Spring 2015 µBiPed Perliminary Design Document

µBiPed Project Spring 2015

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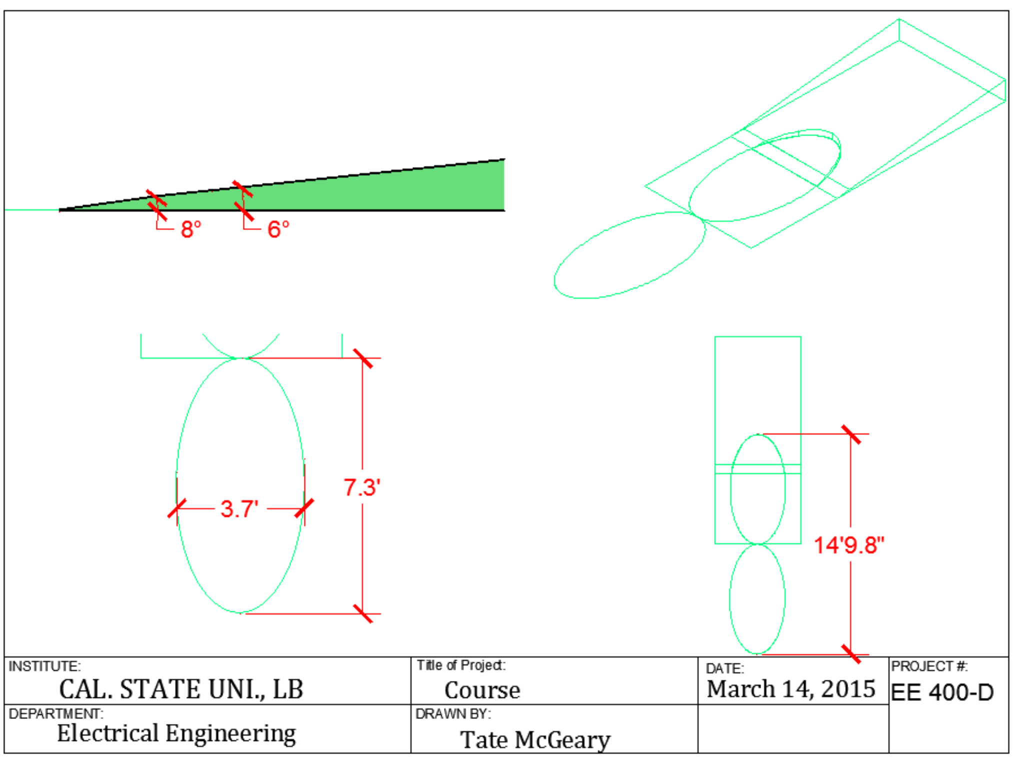
Mission Objective:

The project mission is inspired by the BiPed designed by Jonathan Dowdall of Project Biped, completed in previous semesters of EE 400D. The goal is to scale down the BiPed design by changing standard servos to micro servos to yield the µBiPed, which will result in design changes to the robot. The robot must be able to communicate and be controlled by the Axterra™ application. The final deliverable of this project is to have the µBiPed maneuver through an obstacle course, while being able to resist outside disturbances.

Mission Profile:

The µBiPed must complete an obstacle course on a figure 8 track in a time of **TBD** (not yet specified). The obstacle course will require the µBiPed to cross over a threshold, at approximately a 45° angle and a 2 cm height. From there the µBiPed must ascend an incline that is initially an 8° slope which then decreases to a 6° slope. Half way through the course the µBiPed must then start its descent down the incline towards the threshold again crossing over it at about a 45° angle proceeding towards its start position until an object (i.e. a wall) causes the µBiPed modify its path. Additionally the µBiPed must be able to withstand external disturbances as per requirements. Finally the µBiPed must be able to traverse multiple types of surfaces which will include carpet, linoleum tile, and rubber. All of this must be completed while using the Arxterra™ interface as per requirements. It has also been specified that microServos must be used.



