

November 12, 2015

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440W Design Specification for *Tesigo*: Smart Cart

Dear Dr. Rawicz:

The attached document from *FOYO Technology Inc.* describing the design specification for *Tesigo: Smart Cart*. *FOYO Technology Inc.* is defining the future of the shopping experience through innovative solution. We are passionate about introducing *Tesigo* that helps shoppers carrying the loads by being operated into manual, remote and auto-following modes.

The objective of Design Specification for *Tesigo* is to provide information and specifications for designing *Tesigo* which divides into hardware and software modules in order to meet functional specification. This document is also discussed about test plans of the product which can break down into unit test, integrated test and system test.

FOYO Technology Inc. was founded by five innovative, creative, analytic and motivated engineering students: Worawee Janpongsri, Mengyao Li, Zheng Chang, Yizhang Xu and Jose Arboleda. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (778) 895-9945 or by email at wjanpong@sfu.ca.

Sincerely,

Worawee Janpongsri

Worawee Janpongsri,
CEO
FOYO Technology Inc.

Enclosure: *Design Specification for Tesigo: Smart cart*

FOYO



Design Specification for a Smart Cart

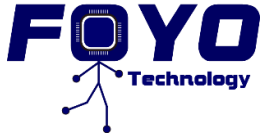
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Submission Date: November 12, 2015

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Design Specification for Smart Cart

Abstract

In this document, *FOYO Technologies Inc.* will discuss the design specification of *Tesigo*. This document includes the specifications for all mechanical, hardware, and software components. The objective of this document is to explain our design approach and describe in detail about our current and future implementation of *Tesigo*.

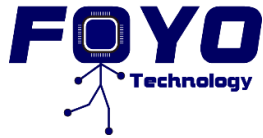
Tesigo consists of three main systems:

Control System - Arduino Algorithms, Tracking System (Kinect sensor), and Motor Drive

Mechanical System - Motor, Wheel Transmission System, Mounting and Wiring considerations

Software System - Android Application (*TesigoApp*)

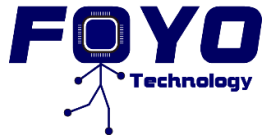
FOYO Technologies Inc. will describe the design logic, function and implementation for each system. The specifications of each system and component will also demonstrate that all functional requirements are met according to the functional specification document. In addition, this document includes the test plan of *Tesigo*. The test plan includes several test cases that will examine the functionality of each system and component. The test plan will be separated into three parts: unit test plan, and integrated test plan, and system test plan.



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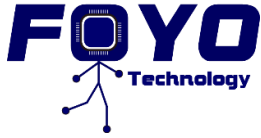


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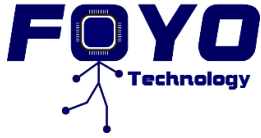


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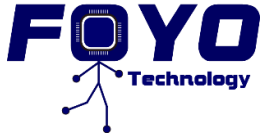
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Glossary

Ah	Ampere hour
App	Application; software designed to run on electronic devices
Android	Mobile operating system currently developed by Google and designed primarily for touchscreen mobile devices
BER	Bit Error Rate
Bps	Bits Per Second
dBm	an abbreviation for the power ratio in decibels of the measured power referenced to one milliwatt
EDR	Enhanced Data Rate, which provides a faster data rate and in some case improved battery life
EEPROM	Electrically Erasable Programmable Read-Only Memory
GPIO	General-purpose input/output; generic pin on an integrated circuit
ISM band	The industrial, scientific, and medical radio band
Kbps	Kilobits Per Second
Mbps	Megabits per Second
PC	General-purpose computer, which include personal computer and mobile phone
PWM	Pulse Width Modulation
SRAM	Static Random-Access Memory
RXD	Data that has been received from the link
TXD	Data to be transmitted over the link



Design Specification for Smart Cart

1 Introduction

Tesigo is an auto-moving robot, which is designed for carrying goods. It can be applied in many areas such as shopping mall, airport, and hospital. *Tesigo* can target a host, and follow the host automatically. So far, there is no such kind of robot works in the market, thus *FOYO Technologies Inc.* believes both companies and customers will be satisfied with our product. User can easily control *Tesigo* by using our mobile App. Our aim is to release users' hands and give everyone an easier life. For the design document, *Tesigo* can be divided into three parts. The first part is mechanical part, it involves main body, and motors design; Kinect sensor, battery and electronics installation. The second part is electronic part, it includes circuit design; dealing with the communication between software and motor driver via Bluetooth and USB cable. The third part is software part; it has mobile app, and auto-following code design.

1.1 Scope

This document specifies the details of each system in *Tesigo*, which includes the design logics, design methods, and pros and cons of the design. All the design details in this document are based on the functional requirement document of *Tesigo*. Additionally, this design document also includes the test plan of each component. All unit tests, integrated tests, and system tests of *Tesigo* will be based on this document.

1.2 Intended Audience

The design specification is intended for all staffs in *FOYO Technology Inc.* The develop team can use this document as a guideline for designing and manufacturing *Tesigo*. The test team can use this document as a test plan for unit, integrated, and system tests.

