California State University Long Beach
College of Engineering
Department of Electrical Engineering

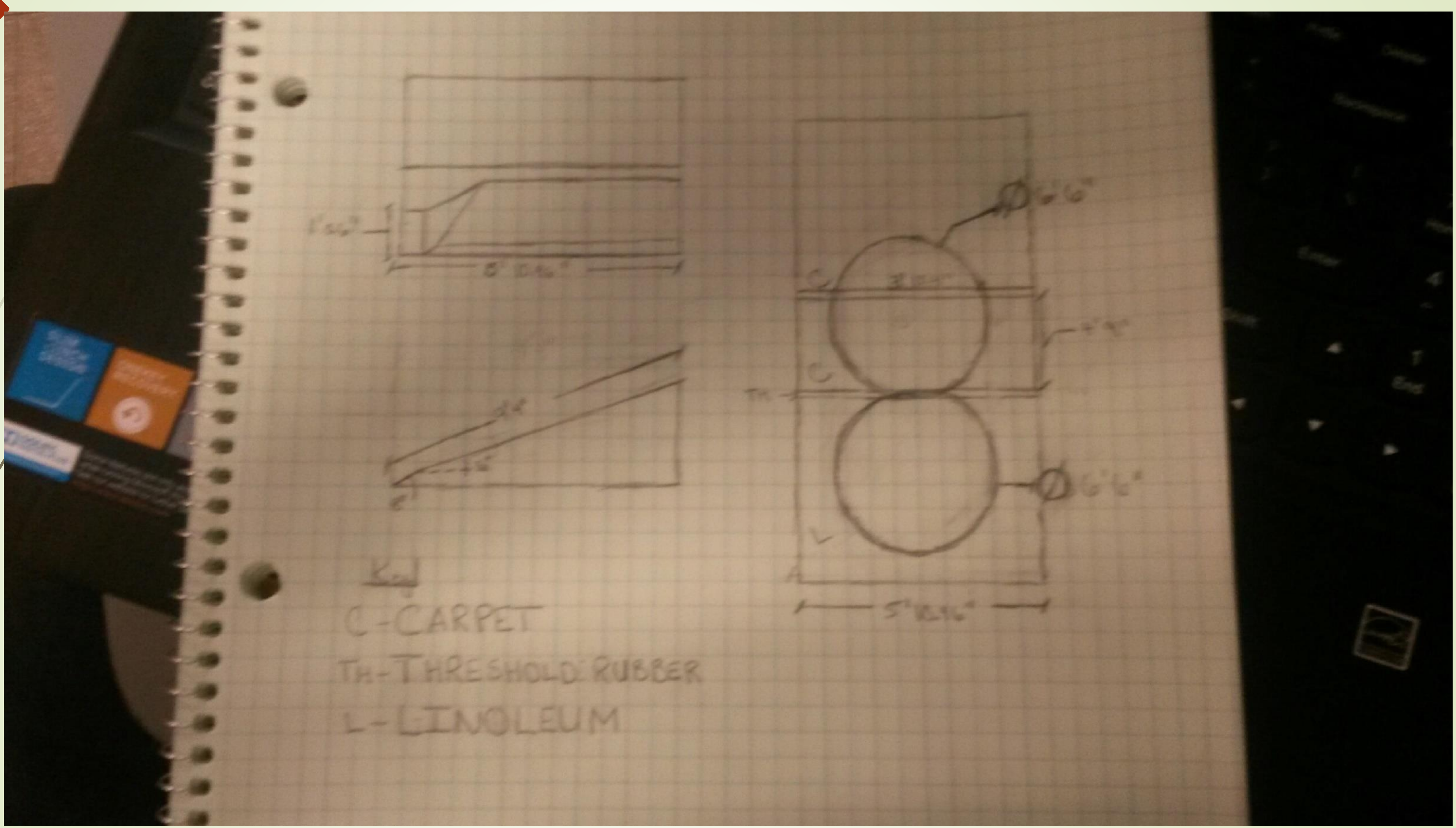
µBiPed

Project Manager & Control and Image Processing: Tate M^c^Geary
Systems and Test Engineering: Mesfer Aldosari
Sensors, Actuators, and Power: Ameen Alattas
3D Printing and Manufacturing: Yakub Dure

Mission Objective and Profile:

- Using the Axterra™ application in remote control mode, a µBiPed will be made. A µBiPed is a BiPed created using micro-servos.
- The µBiPed will have to walk on surfaces of varying gradients, and types. The µBiPed will also have to maneuver over uneven surfaces of at most 2 cm and avoid obstacles.
- The µBiPed should be finished May 8th 2015

Course:



Requirements: Level 1

- The µBiPed must be finished by the 8th of May, 2015 to correspond with the duration of the EE 400D class.
  - **Verification:** http://web.csulb.edu/divisions/aa/calendars/documents/2014-2015_academic_calendar_updated.pdf
- The µBiPed must move (i.e. walk in a human-like fashion) up an incline that starts initially at 8° and then decreases to a 6° slope in relation to level ground. This is due to the obstacle course prescribed in the specifications.
  - **Verification:** To test this parameter, the µBiPed will be sent up an incline at varying grades, starting at 6° and going till at least 8°. The incline grade may increase past the 8° in order to test failure point.
- The µBiPed must avoid walls at a distance of **TBD**. Determined by the mission profile. The distance may be determined based off of the constraints of the parts used to determine distance, or the customer may indicate distance.
  - **Verification:** Will have the µBiPed walk towards an object, i.e. a wall, and see if the µBiPed will stop or try and change path. The distance will be measured with a tape measure.