Any requirements marked **TBD in this document means that testing needs to be done, or the values have to be specified due to lack of information. To correct the **TBD** more research and testing of various parts will have to be performed.*

Requirements:

Level 1

1. The µBiPed must be finished by the 8th of May, 2015 to correspond with the duration of the EE 400D class.
    a. **Verification:** http://web.csulb.edu/divisions/aa/calendars/documents/2014-2015_academic_calendar_updated.pdf
2. 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.
    a. **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.
3. 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.
    a. **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.
4. 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.
    a. **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.
5. The µBiPed must walk on surfaces of varying friction coefficients:
    a. Carpet: 1.0 static [1]
    b. Linoleum: 0.5 static [2]
    c. **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.
6. 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.

   a. **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.

7. 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.
   a. **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.
8. 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.
   a. **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.
9. The µBiPed must be miniaturized as is dictated by its own name, size **TBD**.
   a. **Verification:** The µBiPed will have its size miniaturized compared to its larger model. Measurement will be done with a ruler or equivalent.

Level 2

1. 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.*
   a. **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.
   b. http://www.arxterra.com/ultrasonic-sensor-examination/
2. The µBiPed will use a gyro, type TBD, in order to allow for completion of *requirement 2, level 1*, and *requirement 6, level 1.*
   a. **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.
3. In order to successfully miniaturize the µBiPed, micro-servos will be used. Type of micro-servos are MG90s 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.

a. **Verification:** Micro-servos will be tested on strength and maximum load they can handle based off the load bearing tests.

4. 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.

    a. **Verification:** Microcontroller will be tested if it can control at least 12 servos and facilitate the additional components needed to implement the µBiPed.

5. 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.

    a. **Verification:** A continuity test to verify proper wiring layout of the PCB.

6. 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.***

    a. **Verification:** Will test the µBiPed with various types of tread to see the traction difference.

7. In order to keep within the specified size restriction, the µBiPed will have light weight batteries. Type of batteries are **TBD**

    a. **Verification:** Testing and calculations will be performed before selection.

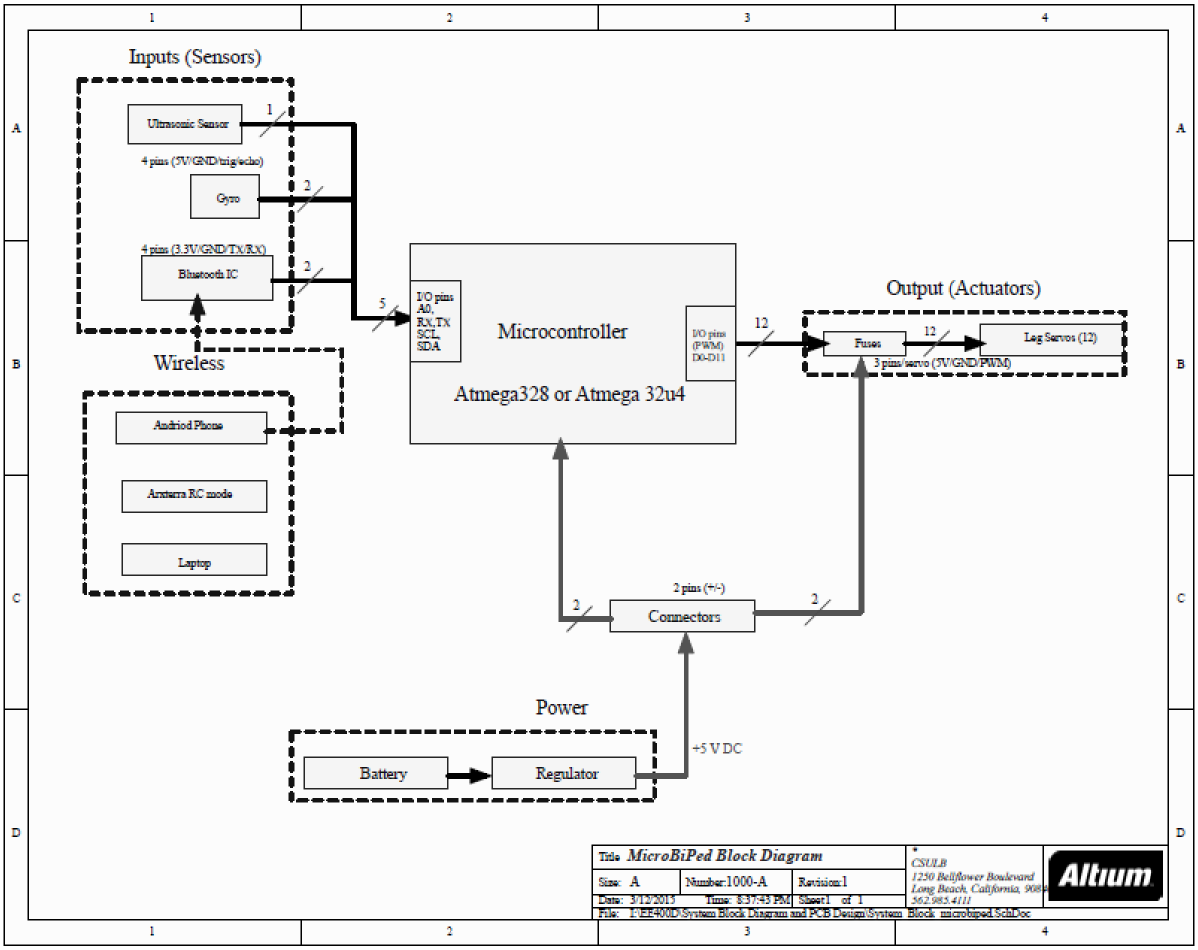
8. A light weight material must be used for the frame in order to keep within the specific mass restrictions of the µBiPed; the type of material is **TBD**. Testing must be done as to whether or not the µBiPed can be made of plastic, or if a lighter material must be used.