2 System Overview

Tesigo has three operating modes: “Follow” mode, “Remote” mode and “Manual” mode.

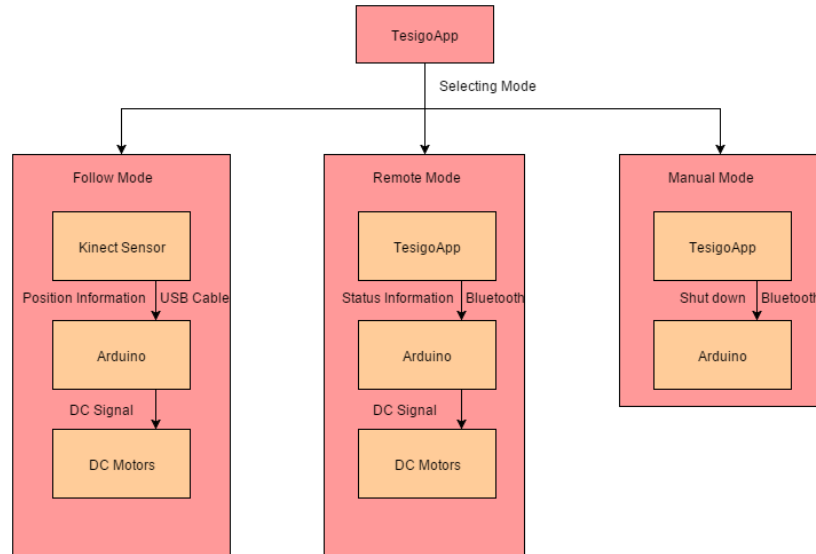


Figure 1: System Diagram

In “Follow” mode, user will be tracked by a Kinect sensor. The Kinect sensor will keep capturing user’s body, and keep feeding user’s position information to Arduino. Arduino will use the position information to control two motors’ movements.

In “Remote” mode, the user can use *TesigoApp* mobile application to remote *Tesigo* directly. This mobile application has a clean user interface that has “Forward”, “Backward”, “Left”, “Right”, and “Stop” buttons. As long as user click single button, *Tesigo* will keep the current state until the user sends another signal to it.

In “Manual” mode, the user will manually control *Tesigo* without any electrical component assistance. When “Manual” mode is on, the power of motors will be turned off.

The prototype of *Tesigo* is powered by two 12V Infinity batteries which are responsible for powering the Kinect sensor, Arduino, motor driver, Bluetooth and two motors. The PC is powered by its own battery. The high-level block diagram of *Tesigo* is shown above.

The low level design of the *Tesigo* will be discussed more details in the rest of the document.

3 Control System

3.1 Arduino UNO

Based on the requirements from [R5.1.1 - C] to [R5.1.12 - B] in functional specification, *FOYO Technologies Inc.* decided to use the Arduino UNO. These requirements relate to control the motors and use Bluetooth adapter. UNO is a microcontroller board based on the ATmega328P, and it has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button [1].



Figure 2: Arduino UNO [1]

Microcontroller	ATmega328P
Operating Voltage	5 V
Input Voltage (recommended)	7 – 12 V
Input Voltage (limit)	6 – 20 V
Digital I/O Pins	14 pins
PWM Digital I/O Pins	6 pins
Analog Input Pins	6 pins
DC Current per I/O Pin	20 mA
DC Current per 3.3V pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Table 1: Arduino UNO Parameter [1]

The table above shows the details of Arduino UNO's parameters *FOYO Technologies Inc.* will use when connect with other components.

3.2 HC-05 Bluetooth

HC-05 Bluetooth module works as a serial (RX/TX) pipe. Any serial stream from 9600 to 115200 bps can be passed seamlessly from PC to Arduino UNO. The default username is HC-05, and password is 1234. HC-05 can be powered by Arduino UNO. HC-05 is not only a master but also a slave, which means HC-05 can both receive and send data, so that it can meet the requirements from [R3.1.0 – B] to [R3.3.0 – C] in functional specification.



Figure 3: Bluetooth HC-05[2]

Bluetooth protocol	Bluetooth Specification v2.0 + EDR
Frequency	2.4 GHz ISM band
Modulation	Gaussian Frequency Shift Keying
Emission power	≤ 4dBm, Class 2
Sensitivity	≤ -84 dBm at 0.1% BER
Speed	Asynchronous: 2.1 Mbps(Max)/160 kbps Synchronous: 1 Mbps/1Mbls
Security	Authentication and encryption
Profiles	Bluetooth serial port
Power Supply	+3.3 VDC 50 mA
Working Temperature	-20 ~ +75 Centigrade
Dimensions	15.2*35.7*5.6 mm

Table 2: Bluetooth HC-05 Specifications [2]

The table above shows the detail of Bluetooth HC-05's parameter.

3.3 VNH5019 Motor Driver

VNH5019 is a compact breakout board for ST's high-power motor driver IC, a fully integrated H-bridge that can be used for bi-directional speed control of a single brushed DC motor [3]. *FOYO Technologies Inc.* used VNH5019 to control the motor.

