Velociraptor Fall 2016

Validation/Verification Report

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Contents

L1-1 Project Cost

Level: System

Requirement: 3rd Generation Velociraptor (Th) budget should not cost more than $150.00. This estimate is based upon Customer and Project Team agreement on October 7th, 2016.

Type: Should

Method: Analysis

Test Objective: Verify that the budget for Velociraptor (Th) is not greater than $150.00.

Responsible Division: PM

Tools:

- Fall 2016 Velociraptor BoM/Reimbursement

Criteria for Success:

1. The total cost of materials for the project will not exceed the budget limit of $150

Procedure:

1. Print Fall 2016 Velociraptor (Th) Reimbursement Form
2. PM reports the value of the BoM to be compared with the budget set by the customer

Receipt	Vendor	Item	Unit Price (including shipping)	Quantity EE Dept. /Total	EE Dept. Extended Cost	Victoria Osaji Purchase	Kevin Armentrout Purchase	Paul Ahumada Purchase
1	OSH Park	External PCB	$24.05	1	$24.05	$24.05	-	-
2	OSH Park	Stencils	$13.28	1	$13.28	$13.28	-	-
3	Digi Key	SMD's	2.66	1	$2.66	-	$2.66	-
4	TI	A to D Converter	3.30	1	$3.30	-	$3.30	-
5	SparkFun	IMU, SMD's	31.08	1	$31.08	-	$31.08	-
6	Lowe's	Hardware	21.34	1	21.34	-	-	$21.34
				Total:	**$95.71**	$37.33	$37.04	$21.34

Conclusion:

The Fall 2016 Velociraptor (Th) Budget of $95.71 is below $150. Therefore, the Velociraptor is successfully below budget.

L1-2 Project Schedule

Level: System

Requirement: 3rd Generation Velociraptor (Th) Project Schedule shall perform during EE 400D Final for Wednesday Section on December 14, 2016 per CSULB Calendar 2016-2017 Final Schedule at 9am.

Type: Shall

Method: Analysis

Test Objective: Verify that the Project is ready to be demonstrated on during the final.

Responsible Division: PM

Tools:

- Printed Validation and Verification report
- Velociraptor (Th) Robot

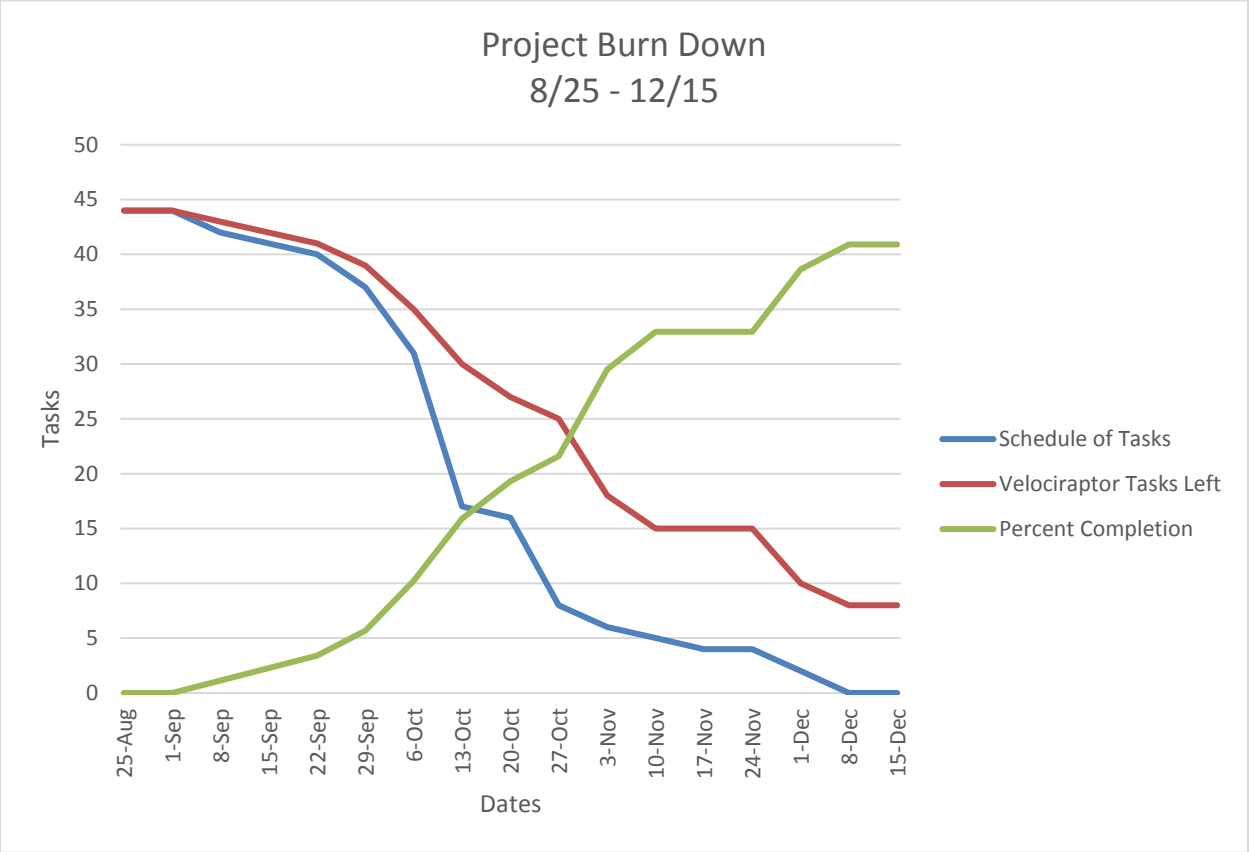
Criteria for Success:

1. Each requirement is evaluated by the customer and is determined whether it is a Pass/Fail based on results and conclusion.
2. Exclude requirements that are demonstrations that will have their results and conclusion evaluated during the game.

Procedure:

1. Fill out Validation and Verification Print Fall 2016 Velociraptor (Th) Validation and Verification Report
2. Provide customer with Validation and Verification Report

Results:



Conclusion:

The schedule shows that the Project did not complete what it was intended to. There was no implementation of the UCI or Theo Jansen legs which resulted in the incompletion. Also, do to setbacks from the complexity of the mechanical design, the control algorithms needed for the robot were put on hold.

L1-3 Appearance

Level: System

Requirement: 3rd Generation Velociraptor (Th) should resemble a Velociraptor of the Theropodous Dinosaur Suborder that is scaled down to below the height of the columns in the game.

Type: Should

Method: Inspection

Test Objective: Observe that the Velociraptor (Th) resembles a velociraptor.

Responsible Division: MFG

Tools:

- Image of Velociraptor
- Velociraptor (Th) Robot

Criteria for Success:

1. The robot passes visual inspection from the customer that the Velociraptor (Th) resembles a velociraptor dinosaur

Procedure:

1. Set up Velociraptor(Th) Robot for Customer
2. Customer visually inspects Velociraptor (Th)

Conclusion:

L1-5 3DoT

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) will use a 3DoT board.

Type: Will

Method: Demonstration

Test Objective: Observe that the Velociraptor (Th) operates from the control of the 3DoT Board and uploaded code.

Responsible Division: E&C

Tools:

- Arduino IDE
- Micro USB cord
- Velociraptor (Th) Robot
- 3DoT Board
- Arxterra Control Panel
- Phone with Arxterra App

Criteria for Success:

1. The robot operates from commands sent by the Arxterra app to 3DoT Board

Procedure:

1. Turn on Arduino IDE
2. Open code for Velociraptor (Th)
3. Attach 3DoT Board
4. E&C uploads code to the 3DoT board
5. Assemble 3DoT board into Velociraptor (Th)
6. Open Arxterra App on Phone
7. Connect Phone to Arxterra Server via community mode
8. Connect phone to 3DoT board via Bluetooth on Arxterra App
9. Send commands to 3DoT Board

Conclusion:

L1-8 Duration

Level: System

Requirement: 3rd Generation Velociraptor (Th) shall operate for a minimum of one hour with a Power Resource of 2350 mA-hours.

