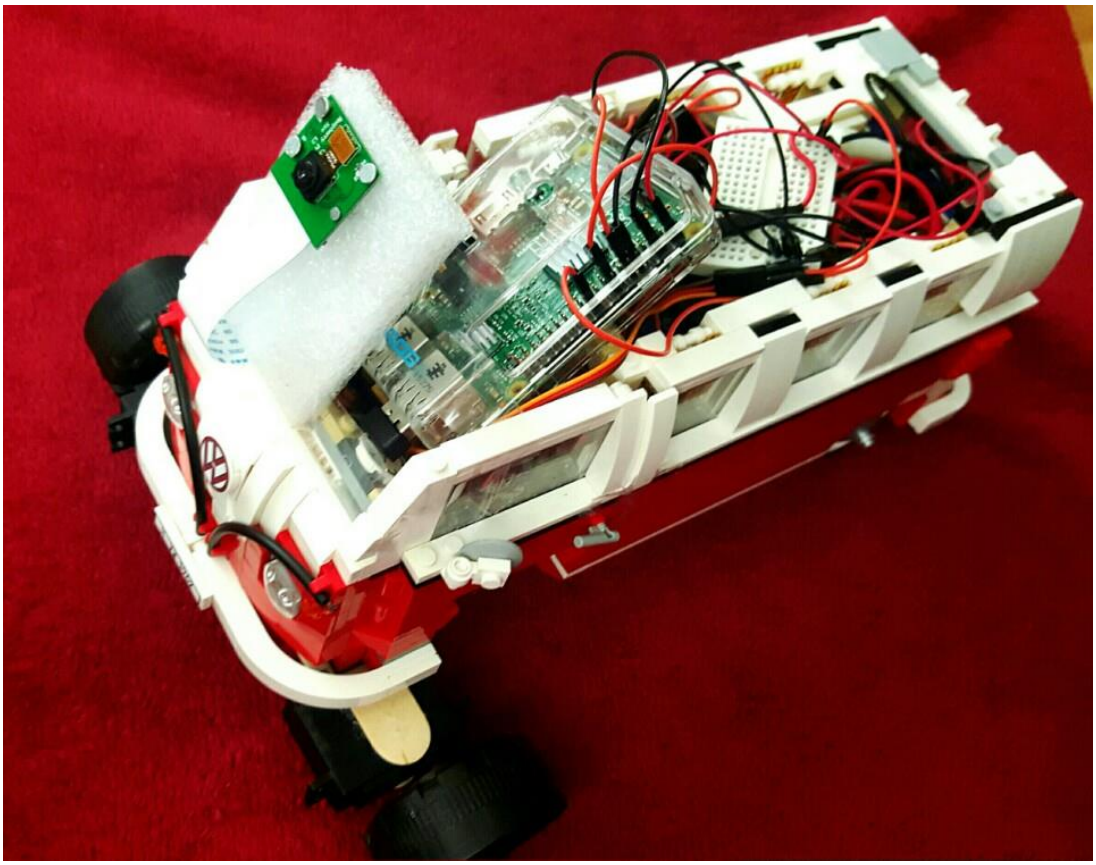
OBSERVER

Remote Control Observer – Car

Project Report

Jeha Kwon



Subject: TPJ655 – NBB

Program: Computer Engineering Technology

Instructor: Benjamin Shefler

Date: April 8, 2016

SENECA COLLEGE OF APPLIED ARTS AND TECHNOLOGY – NEWNHAM CAMPUS

Table of Contents

Introduction

In today's world, many people live with irreplaceable family members in their home. Pets! Our lovely pets give us valuable time, sweet affection, and priceless memory. Even though, we really wish to stay with them 24/7, it is very difficult to stay with your precious all the time. Moreover, whenever you are at work, school, or outside, you will feel nervous, worry, and anxious because you will never know what your pets are doing all by themselves. Don't you want to know what your pets are doing at home when you are not around them? I've seen some people set up a camera on the corner of high ceiling, but they are unable to find their pets since pets are not immovable objects. Therefore, I propose the remote controllable robot rather than spending relatively expensive money and an inefficient way to monitor our pets. A user can control this robot with their own computer to follow the pets wherever and whenever they go also monitor his/her own pets with live streaming video all the times. You will never miss your lovely pets not even one minute! With "Observer", You, as a pet owner, will never have to give up your invaluable time with your special family member and feel always with them wherever you go.