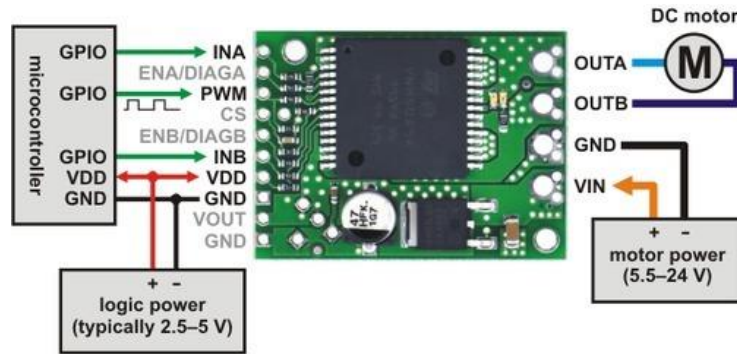


Figure 4: VNH 5019 Motor Driver [3]

The following table shows the specifications of the VNH 5019.

Operating Voltage	5.5 – 24 V
Output current	12 A continuous (30 A maximum)
PWM operation	Up to 20 kHz
Current output proportional to motor current	Approximate 140 mV/A
Motor indicator LEDs	Green: clockwise; Red: counterclockwise

Table 3: VNH 5019 Motor Driver Datasheet [3]

3.4 Circuit Intergration

Based on the datasheet provided previously, the circuit is designed as Figure 4 shown below.

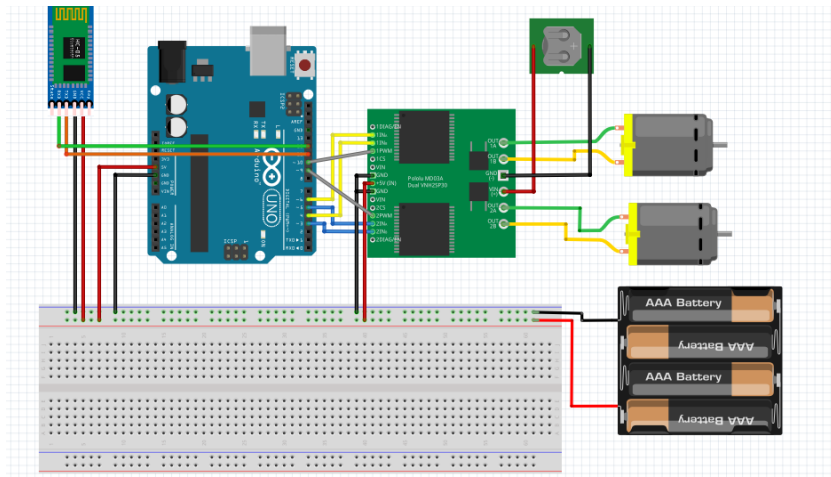


Figure 5: Wires Connection between Each Component

Figure 5 shows the Circuit block diagram of Integration. It shows all pin connection details.

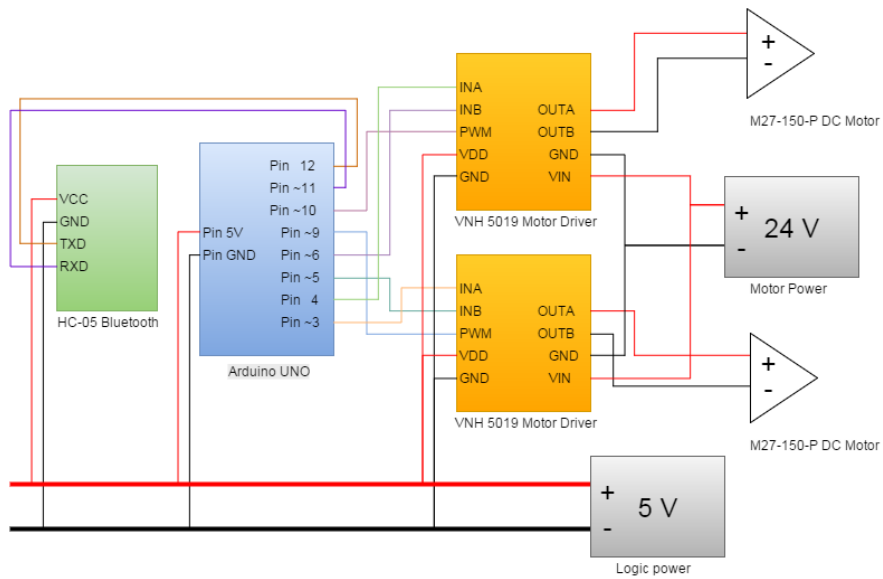


Figure 6: Circuit Block Diagram

4 Mechanical System

This section will focus on the design of mechanical system of *Tesigo*, which includes mechanical components, transmission system, and design in mounting and wiring. *FOYO Technologies Inc.* will discuss these in the following pages.