- The µBiPed must walk over or on an object at about a 45° angle and a height of 2 cm. This is part of the mission profile dictated by the specifications.
  - **Verification:** The µBiPed will walk over an object of about 2 cm +/- 1 cm. The 2 cm is for margin of error. This will be measured by a ruler.
- The µBiPed must walk on surfaces of varying friction coefficients:
  - Carpet: 1.0 static [1]
  - Linoleum: 0.5 static [2]
  - **Verification:** The µBiPed will walk on all three types of surfaces. Carpeting will vary, it will range from thick to thin. Verification for each surface friction coefficient was found on the below websites.
- The µBiPed must stabilize when disturbed by a force/time of **TBD**. The force has not yet been calculate. This requirement is dictated by the specifications and mission profile.
  - **Verification:** The µBiPed will be hit to test response to immediate impact, and will be tested for force applied over time, i.e. a push. Force will be measured by a force gauge or equivalent.

References:
[1] https://pisci.wikispaces.com/Coefficients+of+Friction
[2] http://www.floorcare-usa.com/pdf/CoefficientFriction.pdf
[3] http://www.engineeringtoolbox.com/friction-coefficients-d_778.html

- The µBiPed must weigh no more than **TBD** in order to facilitate the miniaturized size of the µBiPed. Otherwise, if the µBiPed is too heavy the project may not be realizable.
  - **Verification:** The servos will be tested for maximum torque, then µBiPed will be weighed with a scale and will be checked if it can move.
- The µBiPed must interface with Arxterra Remote Control™ mode as defined by the specifications. The RC mode must be used because the µBiPed must conserve its mass; any additional mass, such as a phone would require the increase of size.
  - **Verification:** The Arxterra Remote Control™ mode will be used to direct movement in the µBiPed. Movement via Bluetooth will verify that connection with Arxterra has been meant.
- The µBiPed must be miniaturized as is dictated by its own name, size **TBD**.
  - **Verification:** The µBiPed will have its size miniaturized compared to its larger model. Measurement will be done with a ruler or equivalent.

Level 2 Requirements

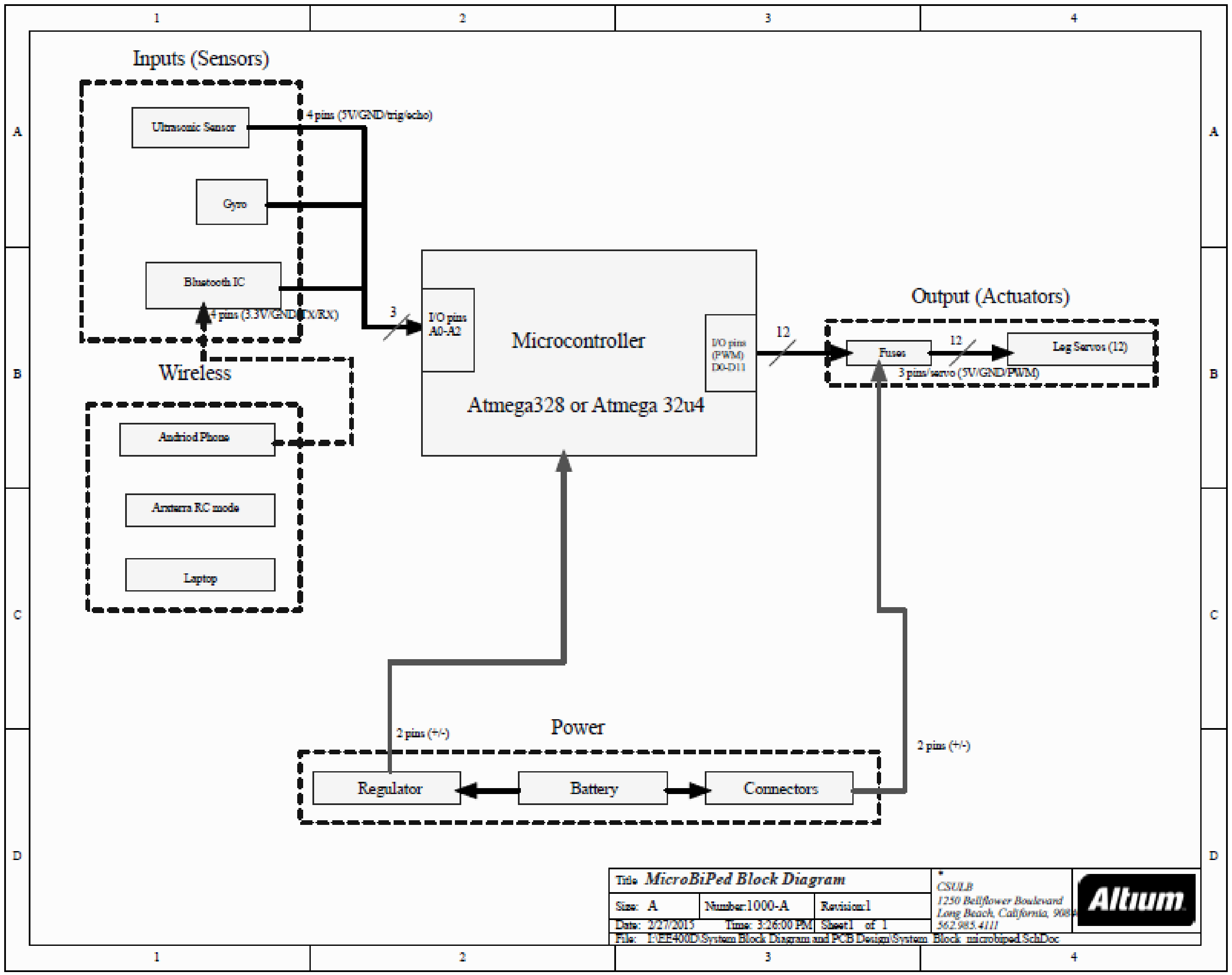
- In order to avoid an obstacle the µBiPed will use an HC-SR04™ ultrasonic sensor. Primary reasons are that it is less susceptible to noise and cost; in addition, the project has one in inventory. ***Refer to requirement 3, level 1.***
  - **Verification:** Based on previous semesters, distance will be determined when height of the µBiPed has been decided to finalize the angle of detection. Calculations will be done similar to previous semesters. Link provided below.
  - http://www.arxterra.com/ultrasonic-sensor-examination/
- The µBiPed will use a gyro, type **TBD**, in order to allow for completion of ***requirement 2, level 1***, and ***requirement 6, level 1.***
  - **Verification:** The µBiPed will be tested on how well the gyro keeps it stable. This will be done by walking over uneven surfaces and not falling over.
- In order to successfully miniaturize the µBiPed, micro-servos will be used. Type of micro-servos are **TBD** after testing. The project must test the micro servos using SolidWorks or through math analysis in order to determine if micro servos provide enough torque to complete the project.
  - **Verification:** Micro-servos will be tested on strength and maximum load they can handle based off the load bearing tests.
- In order to miniaturize the µBiPed, a microcontroller, type **TBD**, must be chosen. The microcontroller should at least have 14 kb of Flash memory and 4.7 kb of SRAM.
  - **Verification: :** Microcontroller will be tested if it can control at least 12 servos and facilitate the additional components needed to implement the µBiPed.