Executive Summary

This report provides an analysis of product and technical overview of the product. Methods of analysis includes functional features, product requirement, product spec and technical overview includes block diagram, component description, theory of operation. All cost calculations and product parts lists can be found on appendix. Result of analysis and technical overview, user will able to figure out general information of this product and how to use the product.

This report also investigates future considerations and maintenance requirement for the using product for long period of time.

This report will guide through every detail information of the product and user guide to control the product. Moreover, with this report user will find out how viable this product is compare to other products on the market at the moment.

Functional Features of the Product

1. Full control of robot by computer
    - Robot will control by user with computer over the network (SSH)
2. Real time camera
    - Camera 3 features
        1. Live streaming over the web
        2. Take photos and store in the raspberry pi
        3. Take videos and store in the raspberry pi
3. Lego Body

Product requirement

- Robot should be balanced well and enough speed to move.
- Robot's network configures should be configured before use
- Robot should stream video over the web
- Web live streaming and controlling robot over the internet from outside, user has to configure port-forwarding
- Robot should able to take picture or video when user want by software
- Robot requires 10 * AA size battery which it will provide around 1.5 hours ~ 2 hours of power.

Product specification

- Battery Life: Approximately 1.5 ~ 2 hours.
- Size (Length * Width * Height): 27cm * 21.5cm * 19cm
- Hard Drive Size: 8 Gb (Hard drive can be substitute to bigger size)
- Camera Quality: 5MP with 1080 P
- Speed: Maximum: ~0.18sec/60°
- Motor Power: 3.2kg.com/44.52oz.in
- Empty Ports: 2 USB PORTS
- Network Interface Card: 150Mbps 11n Wi-Fi USB Adapter
- Power Consumption: Maximum 20 W

Operating Instruction

- **Power**
  - Find Red Switches on the back of the car
  - Press down Switch 1, Switch 8 (Switch 1 is to turn on/off raspberry pi, Switch 8 is power to motors).
  - You may also press upward on Switch 1 and plug power cord to wall socket (For heavy uses on camera, this is more recommended)
- **Configuring Wi-Fi Network**
  1. After Raspberry pi is turned on, Turn on “Terminal”
  2. Type or Copy in terminal

     “ sudo gedit /etc/network/interfaces ” without “ ”.
  3. Change wpa-ssid “hama” into your own network name.

     Ex) wpa-ssid “mynetwork”
  4. Change wpa-psk “password” into your own network password.

     Ex) wpa-psk “12345678”
- **Software**
  - **Live Streaming Camera**
    1. After Raspberry pi is turned on, turn on “Terminal
    2. Type or copy in terminal

       “ ifconfig ” without “ ” and remember ip address

       (inet addr:xxx.xxx.xxx.xxx) of “wlan0” network.
    3. Type or copy in terminal

       “ cd /home/pi/Desktop/project/stream ” without “ ”.
    4. Type or copy in terminal

       “ sudo ./motion ” without “ ”.