    a. **Verification:** Different materials will be strength tested and weighed. Strength testing will be verified by hand, and weight will be verified with a scale.

9. 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.***

    a. **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.

System Block Diagram



The µBiPed consists of three systems: inputs, microcontroller, and outputs. The inputs consist of three types of sensors, a Bluetooth IC (HC-06), ultrasonic sensor (HS-SR04), and a gyro (TBD), which are all for the µBiPed to receive commands and signals to move in a human like fashion. The microcontroller consists of an ATmega processor (TBD) which will receive the signals form the sensors to output the desired outcome to the servos. The outputs consist of twelve servos controlled by PWM transmitted from the microcontroller.

Trade off Studies

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

1. Servo Comparison
   a. The above is a chart of four possible servos the µBiPed project is looking into, that compares torque, speed, weight, rotation, and price.
   b. Torque is important because if the servos do not have enough torque the µBiPed will not move.
   c. Speed and weight are important for the sizing of the batteries.
      i. Heavier servos means larger batteries
      ii. Slower servos means larger batteries due to a larger operation time to complete the course
   d. Rotation is important because a 90 degree servo will not have the necessary movement to complete the required range of motion.
   e. Pricing is a desired aspect to know because if two components have similar specifications the lowered priced component will be chosen.
   f. After comparing the servos on the table above the µBiPed group landed on the MG90S to use in the project for couple of reasons:
   g. Although HK15178, TGY-S0090M, and Turnigy D56LV have less weight than MG90S, they don't have as much torque to move the µBiPed
   h. The Savox SH-0256 ultra-torque would be the best servo to use, but from the budget standpoint the project can't afford to pay $27.99 per servo
   i. Available in the U.S which means fast shipment because some servos from outside the status take longer time to be delivered which will result in a delay through the µBiPed project
2. Frame material comparison
   a. Molding is a manufacturing process which involves pouring a liquid molding material in a hollowed block which is then allowed to settle and solidify into the shape of the desired object.
   b. The material that may be used for the project is the Polyvinyl chloride (PVC). The material is perfered because of its light weight characteristics, strength, and availability. In addition it is also available in rigid and flexible forms.
      i. Tensile strength is 2.60 N/mm²
         Notched Impact Strength 2.0 - 45 Kj/m²
         Density1.38 g/cm3
         The mass per cubic cm is 1.38 g which makes it extremely light weight material

c. The above information means that it is a light weight material that provides good strength however it still needs to be compared to the 3-D print parts. Once a comparison is done the µBiPed will choose between the two materials.
d. Look into weight of a 3-D print object

3. Foot-tread comparison
   a. Compare rubber, carpet, and plastic tread
      i. Which material has the greatest coefficient of friction across all three surface types in the course will be chosen.
      ii. Research into the different friction coefficients between different surfaces will be done.