4.1 AmpFlow M27-150-P Motors

Tesigo uses two 24V, 150W DC motors for movement. M27-150-P motor is ideal for cost-sensitive applications such as robots, motorized scooters, go-karts and electric bicycles [001]. Based on the requirements from [R3.3.0-C] and [R3.3.1-C] in functional specification, the motors should be operated at 12V and move the cart with 30KG load with minimum current of 5A. Therefore, *FOYO Technologies Inc.* decided to use the M27-150-P motors at 12V or 18V. It also can be used at higher voltages for produce higher RPM, torque and power. [4]



Figure 7: M27-150-P Motor [4]

The following table shows the detail of M27-150-P motor’s parameter. [5]

Watts- Continuous	150
Diameter (inches)	2.7
Length (inches)	3.9
Efficiency	79%
Voltage	24
No- Load RPM @ 24V	3800
Pounds	3.0

Table 4: M27-150-P Motor Specifications [5]

The motor's performance chart is shown in the figure below. [6]

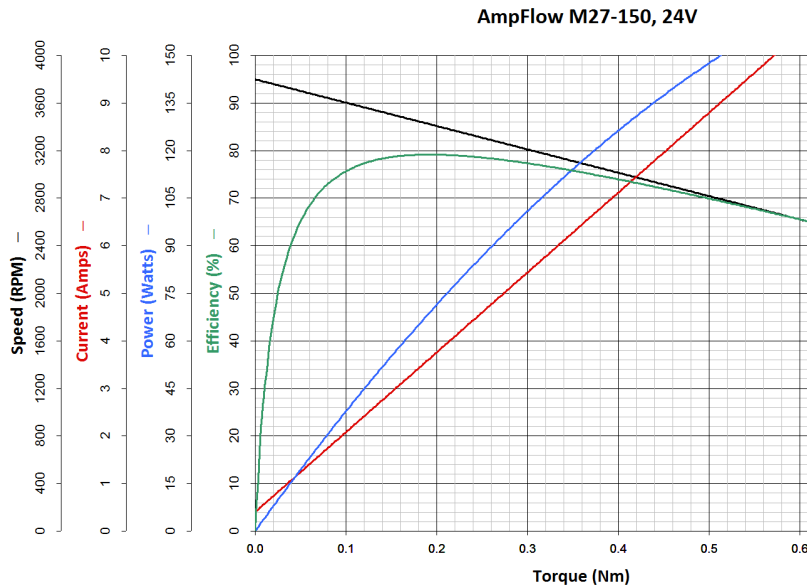


Figure 8: Performance of AmpFlow M27-150-P Motor [6]

4.2 Battery

Based on the requirements [R2.4.2-C], [R2.4.3-C] and [R4.1.0-C] in the functional specification, *FOYO Technologies Inc.* decided to use one 12V 5Ah and one 12V 2.7Ah lead-acid batteries. 12V 5Ah battery will power the Arduino, motors, motor drivers and Bluetooth, and 12V 2.7Ah battery will power the Kinect sensor.



Figure 9: 12V 2.7Ah and 5Ah Rechargeable Sealed Lead Acid (VRLA) Battery [7] [8]

4.3 Cart Frame

The cart frame of *Tesigo* is based on Peg-Perego Skate System infants and toddlers stroller [9]. The original cart frame is shown below.



Figure 10: The Original Cart Frame [9]

4.4 Transmission System

Tesigo uses a timing pulley system as its transmission system. The small pulley is connected to AmpFlow M27-150-P belt motors while the large pulley is connected to the wheels. The figure below shows how the transmission system looks like.

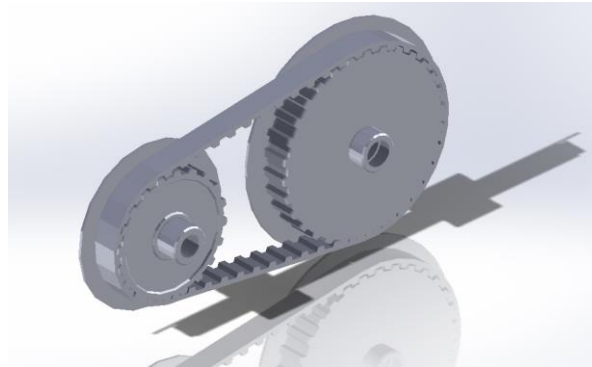


Figure 11: Transmission System

According to our calculation, the transmission ratio of this system is 1:3, which will reduce the speed and increase the torque of the cart.

4.5 Mounting & Wiring

For safety purpose, all components and wires should be mounted onto the cart. The bottom of the cart is covered with a wooden board with holes for screws. All the components and wires are settled on the wooden board.

5 Software System

5.1 Android Application

Android Application called *TesigoApp* will be downloaded for free. *TesigoApp* allows users to operate *Tesigo* in remote mode via Bluetooth.