5. Do Not close the terminal window. (if you need terminal, just simply right click on existing terminal and open new terminal window. If you close terminal window, this may stop live streaming)
6. Now click on Chrome or any Internet application
7. On address bar type " ip address of wlan0:8081 "

   Ex) 192.168.0.100:8081

- **Controlling car instruction**

1. After Raspberry pi is turned on, turn on "terminal"
2. Type or copy in terminal

   " cd /home/pi/Desktop/project/PiBits/ServoBlaster/user " without " ".
3. Type or copy in terminal

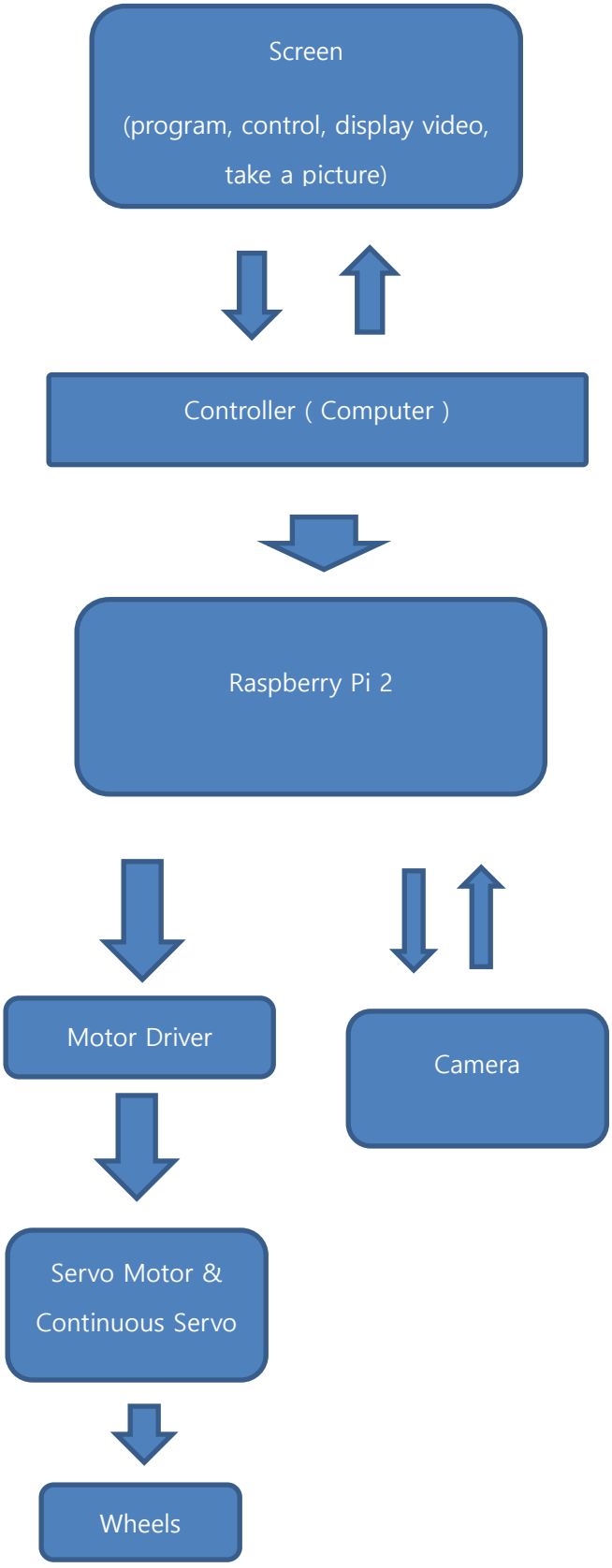
   " sudo python servo.py " without " ".
4. Follow the instruction after servo.py turned on.

- **Controlling over SSH with any other devices (ipad, other computer, etc)**

1. If your using Window, Please install Putty.exe.
2. After install turn on Putty.exe and on Host type Raspberry pi's ip address and connect.
3. If your using Linux, Turn on Terminal and type " sudo ssh (raspberry pi's ip address)

   Ex) sudo ssh 192.168.0.100
4. After you connected to raspberry pi with SSH, just follow other instructions above.