- Due to the miniaturization of the µBiPed, a PCB board will be fabricated that includes the wiring for the gyro, the Bluetooth IC, and the servo pins that will allow for the microcontroller to interface with the assembly.
  - **Verification:** A continuity test to verify proper wiring layout of the PCB.
- In order to traverse multiple surfaces ***(requirement 5, level 1)*** the µBiPed's legs must have some type of tread or rubber sole added to it. ***See reference 3 on page 1.***
  - **Verification:** Will test the µBiPed with various types of tread to see the traction difference.
- In order to keep within the specified size restriction, the µBiPed will have light weight batteries. Type of batteries are **TBD**
  - **Verification:** Testing and calculations will be performed before selection.
- A light weight material must be used for the frame in order to keep within the specific mass restrictions of the µBiPed; the type of material is **TBD**. Testing must be done as to whether or not the µBiPed can be made of plastic, or if a lighter material must be used.
  - **Verification:** Different materials will be strength tested and weighed. Strength testing will be verified by hand, and weight will be verified with a scale.
- As mentioned in item 5, a Bluetooth IC will be chosen that will communicate to the Arxterra™ program. An IC must be used in order to minimize the µBiPed size and mass. The type of Bluetooth IC is **TBD**. ***Requirement 9, level 1.***
  - **Verification:** To test if the Bluetooth IC works properly commands will be given from the Arxterra Remote Control™ program and the robot will respond accordingly.

Systems and Test

By: Mesfer Aldosari

System Block Diagram



Interface Definition

ARDUINO MICRO PIN CONNECTIONS

PIN	SYMBOL	FUNCTION
1	MOSI	MASTER OUT SLAVE IN
2	SS	SLAVE SELECT
3	TX	TRANSMIT / DIGITAL PIN 1
4	RX	RECEIVE / DIGITAL PIN 0
5	RST	RESET
6	GND	GROUND
7	D2	DIGITAL PIN 2 / SERIAL DATA LINE
8	D3	DIGITAL PIN 3 / SERIAL CLOCK LINE / PWM
9	D4	DIGITAL PIN 4 / ANALOG 6
10	D5	DIGITAL PIN 5
11	D6	DIGITAL PIN 6 / ANALOG 7 / PWM
12	D7	DIGITAL PIN 7
13	D8	DIGITAL PIN 8 / ANALOG 8
14	D9	DIGITAL PIN 9 / ANALOG 9 / PWM
15	D10	DIGITAL PIN 10 / ANALOG 10 / PWM
16	D11	DIGITAL PIN 11 / PWM
17	D12	DIGITAL PIN 12 / ANALOG 11
18	D13	DIGITAL PIN 13 / PWM
19	3V3	+ 3.3 V
20	REF	ANALOG REFERENCE
21	A0	ANALOG 0
22	A1	ANALOG 1
23	A2	ANALOG 2
24	A3	ANALOG 3
25	A4	ANALOG 4
26	A5	ANALOG 5
27	NC	NOT CONNECTED
28	NC	NOT CONNECTED
29	5V	+ 5.0 V
30	RST	RESET
31	GND	GROUND
32	VIN	VOLTAGE IN (7-12 V)
33	MISO	MASTER IN SLAVE OUT
34	SCK	SYNCHRONOUS CLOCK

HC-SR04

PIN	SYMBOL	FUNCTION
1	VCC	VOLTAGE SOURCE
2	TRIG	TRIGGER INPUT
3	ECHO	ECHO OUTPUT
4	GND	GROUND

HC-06 BLUETOOTH V2 CLASS 2.0

PIN	SYMBOL	FUNCTION
1	VCC	VOTLAGE SOURCE
2	GND	GROUND
3	TXD	TRANSMITE
4	RXD	RECEIVE

L3G4200D

PIN	SYMBOL	FUNCTION
1	GND	GORUND
2	VCC	VOLTAGE SOURCE
3	SCL	SERIAL CLOCK LINE
4	SDA	SERIAL DATA LINE
5	SDO	SERIAL DATA OUTPUT
6	CS	SPI ENABLE
7	INT2	PROGRAMMABLE INTERRUPT
8	INT1	PROGRAMMABLE INTERRUPT