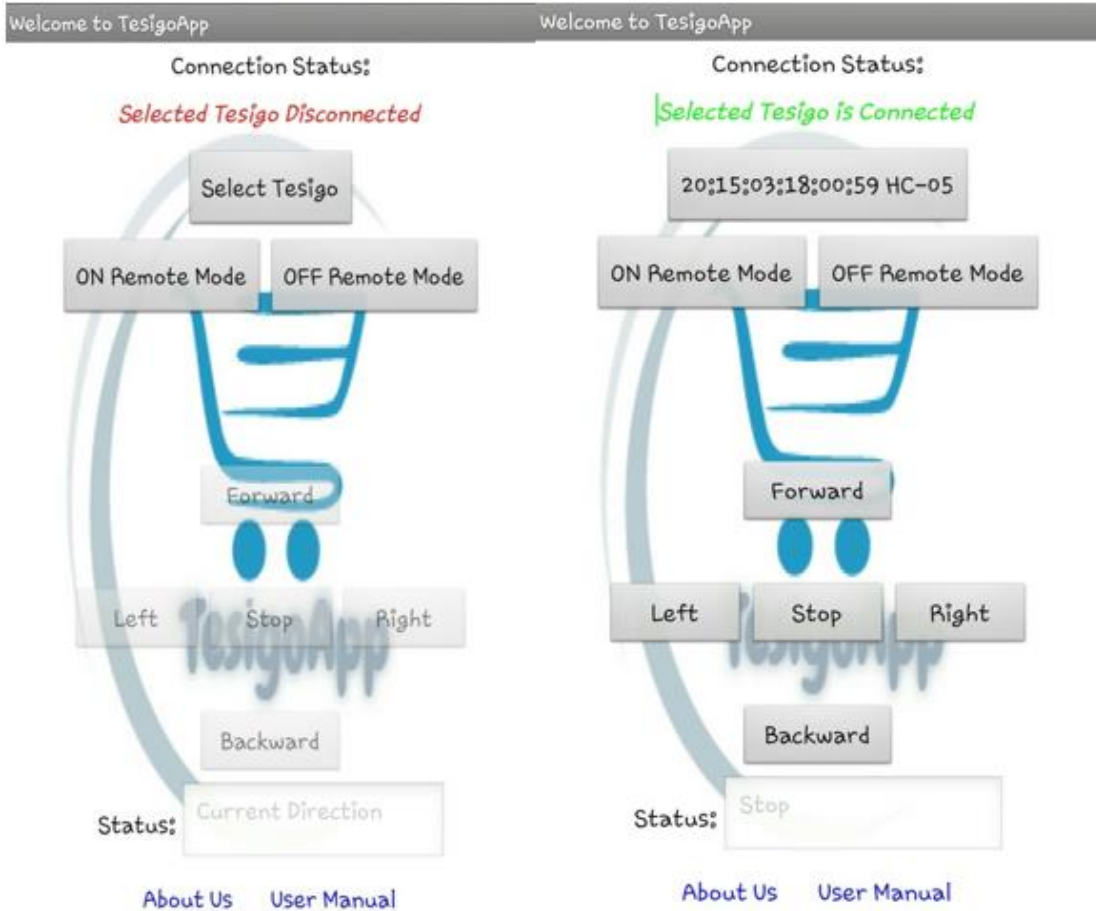


Figure 12: User Interfaces of Remote Controlling

Figure 12 shows the main screen of *TesigoApp*. By clicking 'Select Tesigo' button, user can select available *Tesigo* from the list and click 'ON Remote Mode' to start operate *Tesigo* in remote mode. *TesigoApp* also provides the connection status between *TesigoApp* and *Tesigo*. If they are connected, it displays 'Selected Tesigo is Connected'. Otherwise, it displays 'Selected Tesigo Disconnected'. After connecting *TesigoApp* with *Tesigo*, the direction control panel is enabled and user can start controlling the movements of *Tesigo*.

In direction control panel, user is allowed to click buttons shown below:

Button	Tesigo	Voice from TesigoApp
Forward	<i>Tesigo</i> moves forward	Forward
Backward	<i>Tesigo</i> moves backward	Backward
Left	<i>Tesigo</i> turns left	Left
Right	<i>Tesigo</i> turns right	Right
Stop	<i>Tesigo</i> stops	Stop

Table 5: Buttons' performances

In addition, there are voices and status telling the user which status *Tesigo* is operating.



Figure 13: User Interface of "About Us"

User can find the information of *FOYO Technology Inc.* by clicking 'About Us' link in Figure 12 and company profile windows will be displayed.

Figure 13 shows the information of *FOYO Technology Inc.* and team members.

For new users, *TesigoApp* also provides the user manual in Figure 14 when users click 'User Manual' link in Figure 12. This tells users each step on how to operate *Tesigo* in remote mode.

User Manual

How to control Tesigo in Remote Mode:

1. Click 'Select Tesigo' button and a list of available Tesigo will be displayed
2. Select Tesigo from the list
3. Click 'ON Remote Mode' button to turn on remote mode
4. If 'Selected Tesigo is Connected' is displayed on screen, then you can control direction of Tesigo. Otherwise, please repeat step1
5. To move Tesigo forward, click "Forward" button
6. To move Tesigo backward, click "Backward" button
7. To turn Tesigo left, click "Left" button
8. To turn Tesigo right, click "Right" button
9. To stop Tesigo, click "Stop" button

Back to Controller

Figure 14: User Interface of "User Manual"

5.2 Kinect Application

In follow mode, the Kinect will track the user and its motion. The Kinect will be able to identify a user who is between 0.8 and 4 meters away (in this section will refer as Y-coordinates, where the Kinect is the zero point) as presented in the figure below.