Block Diagram



Component image and components description

#	Component Name	Specification
1.	Raspberry Pi 2 Model B 	Programmable micro processor - A 900MHz quad-core ARM Cortex-A7 CPU - 1GB RAM - 4 USB ports - 40 GPIO pins - Full HDMI port - Ethernet port - Combined 3.5mm audio jack and composite video - Camera interface (CSI) - Display interface (DSI) - Micro SD card slot - VideoCore IV 3D graphics core
2.	SainSmart Camera 	- Dimensions: 25mm * 20mm * 9mm - 5 megapixel - Maximul 2592 * 1944 pixel - Support 1080p, 720p - 640 * 480 p 60/90 video
3.	FS5103R 	- Operating Voltage: 4.8V~6V (5V works best) - Average Speed: ~0.18sec/60° - Stall Torque (4.8V): 3kg.cm/41.74oz.in - Stall Torque (6V): 3.2kg.cm/44.52oz.in - Required Pulse: 500us-2500us - Connector Wire Length: 30cm / 11.8" - Dimensions: 37mm x 54mm x 20mm / 1.5" x 2.1" x 0.8" - Weight (no horns): 40g - Spline Count: 25

4.	RioRand DC Volt Converter 	- Input voltage :8-35V - Output voltage :1.5-24V adjustable - Output current : 5A MAX, recommended: below 5V,4A long-term; 6-9V, 3A; 10V-15V,2.5A - Working temperature: -40-85°c - Operating Frequency: 300KHz - Conversion efficiency: up to 92% - over-current protection, over-temp protection - Waterproof, moisture-proof, dust-proof, shock-proof - Dimension: 54 * 35 * 21.5mm
5.	MG995 	- Stable and Shock Proof - Connector Wire Length 300mm - Operating Speed : 0.17sec / 60 degrees (4.8V no load) - Operating Speed : 0.13sec / 60 degrees (6.0V no load) - Stall Torque : 9 kg-cm (180.5 oz-in) at 4.8V - Stall Torque : 12 kg-cm (208.3 oz-in) at 6V - Operation Voltage : 4.8 - 7.2Volts - Gear Type: All Metal Gears - Item size: 40 * 19 * 43mm - Net weight: 66g (with accessories)

Theory of operation of the entire system

- Hardware Function:

All control will communicate through the SSH on the computer or Ipad. Raspberry pi will use “EDIMAX” Wi-Fi USB adapter network card to connect in to network. This will provide ip address of home network and user will able to connect through SSH over internet. Every device such as servo motors, Wi-Fi adapter, including Raspberry pi 2 will use only 5V maximum voltage to provide power. Moreover, Raspberry pi will use approximately 1~2A current draw and 3 servos will use 750mA~1000mA current draws. However Raspberry Pi 2 may use up to 2.5A current draw based on which devices connected in to Raspberry Pi. On Observer only Wi-Fi adapter and Bluetooth keyboard adapter is used which results total approximately 1.5A current will be used. For the servo motors, it usually uses 200~300mA for each servo motors and this will result of 750mA or up to 1000mA of current uses. On the Observer as a power source, it uses AA battery which has approximately 1.5v and 1.5A on each batteries and 4 batteries are connected to 3 servomotor providing total 6V, 1.5A and 6 batteries are connected into Raspberry pi 2 providing total 9V, 1.5A by serial connection of batteries. Since every device runs on 5V, DC regulator have been used to reduce the voltage of power source to fixed 5V and 1.5A current.

Calculation of Current usage for each devices

Raspberry Pi 2

Raspberry Pi 2 operating (turn on): 200mA

Wi-Fi: 250mA

HDMI: 50mA

Camera: 250mA + @ (when came takes pictures or recording it draws more current)

Bluetooth Keyboard: approximately 200mA

GPIO pins: 50mA

Total current draw 1000mA + @ (due to camera)

Servo Motors

Standard Servo Motor 250~500mA

Total Current draw 750mA~1000mA

- Software Function

When Observer running 3 software will be operating at same time.