4. Battery type comparison

Feature	**NiMH**	**LiPO**
Weight	0.6 Wh/gram	0.132 Wh/gram
Rated Voltage	1.25 V	3.7 V
Safety	Safe	Dangerous

   a. The above chart compares four products from different vendors of different types and ratings.
   b. When comparing the two types of batteries it is important to take note of the comparative safety issues with both batteries as well mass, voltage and power per a gram. For NiMH the battery is composed of relatively safe chemicals when compared to LiPO. However at the cost of this safety the NiMH does not deliver as much voltage nor does it have as much power density when compared to the LiPOs. This means that for the µBiPed a NiMH may be safer to use but it may be too heavy for the servos. If this happens that means a different type of battery will have to be chosen, most likely a LiPO or similar lithium type battery.

Rapid Prototyping

In order to test the µBiPed, the code form Dr. Dowdall will be uploaded onto an ATmega microcontroller but will be modified to control only six servos. The choice of six servos is to allow for the manipulation of one leg. The purpose is to experiment with leg motion. As the µBiPed is required to step over an object of a certain height, it is important to track the default motion of the leg. This means that if the default movement of the legs does not rise of the 2 cm height a modification to the code will have to be made in order to allow for the ability to walk over an object of 2 cm.

Interface Definitions

1. Input Sensors
   a. Ultrasonic Sensor – HC-SR04

i. The ultrasonic senor will connect to an analog pin on the microcontroller from its trigger pin. It will be used to detect obstacles in the way of the robot and prevent the µBiPed from hitting the object.
ii. Primary reasons for the choice is because it is less susceptible to noise and cost; in addition, the project has one in inventory.

b. Gyroscope
   i. The gyroscope will be attached to the SDA and SCL pins for the microcontroller. The gyroscope will be used to keep track of the orientation of the µBiPed and make slight corrections so that the µBiPed will remain balanced.
   ii. Type: **TBD**

c. Bluetooth IC – HC-06
   i. This a slave Bluetooth device attached to the RX and TX pins of the microcontroller. The HC-06 will be used to communicate to an Android phone and receive commands from the Arxterra™ application.

2. Microprocessor
   a. The microprocessor will need to use a ATmega microcontroller that is light weight and allows for the use of Dowdall's code and Arduino IDE.
      i. Requirements of the microprocessor:
         1. Dynamic memory or SRAM: 4.7 KB
         2. Flash memory: 14 KB
      ii. Meeting these requirements are imperative for the µBiPed group because the variable initialization does not take up the most dynamic memory in fact only about 17% of the dynamic memory is used by the global variables. This was done by parsing out the code and checking which lines use the most memory. Rather the lines of code that use the **map()** function require the most dynamic memory.
         1. **Map()** remaps the range of a variable for the code made by Dr. Dowdall that equates to long arrays.
   b. Type: **TBD**

Pin definitions for an Arduino Micro™: (Subject to change by CDR)

ARDUINO ATmega 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

GYRO (TBD)

PIN	SYMBOL	FUNCTION
1	GND	GORUND
2	VCC	VOLTAGE SOURCE
3	SCL	SERIAL CLOCK LINE
4	SDA	SERIAL DATA LINE
5	SD0	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	⟷	21	A0
BROWN	B	⟷	-	-
RED	R	⟷	-	-
ORANGE	O	⟷	22	A1
BROWN	B	⟷	-	-
RED	R	⟷	-	-

The above tables show how the pinouts for the each component to be used. The pinout is done in assumption of using an ATmega32u4, however the ATmega 32u4 may be changed if the code provided by Dr. Dowdall cannot have the dynamic memory usage reduced.

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

The above is a project cost breakdown of the µBiPed. The cost is developed from an estimate of what materials may need to be used or bought in order to complete the µBiPed by the end of the semester. The margin of 15% is chosen for parts that have over a $20 gap from highest to lowest, while a 10% margin is chosen for parts with less than a $20 dollar gap between highest and lowest. The goal of the project is keep it below 400 dollars, which each member of the team willing to front some the cost. The price for each member will be ≈$100.