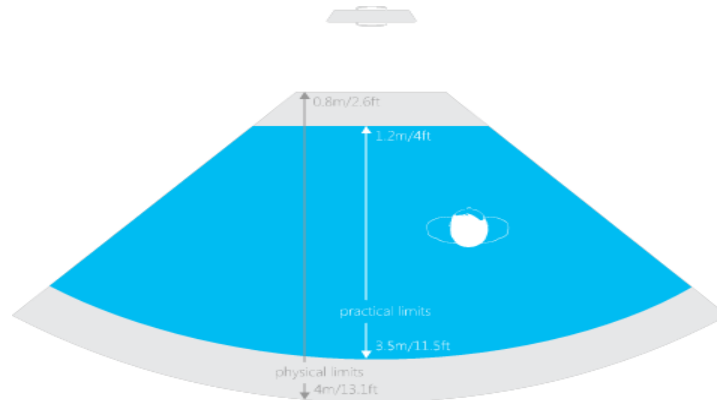


Figure 15: Horizontal Field of View

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The range of motion along to the Kinect field of view (in this section will refer as X-coordinates, where the Kinect is the zero point), which the tracking system will remain active is -0.25 meter (right side of the Kinect) and 0.25 meters (left side of the Kinect) approximately.

The tracking implementation used for this specific project will be the strategic *First person gets control*, which means that the first person identified by the Kinect will be the user target as shown in the figure below. When the Kinect lost track of the user, it will remain in stop until the user select follow mode from *TesigoApp* and enter again in the field view of the Kinect.



Figure 16: First person gets control

Once the user is identified, the Kinect will enable the skeleton tracking method, which allows it to keep track of the user's position. This method provides the detailed information about the position in the camera's field of view.

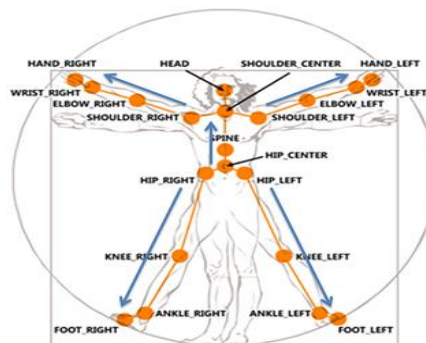
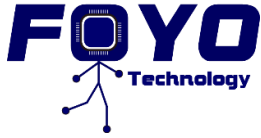


Figure 17: Joints from Kinect perspective



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In the figure above, it is possible to appreciate the twenty joints of which the Kinect keeps tracks. For the design of proof of methods, the Spine joint will be used as a point of reference to track the user's distance. Since *FOYO Technologies Inc.* considers that it will be better to rely on a joint that is around the mid part of the body, in case that the Kinect loses vision of the lower part or the upper part of the body (from shoulder to head), which are more prone to be out of the field of view.

5.3 Kinect and Arduino Integration

In order for the Kinect to work at full capacity it needs to be connected to a PC or a tablet with the following minimum specifications:

64-bit (x64) processor
Physical dual-core 3.1 GHz (2 logical cores per physical) or faster processor
the Kinect Adapter for Window for use with the Kinect for Xbox One sensor
4 GB of RAM
Graphics card that supports DirectX 11
Windows 8 or 8.1, Windows Embedded 8, or Windows 10

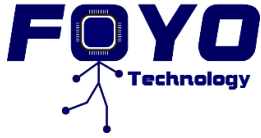
Table 6: Minimum Requirements PC for Kinect

For proof of methods, *FOYO Technologies Inc.* decided to use a laptop that met the minimum requirements specified before, but for later steps in the project *FOYO Technologies Inc.* will use a mini PCs that will reduce the cost and the overall weight on the *Tesigo cart*.

The laptop will be running a Windows Store application (KinectApp) that will enable and control the Kinect, and it will also run another application (BridgeApp) that will work as the bridge between the KinectApp and the Arduino.

KinnectApp:

In general, this application is in charge of managing the Kinect and keeping track of the user. KinnectApp will be constantly reading the location of the user and will be outputting commands such as "Forward", "Right", "Left" and "Stop".



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BridgeApp:

In general, this application will read the kinectApp's output and send these outputs to Arduino via the USB port. It is also in charge of enabling and disabling the data which is sent from the KinectApp. In other words, it will receive a signal from Arduino that will indicate in which mode the *Tesigo* is currently working. According to this, the bridgeApp will enable or disable the KinectApp.

6 Unit Test

6.1 Motor Test

Motor power testing method:

Move the cart with a constant speed with the load of 30KG.

Expecting outcome:

Based on the requirement of [R 3.4.1-C] in the functional specification, the cart should move at the speed of 0.6m/s with the load of 30KG on it.

Motor breaking test method:

Move the cart at speed of 0.6m/s and suddenly turn off the power to the motor.

Expecting outcome:

Based on the requirement of [R3.4.0-C] in the functional specification, the cart should reach the full stop less than 0.5 second.