1. Servod
2. Stream
3. Servo.py (self-created python program)

“Servod” software is open source software which it manages all the servo motors. This software allows to control multiple servos at same time. “Stream” software provides live streaming camera over the internet. This software will take picture every one second and it will upload to 8081 open port every one second. Since it has 1 fps live stream is little slow and it causes lagging. However, it will provide simple network live streaming. “Servo.py” is self-created program by jeha kwon. This program will provide full control of Observer (remoted control car). This program is based on python programming language. When program is executing it will automatically run “Servod” software to initialize servo motors. After initialization software will ask user to input numbers which controls servo motors. Every servo control is done by “setServo()” function and speed of servos motor direction of servos are already configured. When user input “7” it will turn on camera snap shot by “os.system(‘raspistill -o image.jpg’) and save to designated folder. Every time user takes picture it will save as same name with increment of 1 (ex. “picture1”, “picture2”, “picture3”). When user press “9” it will turn on video by “raspivid -o 5_sec_video.avi -t 5000’) which will take 5 second video and save to designated folder as well.

On servo.py software, most of the codes are using “os.system()” function which it allows software to run “terminal” command on python script. Since servo motor are running with “servod” software it is necessary to use “terminal” command to activate multiple servo motors. Software is text user interface only because SSH can only handle text user interface software.

Maintenance Requirements

- Battery should always have recharged before running robot.
- Make sure there are no problem between wire connections.
- Without full battery motor may operate differently
- Every time user connects different network, IP address of robot will be change, robot's IP address should always have checked and make sure user using correct IP address. (when IP address changes, live streaming address will change as well)
- Variable DC regulator may change values over long period time usage. DC regulating value must be 5 V output. User should check the value minimum every month.

Future consideration

There are new technology coming out very fast, with new technology for the future development, this robot can cut the cost down by a lot. Even right new raspberry pi zero just came out which is only $5.00 (US). By customizing body with cheaper product rather than Lego this will reduce cost a lot as well. Moreover, rather than controlling the robot with computer, by using android programming or IOS programming and use smartphone to control robot. Which is more efficient way to control the robot since everyone uses smart phone these days.

New features

- Computer controlling will be substitute to smart phone
- Program will be created as android app or IOS app
- Cheaper microprocessor (Raspberry pi zero)
- Cheaper body product