SERVO

WIRE COLOR	SYMBOL	FUNCTION
ORANGE	O	PWM INPUT
BROWN	B	GROUND
RED	R	VOLTAGE SOURCE

CONNECTIONS

HC-SR04		TO	ARDUINO MICRO	
PIN	SYMBOL		PIN	SYMBOL
1	VSS	↔	29	5V
2	TRIG	↔	9	D4
3	ECHO	↔	-	-
4	GND	↔	6	GND
HC-06				
1	VCC	↔	19	3V3
2	GND	↔	6	GND
3	TXD	↔	4	RX
4	RXD	↔	3	TX
L3G4200D				
1	GND	↔	6	GND
2	VCC	↔	19	3V3
3	SCL	↔	8	D3
4	SDA	↔	7	D2
5	SD0	↔	19	3V3
6	CS	↔	-	-
7	INT2	↔	-	-
8	INT1	↔	-	-

SERVOS				
ORANGE	O	↔	9	D4
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	10	D5
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	11	D6
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	12	D7
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	13	D8
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	14	D9
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	15	D10
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	16	D11
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	17	D12
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	18	D13
BROWN	B	↔	-	-
RED	R	↔	-	-
ORANGE	O	↔	22	A1
BROWN	B	↔	-	-
RED	R	↔	-	-

Resource Reports

Mass Report

Device	Mass (g)	Quantity	Total mass (g)
Arduino Micro Atmega 32u4	13[3]	1	13
Micro Servos (MG90S)	13.4[2]	12	160
Sain Smart HC-SR04 Ultrasonic Sensor	8.5 [1]	1	8.5
L3G4200D	13	1	13
HC - 06	1	1	1
Battery	**TBD**	**TBD**	**TBD**
Plastic	**TBD**	**TBD**	**TBD**
TOTAL MASS:			**TBD**

References:
[1] http://www.amazon.com/SainSmart-HC-SR04-Ranging-Detector-Distance/dp/B004U8TOE6
[2]http://www.hobbyking.com/hobbyking/store/__9392__Turnigy_MG90S_Digital_Metal_Gear_Servo_1_8kg_13_4g_0_10sec.html
[3] http://arduino.cc/en/Main/arduinoBoardMicro

Power Budget

Device	Quantity	Ave. Operating DC Voltage (V)	Ave. Operating Current (mA)	Ave. Total Current (mA)	Power (mW)	Margin of error
Micro Arduino Atmega32u4	1	5	50	50	250	15%
Micro servos (MG90S)	12	5	370	8880	44400	15%
Sain Smart HC-SR04 Ultrasonic Sensor	1	5	2	2	10	15%
L3G4200D*	1	3.6	6.1	6.1	21.96	10%
HC-06	1	3.3	8	8	26.4	5%
Total				8946.1	44708.36	

Bill of Materials For Sensors, Actuators, Power:

Device	Quantity	Cost ($)	Total Cost ($)	Margin (%)	Margin Cost ($)
Micro Arduino Atmega32u4	1	25.65	25.65	10	2.57
Micro servos (MG90S)	12	4.00	48.00	15	7.2
Sain Smart HC-SR04 Ultrasonic Sensor	1	-	-	-	-
Gyro -MPU	1	49.95	49.95	10	5
HC-06	1	5.99	5.99	15	0.89
Total			129.59		15.66

Bill of Materials Design and Manufacturing:

Device	Quantity	Cost ($)	Total Cost ($)	Margin (%)	Margin Cost ($)
Layer PCB	1	43.15	43.15	15	6.47
Silicone Mold Maker	5	15.00	75.00	15	11.25
Casting Resin	5	13	65.00	15	9.75
Epoxy	1	10.00	10.00	15	1.5
Total			193.15		28.97

System Verification

- **Incline Test**
  - To meet requirement 2, level 1 the µBiPed will be directed to walk up a incline initially at 8° then lowered to 6°.Test result **TBD**
- **Sensor Test**
  - To fulfill requirement 3, level 1 a HC-SR04 ultrasonic sensor will be used to avoid obstacles that may impede the µBiPed. To test this, the HC-SR04 will be tested independently by writing code to check if the part functions properly can provide an interrupt command. Results are **TBD**
- **Communication Test**
  - A Bluetooth Version 2 Class 2.0 component will be chosen and tested for compatibility with the Arxterra Remote Control™ mode. Compatibility will be tested by sending a command to the Bluetooth component from Arxterra Remote Control™. Test result **TBD**
- **Gyro Test**
  - Gyroscope will be tested by checking the direction or orientation of itself when relayed through a micro-controller. Code for this will be implemented or created. Results are **TBD**

Sensors, Actuators, and Power

By: Ameen Alattas

Bluetooth

Taken from DX.com see Reference 1 at the bottom

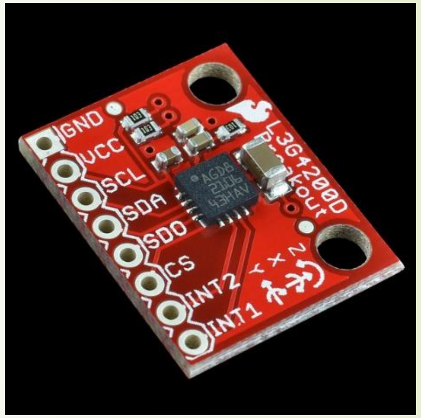
- Due to mass constraints the µBiPed will attempt to use the HC-06, which is only the Bluetooth on the JY-MCU.
  - JY-MCU pictured top right.
  - HC-06 pictured bottom right.
- Primary reason for choice was due recommendation, and information on use from previous semesters. Cost was also an important factor and the HC-06 cost is $5.99.
  - Other reason includes that the HC-06 is a Bluetooth Class 2 V2 rated device to communicate with Arxterra

Taken from elecfreaks.com see Reference 2 at the bottom

References:
[1] http://www.dx.com/p/jy-mcu-arduino-bluetooth-wireless-serial-port-module-104299
[2]http://www.elecfreaks.com/store/images/product_images/Wireless/bluetooth/bluetooth-HC05-02.jpg