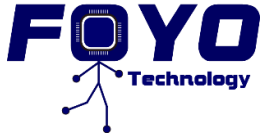
6.2 Battery Test

Battery life testing method:

Connect the full charged battery to the final integrated system and let the system run.

Expecting outcome:

The system should run for 5 hours.



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Battery charging speed testing method:

Charge the 12V 5Ah battery with 13.65V and 2.275A.

Expecting outcome:

Based on the requirement of [R2.4.3-C] in the functional specification, the battery should be full charge in 5 hours.

6.3 Bluetooth Test

Testing Method:

1. Connecting the Bluetooth HC-05 to Arduino, and Arduino to PC.
2. Open the Arduino IDE, and open the Serial Monitor. Send the command AT. Check the feedback.
3. Send command "AT + Version". Check the feedback.

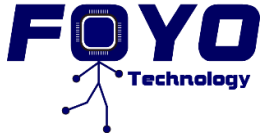
Expecting Outcome:

1. The signal will light on Bluetooth adapter.
2. The Bluetooth's signal light will show a two second blink.
3. Console will show "OK" after send the AT command.
4. Console will show "OK"+ the version of HC-05 Bluetooth.

6.4 Arduino & Motor Driver Test

Testing Method:

1. Write the simple test code for Pin3 and Pin5, `digitalWrite (3, high)` and `digitalWrite (5, low)`, add a LED light on both pin, run the program to see if the LED lights up.
2. Run the DC motor with command "`analogWrite (9, VALUE)`" to change the duty cycle VALUE from 0 to 255. Then check the speed of the axis, in order to prove PWM pin works.
3. Run the remote control mode, and click "forward", "backward", "stop". Check the signal light on the motor driver, and also the turning direction on the motor.



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Expecting Outcome:

1. LED lights up.
2. The speed of the motor will increase when the VALUE increase from 0 to 255 under the same voltage and current conditions.
3. The corresponding output is shown in the table 7.

Input	Light Signal	Turning Direction of Motor
Forward	Green Light on	Clockwise
Backward	Red Light on	Counterclockwise
stop	Light off	Stop

Table 7: Test Result

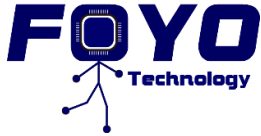
6.5 Android Application - *TesigoApp*

TesigoApp is tested to ensure it can be downloaded and installed successfully for free on Android mobiles. In addition, this test is to ensure some functions of *TesigoApp* can be performed successfully in unit test and is ready for the integrated test in the next step.

On the main screen (Figure12), the connection status should show ‘Selected *Tesigo* Disconnected’ and direction control panel should be disabled since there is no connection between *TesigoApp* and *Tesigo*. By clicking following buttons, the expected performances of *TesigoApp* are shown in the table below.

Screen	Button/Link	Status	Action	Expected Performance
Main Screen	Select <i>Tesigo</i>	Enabled	Click	Shows list of devices
	ON Remote Mode	Enabled	-	-
	Off Remote Mode	Enabled	-	-
	Forward	Disabled	-	-
	Backward	Disabled	-	-
	Left	Disabled	-	-
	Right	Disabled	-	-
	Stop	Disabled	-	-
	About Us	Enabled	Click	About Us screen initialed
	User Manual	Enabled	Click	User Manual screen initialed
User Manual/ About Us	Back to Controller	Enabled	Click	Main Screen initialed

Table 8: Expected Performance of *TesigoApp*



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On About Us screen Figure13, should contain information of FOYO Technologies Inc. Similarly, on User Manual screen Figure14, the steps of how to control *Tesigo* in remote should be displayed.

6.6 KinectApp Test:

This test is to ensure that the Kinect keeps track of the right person among many people and that the KinectApp is outputting the correct commands according to the motion of the user.

Tracking Test

Test Method:

1. The user will take position in front of the Kinect within a range of 0.8 and 4 meters of distance.
2. The user will move forward, backward, right and left.
3. One to five people will position themselves into the field view of the Kinect.
4. Everyone except for the user will move in any direction without totally blocking the vision field between the Kinect and the user.
5. While everybody moves, the user will move too without totally blocking the vision field between the Kinect and the user.

Expected Outcome (in the window of the *KinectApp*):

1. The X-coordinates and Y-coordinates in the window of the *KinectApp* will show the values of the current position of the user
2. The values of the X-coordinates and Y-coordinates will increase or decrease according to the motion of the user.
3. The Kinect will recognize one to six people since six people is the limit number that can be recognized at the same time. After the limit of six people, the additional people will be ignored.
4. The values of the X-coordinates and Y-coordinates will not be changed.
5. The values of the X-coordinates and Y-coordinates will increase or decrease according to the motion of the user.

Output Command Test

The commands outputted by *KinectApp* are based on the distance of the user with respect to X and Y coordinates. The command outputs are displayed in the debugger window of Microsoft Visual Studio.