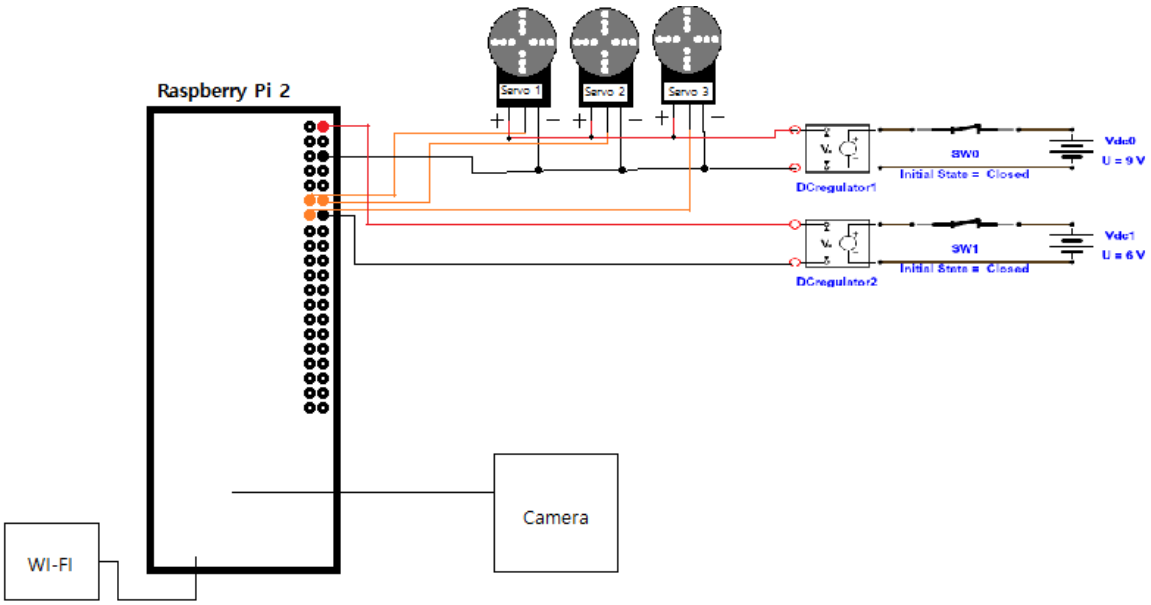
Total cost you can reduce

◆ LEGO Body	+ $129.99
◆ Raspberry Pi 2 Model B	+ $59.99

Total cost you can save (Before Tax)	$189.98 (CAD)
Total Cost you can save (After Tax)	$214.67 (CAD)

Appendix

A) Electrical Schematic



B) Parts List

Part #	Model	Reference designation	Component Description	Supplier	Cost/Unit	Qnty	Sub Total
1	Raspberry Pi 2 Model B	Raspberry pi 2	Micro Processor	Amazon www.amazon.ca	$59.99	1	$59.99
2	SainSmart Camera	Camera	Camera	Amazon www.amazon.ca	$26.99	1	$26.99
3	AA Battery	VDC0 & VDC1	Battery	Shoppers	$0.91	12	$10.99
4	FS5103R	Servo1 & Servo3	Continuous Servo motor	Digi-Key	$18.59	2	$37.18
5	RioRand DC Volt Converter	DCregulator1 & DCregulator2	DC Regulator	Amazon www.amazon.ca	$13.99	2	$27.98
6	MG995	Servo2	Servo motor	Amazon www.amazon.ca	15.99	1	$15.99
7	10220	none	Lego Body	LEGO www.lego.com	$129.99	1	$129.99

Total (No TAX): $309.11

Total (with TAX (13%): $349.29

C) List of all User Names and Passwords used in your program

- Raspberry pi login id

  Root

  Password

  1234

- Network ID

  Hama

  Password

  jk123456

D) Bibliography/References

1. http://static.electronicsweekly.com/gadget-master/wp-content/uploads/sites/4/2015/02/Raspberry-Pi-2.jpg

2. SainSmart Camera Module Board 5MP Webcam Video 1080p 720p for Raspberry Pi2/Pi3 (Free US Shipping). (n.d.). Retrieved April 08, 2016, from http://www.sainsmart.com/raspberry-pi-camera-module-board-5mp-webcam-video-1080p-720p.html

3. http://www.riorand.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/6/1/61ohcjmfeel._sl1200_.jpg

4. Continuous Rotation Servo. (n.d.). Retrieved April 08, 2016, from https://www.adafruit.com/product/154

5. http://www.geeker.co.nz/images/detailed/1/mg995.jpg

6. Raspberry Pi 2 Model B. (n.d.). Retrieved April 08, 2016, from https://www.raspberrypi.org/products/raspberry-pi-2-model-b/

7. Power Supply. (n.d.). Retrieved April 08, 2016, from https://www.raspberrypi.org/documentation/hardware/raspberrypi/power/README.md

E) Contact Information

- Jeha Kwon

  E-mail Address: jehakwon@gmail.com

F) Description of the CD attached

-Project Folder

- PiBits folder
    - Servo controlling software and servo.py (controlling robot software) included.
- PIGPIO folder
    - Raspberry Pi GPIO libraries and update files.
- Stream folder
    - Live streaming software and excitable file included.

- **Final Project GanntChart**
- **Final Project Report (Document)**
- **Final Project Report (PDF)**
- **Project Proposal**
- **Final Project Presentation PowerPoint**

G) CD