Type: Shall

Method: Test

Test Objective: Observe that the Velociraptor (Th) average current draw is less than the Power Resource of 2350 mA-hours.

Responsible Division: ALL

Tools:

- Arduino IDE
- Micro USB cord
- Velociraptor (Th) Robot
- 3DoT Board
- Arxterra Control Panel
- Phone with Arxterra App
- Ammeter

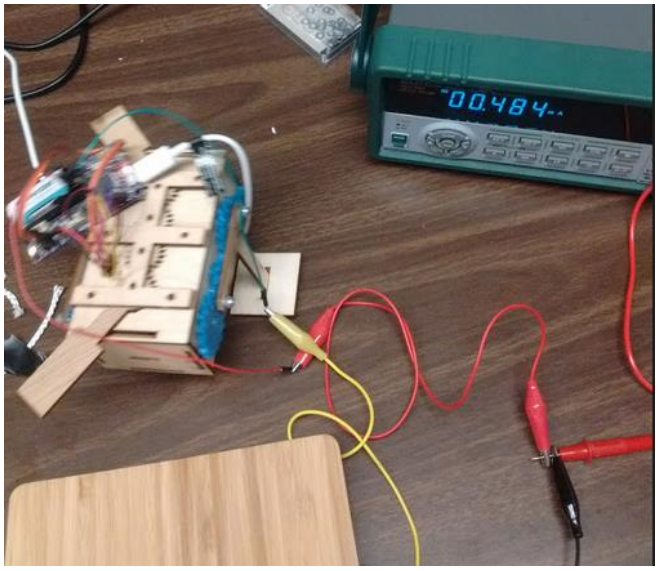
Criteria for Success:

1. Measured current draw from Velociraptor is less than Power Resource of 2350 mA-hours.

Procedure:

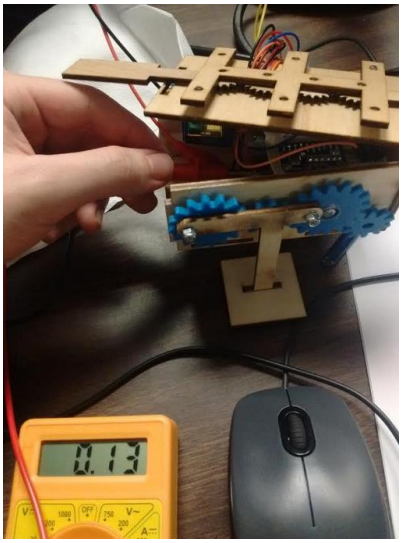
1. Turn on Arduino IDE
2. Open code for Velociraptor (Th)
3. E&C uploads code to the 3DoT board
4. Assemble 3DoT board into Velociraptor (Th)
5. Connect Ammeter in series with external
6. Open Arxterra App on Phone
7. Connect Phone to Arxterra Server via community mode
8. Connect phone to 3DoT board via Bluetooth on Arxterra App
9. Send forward command to 3DoT Board
10. Observe Ammeter current draw over 30 seconds to find average current draw during operation

Results:



Ammeter in series with battery and 3DoT Board system

The average current draw was 375mA-hours. The result is a lower than expected current with two DC motors, a servo, and a 3DoT board connected. To see if this value was accurate, the DC motor leads were disconnected and the current draw of the motor in the physical system was measured.



DC Motor

The current for one DC motor in the mechanical system was an average value of 110 mA. The verification of 110mA for the DC motor confirms the lower than expected average current of 375mA.