Power breakdown

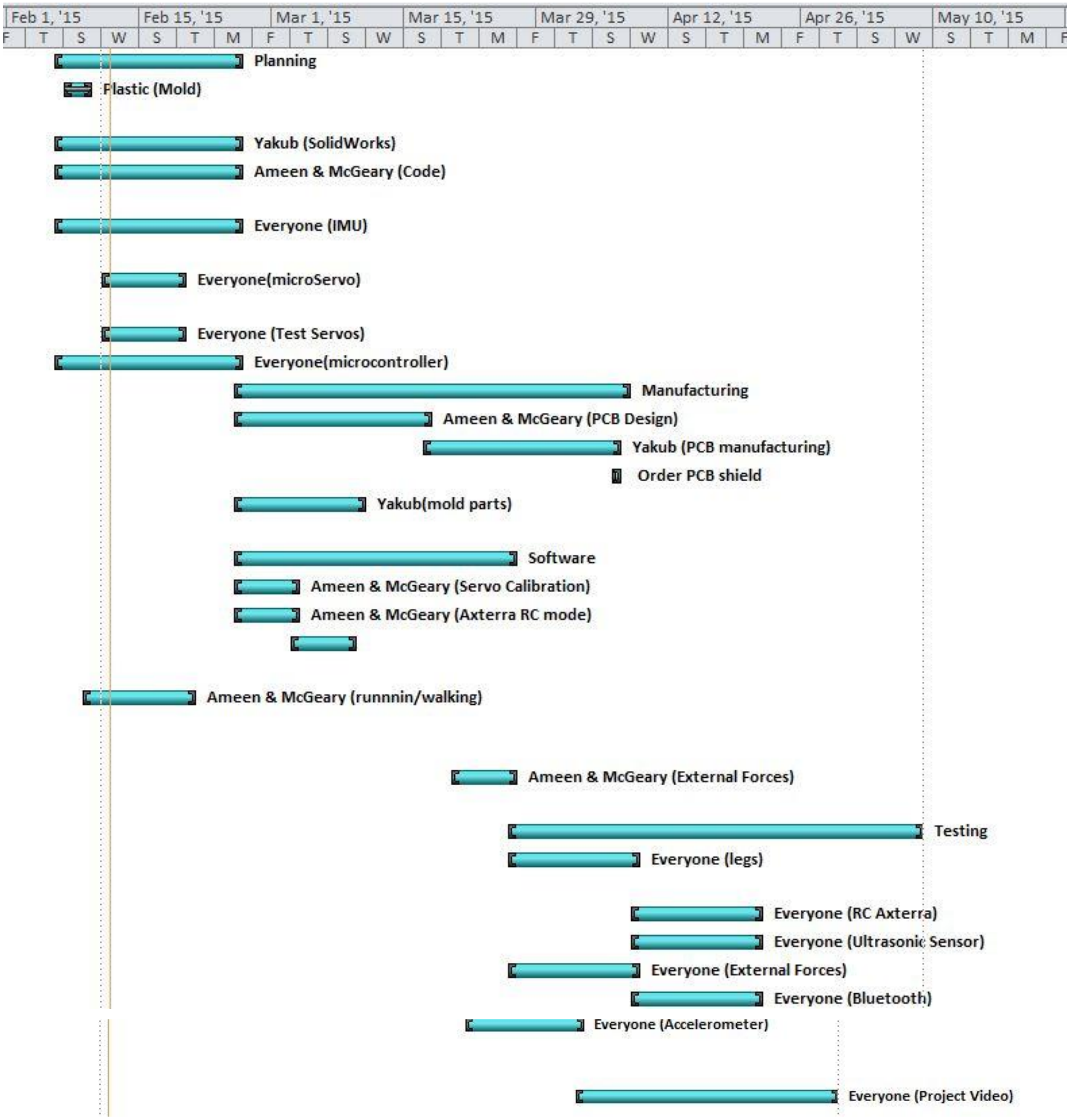
Device	Quantity	Operating DC Volt. (v)	Min Current (mA)	Max Current (mA)	Ave. Current (mA)	Total Current (mA)	Power (mW)	Margin of error
Micro Arduino	1	5	40	50	45	45	225	15%
Micro servos MG90S	12	5	230	420 (stall)	325	3900	19500	15%
HC- SR04 Ultrasonic Sensor	1	5	10	20	15	15	75	15%
Gyro	1	3.6	6	10	8	8	28.8	15%
HC-06	1	3.3	10	40	25	25	82.5	15%
Total						3993	19911.3	

The power breakdown is a projected estimation based off of values obtained from the data sheets of the parts. The margin of error is the percent the project is willing to tolerate being off from the theoretical values. When the power breakdown is finalized it will be used to find the best battery for the project that is both lightweight and delivers the desired amount of voltage.