Gyroscope

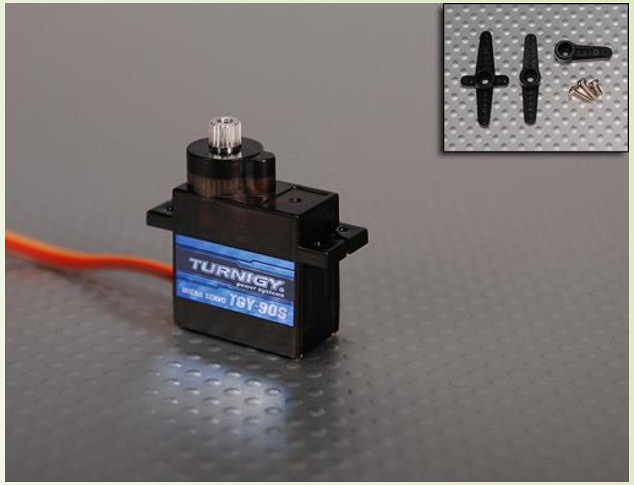
- Currently the µBiPed group is looking into the L3G4200D gyroscope
  - Most commonly used breakout boards for the Arduino use this gyroscope
  - Cost effective
  - Documentation on use from outside sources



Taken from sparkfun.com see reference 1

References:
[1] https://www.sparkfun.com/products/10612

Servos



Taken from hobbykings.com see reference 1.

- The µBiPed group is looking into using the MG90S
- Primary Reasons for favoritism:
  - MG90S provides the most torque for cost out of other servos being considered, at 1.8 kg/cm.
    - See Appendix A for other servos that may be considered.
  - At $4.96 x 1 servo, the MG90S is more cost effective when compared to servos with higher torque.

References:
[1]http://www.hobbyking.com/hobbyking/store/__9392__Turnigy_MG90S_Digital_Metal_Gear_Servo_1_8kg_13_4g_0_10sec.html

Control

By: Tate McGeary

Microcontroller: Arduino Micro

Taken from Arduino.cc see reference 1.

- Arduino Micro
  - Flash: 32 KB (4 KB dedicated to boot)
  - SRAM: 2.5 KB
  - Weight: 13g
- Code:
  - Flash: 14 KB
  - SRAM: 4.7 KB
- Relavance:
  - SRAM of code exceeds the best choice for a micro-controller for the µBiPed
    - Other microprocessors are now being considered

References:
[1] http://arduino.cc/en/Main/arduinoBoardMicro

Studies:

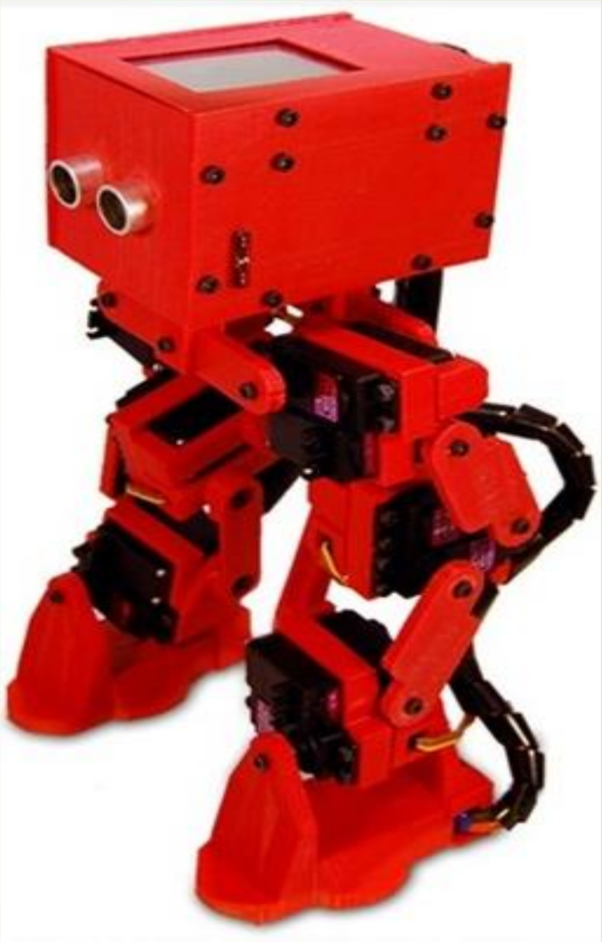
- Controllers
  - Looking if a controller needs to be made
    - Read studies on BiPeds from IEEE and see their methods
  - Can servos be controlled via PIDs or observer controllers?
    - Benefits to a PID controller vs Observer controller?
- Arduino Micro:
  - The Arduino Micro can control 12 servos, but it is limited by the amount of SRAM
    - Option: Increase SRAM with a 23A256/23K256
    - Other Options: look into variable optimization in the code.

3D - Manufacturing

By: Yakub Dure

Design:

- The µBiPed will use Jonathan Dowdall's design depicted to the right.
- It will be scaled down to fit micro-servos of dimensions 22.5x12x35.5 mm
- The upper portion of the µBiPed will still contain the ultrasonic sensor, PCB board, and microprocessor
- A mirror system will not be included as a Samsung phone will not be used
  - The phone is deemed too heavy to be lifted by the µBiPed, instead Remote Control mode will be used to control the µBiPed.