Conclusion:

During normal operation, the robot's current draw of 375mA-hours was less than the allotted resource of 2350 mA-Hours. The robot will successfully operate for the duration of the game.

L1-9 Custom PCB

Level: System

Requirement: 3rd Generation Velociraptor (Th) Project Schedule shall use an external PCB with an I2C Interface (JP5) as the 3DoT Board.

Type: Shall

Method: Inspection

Test Objective: Observe that the Velociraptor (Th) has an external PCB I2C interface connected to the 3DoT board's I2C interface.

Responsible Division: All

Tools:

- External PCB
- 3DoT Board
- Velociraptor (Th) Robot

Criteria for Success:

1. The external PCB has a SDA, SCL, Vcc, and ground connected to the correct pins of the 3DoT Board's SDA, SCL, Vcc, and ground.

Procedure:

1. Open the cover of the robot
2. Locate external PCB and 3DoT Board
3. Observe wire connections are in correct placement for SDA, SCL, Vcc, and ground

Conclusion:

L1-10 3DoT Library

Level: System

Requirement: The velociraptor shall use a 3DoT board library.

Type: Inspection

Method: Test

Test Objective: To see if Velociraptor group used the 3DoT library to control the robot.

Tools:

- 3DoT Board
- 3DoT Library
- External Sensors

Procedure:

1. Download the 3DoT library from the EE400D class website
2. Upload the code into the Arduino
3. Modify code for specific project
4. Upload code to 3DoT for Velociraptor (Th)

Criteria for Success: The 3DoT library will be necessary to develop the control codes for implementing the 3DoT board.

Results:

Diagram 1: Robot3DoT was the 3DoT library code we had to use in coding the velociraptor

Conclusion: The 3DoT library was modified to ensure that implementation of the 3DoT board was successful.

L2-1 Mass

Level: System

Requirement: 3rd Generation Velociraptor (Th) Project Schedule shall weigh no more than 672 grams.

Type: Will

Method: Test

Test Objective:

1. Find maximum torque for the GM9 to calculate the mass of the robot that can be driven with a 50% margin

Responsible Division: MST

Tools:

- GM9 Motor
- Power Supply
- Ammeter
- Scale

Criteria for Success:

1. The robot does not weigh more than the calculated value of mass

Procedure:

1. Connect GM9 to Power supply
2. Connect ammeter in series with Gm9 and Power Supply
3. Turn on Power Supply at 3.7V
4. Measure No-Load current
5. Find Stall current by stopping motor shaft
6. Measure stall current
7. Find Stall torque from values
8. Calculate mass at 50% margin stall torque
9. Measure mass of robot

Analysis:

A blog post to find the stall torque, .311 N-m is on Arxterra for the GM9 motor. From the Stall Torque, we can apply the equations used in PDD to determine the mass.

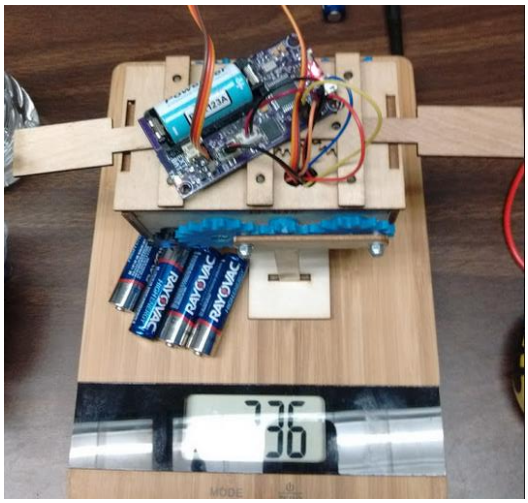
$$T = \left(\frac{m}{2}\right) * g * legRadius$$

$$m = 2 * \frac{T}{g * legRadius}$$

$$m = 1008grams$$

$$m_{50\%} = 671grams$$

The motors can move a robot at a 50% margin of mass at 671 grams.



The measured mass is 336 grams.