X-coordinates (user) in meters	Y-coordinates (user)	Expected output
$-0.25 < X < 0.25$	$Y < 0.8$	Stop
$-0.25 < X < 0.25$	$Y > 0.8$	Forward
$X > 0.25$	$Y > 0.8$	Left
$X < -0.25$	$Y > 0.8$	Right
$X > 0.25$ or $X < -0.25$	$Y < 0.8$	Stop

Table 9: Command Test

7 Integration Test

7.1 Android Application with Microcontroller via Bluetooth

This test is to ensure that Android application sends the correct signals to microcontroller via Bluetooth.

In figure12 shows when *TesigoApp* selects and connects with *Tesigo* via Bluetooth, the connection status will show ‘*Selected Tesigo is Connected*’.

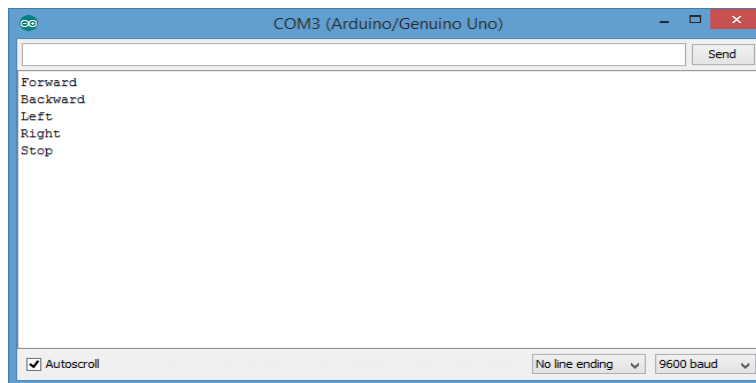


Figure 18: Serial Monitor Example Output

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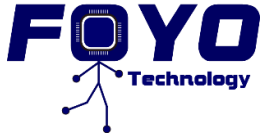
Screen	Button/Link	Status	Action	Expected Performance
Main Screen	Select Tesigo	Enabled	Click	Show list of devices
	ON Remote Mode	Enabled	Click	Connect with Bluetooth
	Off Remote Mode	Enabled	Click	Disconnect with Bluetooth
	Forward	Enabled	Click	Send 'Forward' to Bluetooth
	Backward	Enabled	Click	Send 'Backward' to Bluetooth
	Left	Enabled	Click	Send 'Left' to Bluetooth
	Right	Enabled	Click	Send 'Right' to Bluetooth
	Stop	Enabled	Click	Send 'Stop' to Bluetooth
	About Us	Enabled	Click	About Us screen initialed
	User Manual	Enabled	Click	User Manual screen initialed
User Manual/ About Us	Back to Controller	Enabled	Click	Main Screen initialed

Table 10: Expected Performance of *Tesigo* and Microcontroller

Figure18 shows the Serial Monitor of Arduino and table below shows the expected performances of Serial Monitor when Bluetooth receives signals from *TesigoApp*.

Signal received	Expected Performance
Forward	Print "Forward"
Backward	Print "Backward"
Left	Print "Left"
Right	Print "Right"
Stop	Print "Stop"

Table 11: The Exceped Performances of Serial Monitor



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7.2 KinectApp/BridgeApp with Arduino Test

This test is to ensure that the *BridgeApp* will read the correct commands from the *KinectApp* then it will write commands in the Arduino when the mode follow is activated. Also, this test assures that the Arduino is reading the correct commands.

Enable Follow Mode	Commands output <i>KinectApp</i>	Commands Input received <i>BridgeApp</i>	Commands output send to Arduino	Signal Received Arduino
1	Stop	Stop	Stop	Stop
1	Forward	Forward	Forward	Forward
1	Right	Right	Right	Right
1	Left	Left	Left	Left
0	Stop	Stop	-----	-----
0	Forward	Forward	-----	-----
0	Right	Right	-----	-----
0	Left	Left	-----	-----

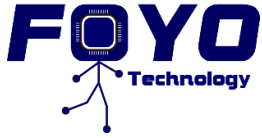
Table 12: *KinectApp/BridgeApp* Test

The input commands of *BridgeApp* are displayed in the debugger window of Microsoft Visual Studio. The Serial Monitor of Arduino will display the output commands of *BridgeApp*.

For the proof of methods, the Kinect is not totally disabled as it is shown in the above table and the Kinect will keep sending the commands. However, for later steps *FOYO Technologies Inc.* will totally disable the Kinect in order to save resources and major efficiency.

7.3 System Test

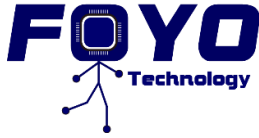
For the system test, *Tesigo* will be tested for three modes: manual mode, remote mode and follow mode. For the manual mode, some young women are invited to test *Tesigo*; for the remote mode, some old people are invited to test *Tesigo*; for the follow mode, a bunch of different height people (140 – 190 cm) are invited to test *Tesigo*. The three different modes will also be tested in different environment situations: library (narrow path, and many corners), AQ (many people).



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Place	Condition	Mode	Test Target
Library	Narrow path, Many corners	Follow mode	Test the <i>Tesigo's</i> reaction in the real situation.
AQ	Many people	Follow mode	Test the accuracy of Kinect sensor's tracking system.
		Remote mode	Test the stability of Bluetooth connection.

Table 13: Result of System Test



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