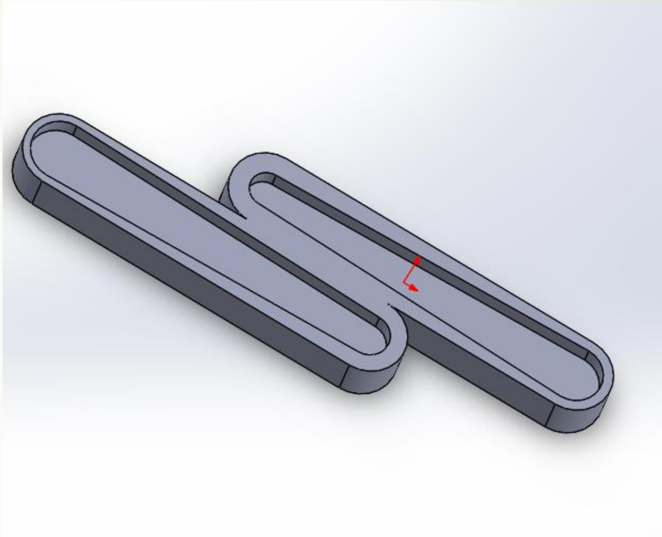


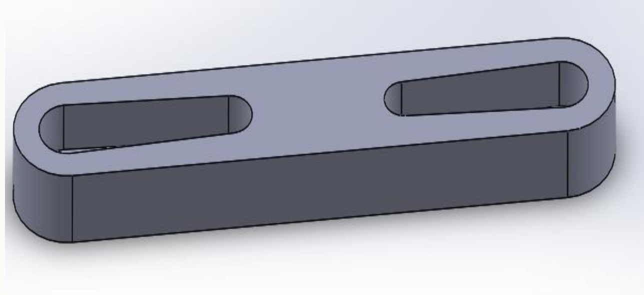
Taken from projectbiped.com see reference 1

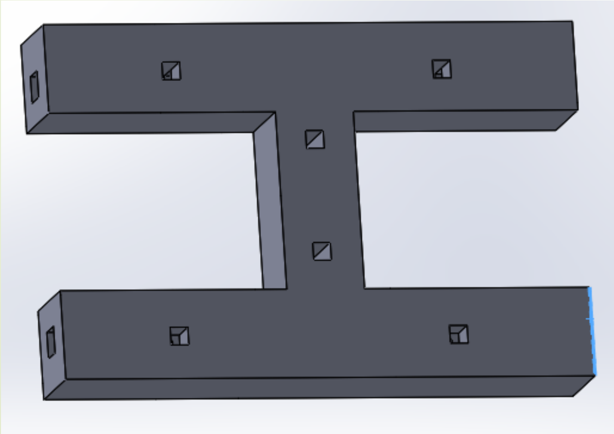
References:
[1] http://www.projectbiped.com/

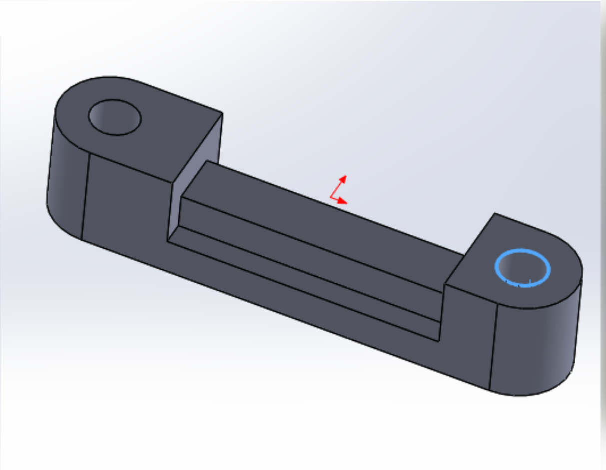
Parts Completed

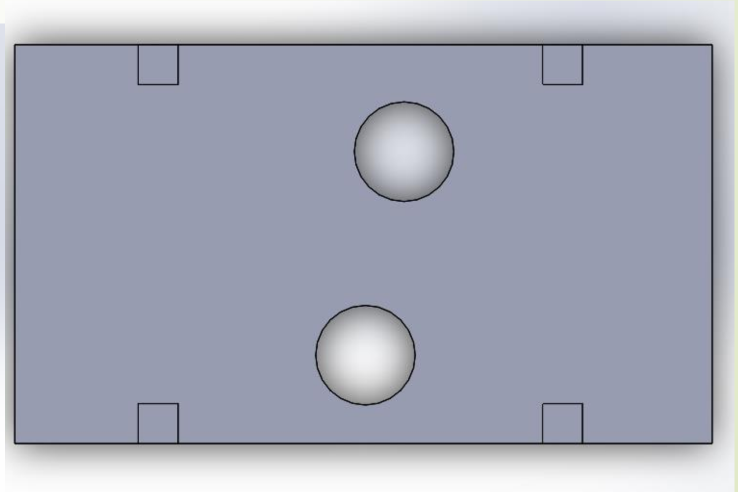
- These parts are roughly scaled to be one third of the size of ROFI parts but will eventually be modified according to the our servo
- Bearing Bar
- Servo Bracket
- Body Strut
- Body Panel – Front
- Center Bracket











PCB & Mold:

- The µBiPed group plans on creating a PCB board that will allow for the microprocessor to interface with all external devices.
  - The PCB board will be designed when parts are decided upon.
- After 3-D printing parts for the µBiPed, the group may use the 3-D prints as the bases for molding
  - Molding is to allow for stronger material to be used
  - And opportunity to switch to lighter materials if needed.

Cost and Schedule.