Conclusion:

The mass of the robot at 336 grams is less than the mass with 50% margin at 671 grams. The Velociraptor successfully meets the mass requirement.

L2-2 Turn

Level: System

Requirement: 3rd Generation Velociraptor (Th) shall turn 0-360 degrees under one minute.

Type: Shall

Method: Test

Test Objective: Apply extra mass to the robot to be equivalent to 505.5 grams.

Responsible Division: E&C

Tools:

- Velociraptor (Th) Robot
- Arxterra App
- Tape
- Timer

Criteria for Success:

1. The robot turns left and right from 0 to 360 degrees in both directions.

Procedure:

1. Turn on 3DoT Board in robot
2. Connect Arxterra phone to 3DoT Board
3. Put app into RC mode
4. Set up Timer for 1 minute
5. Press turn right button
6. Record results
7. Set up timer for 1 minute
8. Press turn left button
9. Record results

Results

Conclusion

L2-3 Custom Commands

Level: System

Requirement: 3rd Generation Velociraptor (Th) MST shall create custom commands to be used with Arxterra Control Panel;.

Type: Shall

Method: Test

Test Objective: To verify that commands not built into the Arxterra Control Panel can be sent to the robot

Responsible Division: MST

Tools:

- Arxterra App
- Arxterra Control Panel
- 3DoT Board
- CoolTerm
- Computer

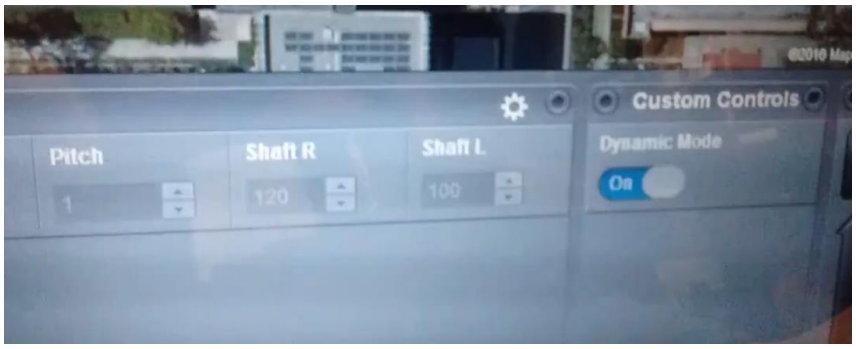
Criteria for Success:

1. A command sent from Arxterra Control Panel is read through the 3DoT board

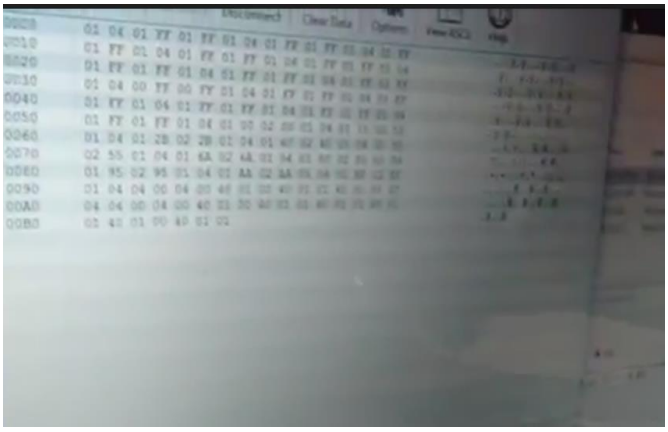
Procedure:

1. Open Arduino IDE
2. Upload code to 3DoT Board
3. Open CoolTerm
4. Connect 3DoT Board to CoolTerm
5. Open Arxterra Phone App
6. Connect Phone to 3DoT Board
7. Turn on community mode
8. On Computer, go to Arxterra Control Panel
9. Press dynamic walking button
10. Observe CoolTerm Results

Results:



Dynamic Push Button That is Pressed Repeatedly



Results on Coolterm of Dynamic Button Being Pressed

Conclusion:

The command bytes being sent for Dynamic Button are read on CoolTerm. This shows that the 3DoT board is connected to the phone, the phone is connected to the Control Panel, and the Control panel can send commands. The Velociraptor successfully meets the custom command requirement.