Project Schedule

The following is a project schedule for the µBiPed group. The schedule is subject to change as the semester proceeds. It should be noted that a new schedule is being worked out as well in order to compensate for the already changed 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 (Bluetoot	0%
26			Test Accelerometer/Gyro IMU	10 days	Thu 3/26/15	Wed 4/8/15		Everyone (Accelerometer)	0%
27			Create Project Video	23 days	Wed 4/8/15	Fri 5/8/15		Everyone (Project \	0%



Personnel Breakdown

Ameen Alattas:

1. Doing a trade-off study of which servos to choose and why.
   a. See trade-off study
2. Once servos are chosen test the actuators for movement
   a. Tools needed:

b. Jump wires
c. Arduino ATMega328
d. USB connection
e. MG90S servo
f. Breadboard
g. Laptop
h. Pencil 7 cm - 11 cm
i. TBD
j. For testing the servo, the µBiPed group attached a pencil to the servo and we hanged about 110g to the pencil that located 7 cm away from the servo. The servo was able to lift the weight without any problems. We still need to know when the servo going to fail by incrementing weight, but we still waiting for the scalar to be delivered.
k. During the test, the maximum current needed is 236 mA without any weight attached to the servos. When 110g was added to the servo arm the maximum current increased from 236 mA to 321 mA.

3. Look for a 3-D gyroscope suitable for the needs of the project

4. Test the HC-SR04 if it is a suitable sensor for the project

   a. Tools needed:
   b. Jump wires
   c. Arduino ATMega328
   d. USB connection
   e. Ultrasonic sensor HC-SR04
   f. Breadboard
   g. Labtop
   h. LED
   i. Procedure:
      i. Attach Ultrasonic Sensor to the breadboard and attach 4 wires from the rails corresponding to the pins on the ultrasonic sensor.
      ii. Connect pin 13 on the arduino to trigger pins on ultrasonic sensor on breadboard.
      iii. Connect pin 5V on the arduino to 5V pin on ultrasonic sensor on breadboard.
      iv. Connect pin GND on the arduino to GND pin on ultrasonic sensor on breadboard.
      v. Connect pin 12 on the arduino to echo pin on ultrasonic sensor on breadboard to the 5-volt pin on the arduino
      vi. Connect led to indicate the distance the sensor can sense an obstacle. In our case we connected a led to pin 11 and GND on the arduino to the breadboard.
   j. Test result:

        i. The test was a success! The sensor could detect an object within 5-5.5cm, which will give ROFI Jr a plenty of time to avoid an obstacle in its way
        ii. Range the sensor could sense an obstacle reliably is 2cm – 397cm

Mesfer Aldosari:

1. Investigating into methods of reducing SRAM in the code provided by Johnathan Dowdall or look into possible methods of increasing SRAM.
2. Investigateing types of batteries
    a. See trade-off study
3. Make sure the mass of parts do not exceed the weight limit of the servos
    a. Working in tandem with Ameen Alattas

Yakub Dure:

1. Finishing SolidWorks™ design of the µBiPed designed around a micro-servo
2. Looking into different materials for possible use in the skeleton of the BiPed
    a. Advantages or disadvantages to 3-D printed parts compared to molded parts
3. Looking into PCB design
4. Learning 3-D printing methods and which materials can be used

Tate McGeary

1. Going over code
    a. In the course analyzing the code provided by Dr. Dowdall it was determined that the majority of SRAM is used during the functions that use the **map()** function. Currently, the group analyzing what the function does and if alternative methods can be used instead of the **map()** if the problem persists through the alteration of the lines of code that use **map()** other methods will have to be looked at.
2. Control systems
    a. Most like will use a PID controller for the gyroscope if the servos allow for the usage.
    b. Potential problems may occur in how most servos function.
        i. Most servos function off of a step or PWM type system. This means that a servo has a predefined length of motion when hit with a PWM. The duration of the PWM will dictate what position the servo move towards. Most servos have a microcontroller in their internals, which contain a controller usually PID. This means that due to the fundamental function of a servo a controller may not be used.
        ii. Currently research into possibilities of implementing a controller to maintain stability.

Sources

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