By: Tate McGeary

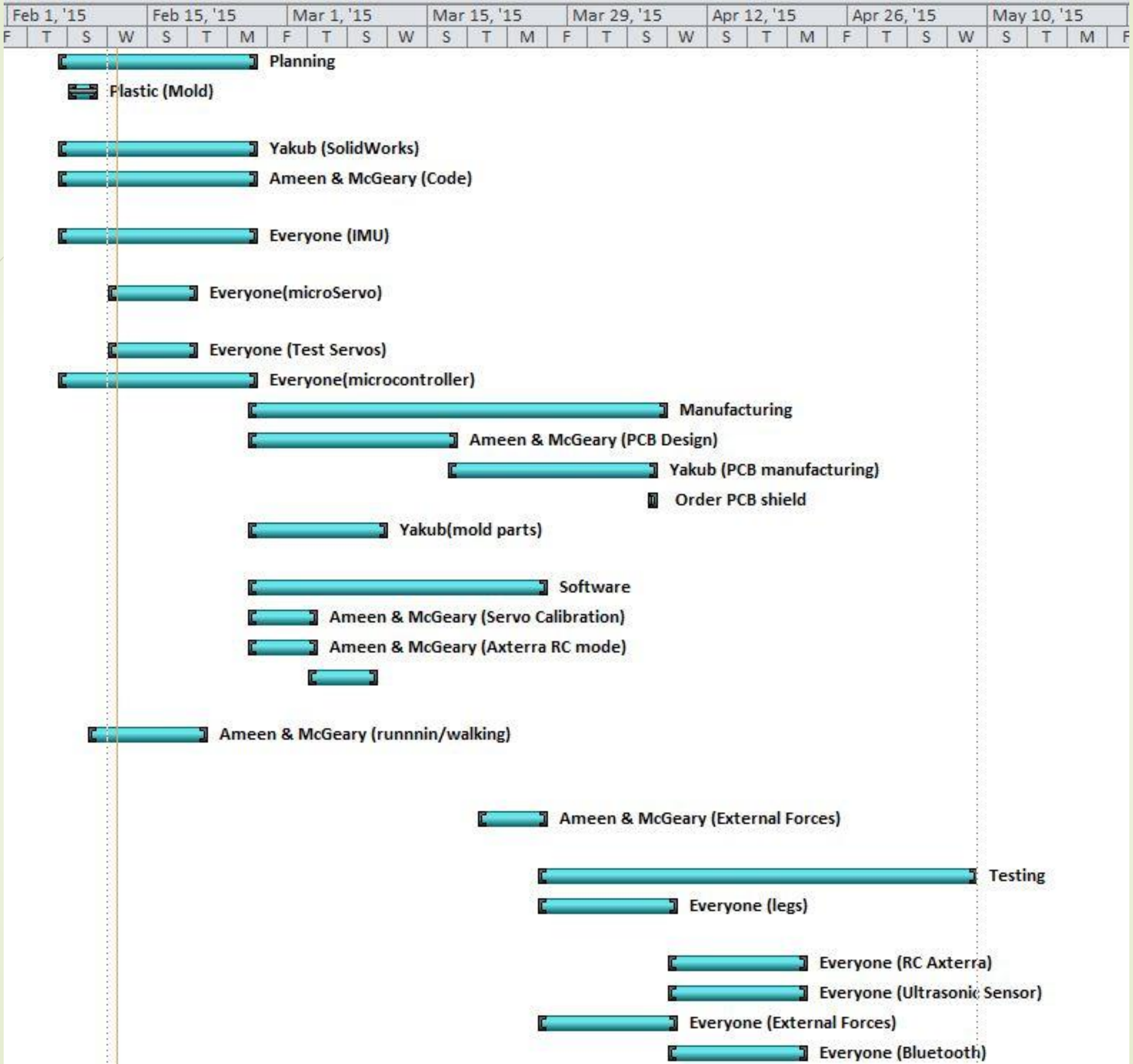
Cost of each system:

System	Cost ($)	Margin Cost ($)
Systems and Test	0	0
Sensors, Actuators, and Power	129.59	15.66
Control and Image Processing	0	00
Manufacturing	193.15	28.97
Total	322.74	44.63

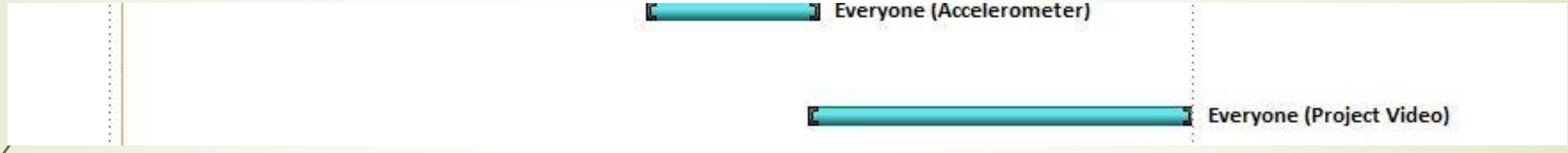
*To see estimation of cost total cost and break down of all parts go to Appendix B.

Schedule:

		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	% Complete
1			**Planning**	14 days	Fri 2/6/15	Wed 2/25/15		Planning	0%
2	✓		Choose material for skeleton	2 days	Sat 2/7/15	Mon 2/9/15		Plastic (Mold)	100%
3			SolidWorks Model	14 days	Fri 2/6/15	Wed 2/25/15		Yakub (SolidWorks)	0%
4			Reviewing previous code	14 days	Fri 2/6/15	Wed 2/25/15		Ameen & McGeary (Code)	0%
5			Accelerometer/Gyro IMU	14 days	Fri 2/6/15	Wed 2/25/15		Everyone (IMU)	0%
6			Choose/buy microServos	7 days	Wed 2/11/15	Thu 2/19/15		Everyone(microSer	0%
7			Test microServos	7 days	Wed 2/11/15	Thu 2/19/15		Everyone (Test Ser	0%
8			Choose microcontroller	14 days	Fri 2/6/15	Wed 2/25/15		Everyone(microcor	0%
9			**Manufacturing**	**30 days**	**Wed 2/25/15**	**Tue 4/7/15**		**Manufacturing**	**0%**
10			PCB Design	15 days	Wed 2/25/15	Tue 3/17/15		Ameen & McGeary	0%
11			PCB Manufacturing	15 days	Tue 3/17/15	Mon 4/6/15		Yakub (PCB manufa	0%
12			Order/ship PCB shield	1 day	Mon 4/6/15	Mon 4/6/15		Order PCB shield	0%
13			Print 3-D parts/Mold Parts	10 days	Wed 2/25/15	Tue 3/10/15		Yakub(mold parts)	0%
14			**Software**	22 days	Wed 2/25/15	Thu 3/26/15		Software	0%
15			Servo calibration/center	5 days	Wed 2/25/15	Tue 3/3/15		Ameen & McGeary	0%
16			Interface Andriod ADK	5 days	Wed 2/25/15	Tue 3/3/15		Ameen & McGeary	0%
17			Interface Axterra RC mode	5 days	Tue 3/3/15	Mon 3/9/15			0%
18			Modify Run/Walking code to allow for stepping over	10 days	Mon 2/9/15	Fri 2/20/15		Ameen & McGeary (runnnin/walking)	0%
19			Modify external force code	5 days	Fri 3/20/15	Thu 3/26/15		Ameen & McGeary (External Forces)	0%
20			**Testing**	32 days	Thu 3/26/15	Fri 5/8/15		Testing	0%
21			Test leg with new microServos	10 days	Thu 3/26/15	Wed 4/8/15		Everyone (legs)	0%
22			Test Axterra RC mode	10 days	Wed 4/8/15	Tue 4/21/15		Everyone (RC Axter	0%
23			Test Ultrasonic Sensor	10 days	Wed 4/8/15	Tue 4/21/15		Everyone (Ultrason	0%
24			Test External Forces	10 days	Thu 3/26/15	Wed 4/8/15		Everyone (External	0%
25			Test Bluetooth	10 days	Wed 4/8/15	Tue 4/21/15		Everyone (Bluetoo	0%



Feb 1, '15
Feb 15, '15
Mar 1, '15
Mar 15, '15
Mar 29, '15
Apr 12, '15
Apr 26, '15
May 10, '15
Planning
Plastic (Mold)
Yakub (SolidWorks)
Ameen & McGeary (Code)
Everyone (IMU)
Everyone(microServo)
Everyone (Test Servos)
Everyone(microcontroller)
Manufacturing
Ameen & McGeary (PCB Design)
Yakub (PCB manufacturing)
Order PCB shield
Yakub(mold parts)
Software
Ameen & McGeary (Servo Calibration)
Ameen & McGeary (Axterra RC mode)
Ameen & McGeary (runnnin/walking)
Ameen & McGeary (External Forces)
Testing
Everyone (legs)
Everyone (RC Axterra)
Everyone (Ultrasonic Sensor)
Everyone (External Forces)
Everyone (Bluetooth)


Everyone (Accelerometer)
Everyone (Project Video)

References:

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Appendix A - Servos

Name	Torque	Speed	Weight	Rotation	Price
HK15178	1.2kg/cm(4.8v) 1.4kg/cm(6v)	0.10/60deg @ 4.8v, 0.09/60deg @ 6v	10g	180 deg.	$3.33
Savox SH-0256 ultra torque	6.0V: 63 oz-in / 4.6 kg-cm	6.0V: 0.16 sec/60°	15.8g	180 deg.	$27.99
MG90S	1.8kg/cm(4.8v) 2.2kg/cm(6v)	0.11sec/60degree(4.8v), 0.10sec/60degree(6v)	13.4g	180 deg.	$4.96
TGY-50090M	1.6kg.cm (4.8v)2 kg.cm (6.0v)	0.08 sec/60deg (4.8v) 0.07 sec/deg (6.0v)	9g	180 deg.	$4.99
Turnigy D56LV	0.58kg/cm(3.7v) 0.89kg/cm(5.5v)	0.13s(3.7v) 0.10s(5.5v)	5.6g	180 deg.	$6.93

Appendix B: Cost Breakdown

Parts	Quantity	Price	Subtotal	Margin (%)	Margin ($)
Microservo	12	$ 4.00	$ 48.00	15	$ 7.20
#1585 2 Layer PCB	1	$ 43.15	$ 43.15	15	$ 6.47
Battery charger	1	$ 15.00	$ 15.00	10	$ 1.50
Gyro	1	$ 12.00	$ 12.00	15	$ 1.80
Bluetooth	1	$ 9.00	$ 9.00	10	$ 0.90
Radio Shack Ping Ultra-Sonic Range Finder Distange Sensor by Parallax for Arduino and More 276-0031 28015	1	$ -	$ -	15	$ -
Battery	2	$ 23.05	$ 46.10	15	$ 6.92
Microcontroller	1	$ 18.65	$ 18.65	10	$ 1.87
Silicone Mold Maker	5	$ 15.00	$ 75.00	15	$ 11.25
Casting Resin	5	$ 13.00	$ 65.00	15	$ 9.75
Epoxy	1	$ 10.00	$ 10.00	15	$ 1.50
A26509-40-ND CONN HDR BRKWAY	2	$ 1.82	$ 3.64	15	$ 0.55
CONN FEMALE 34POS	1	$ 1.53	$ 3.06	15	$ 0.46
S7004-ND CONN HEADER FEMALE 6POS	3	$ 0.68	$ 2.04	15	$ 0.31
S5520-ND CONN HEADER FEMALE 12POS	1	$ 1.53	$ 1.53	15	$ 0.23
Splitter Parallel Battery Connector	1	$ 5.99	$ 5.99	15	$ 0.90
Connector Adapter Plug Converter	1	$ 6.99	$ 6.99	15	$ 1.05
Shipping Costs and Tax		$ 30.00	$ 30.00	15	$ 4.50
		All Parts	$ 395.15	Margin (+/-)	$ 57.14