L2-4 IMU Sensor

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) MST shall create a custom command to be used with Arxterra Control Panel that reads pitch and roll from the IMU sensor

Type: Shall

Method: Test

Test Objective: To verify that the pitch and roll custom telemetry will be sent to Arxterra Control Panel.

Responsible Division: E&C and MST

Tools:

- Arxterra App
- Arxterra Control Panel
- Velociraptor (Th)
- Computer

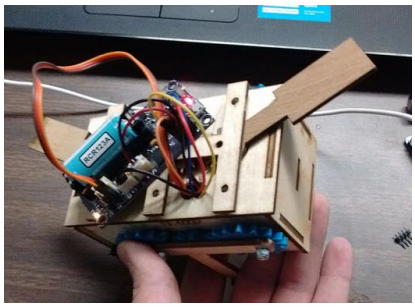
Criteria for Success:

1. As the robot tilts, the roll and pitch is read from the robot

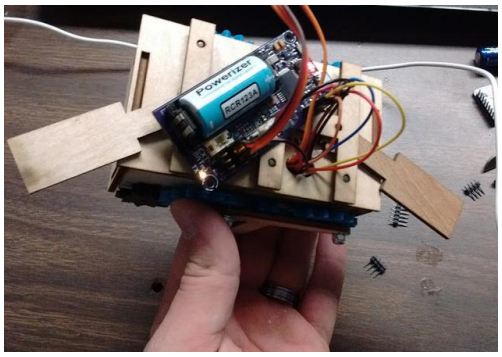
Procedure:

1. Open Arduino IDE
2. Upload code to 3DoT Board
3. Open Arxterra Phone App
4. Connect Phone to 3DoT Board
5. Turn on community mode
6. On Computer, go to Arxterra Control Panel
7. Tilt the robot
8. Observe the results of pitch and roll

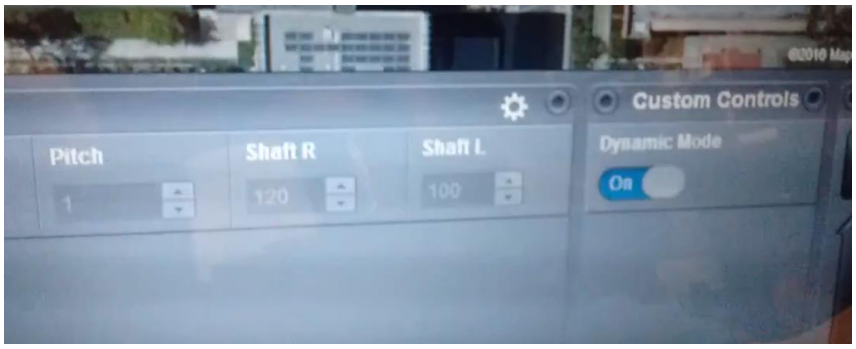
Results:



Robot Tilted Back



Robot Tilted Forward



Example Results of Pitch

Conclusion:

The robot had its pitch change and the servo reacted. The current code has it so the servo changes its position based upon the pitch angle. When the robot was tilted in different directions resulted in positive and negative angles for pitch and roll appearing on the control panel. The Velociraptor successfully meets the IMU sensor requirement.

L2-5 Rotary Sensor

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) MST shall create a custom command to be used with Arxterra Control Panel that A to D converter for the rotary sensors.

Type: Shall

Method: Test

Test Objective: To verify that the shaft positions for custom telemetry will be sent to Arxterra Control Panel.

Responsible Division: All

Tools:

- Arxterra App
- Arxterra Control Panel
- Velociraptor (Th)
- Computer

Criteria for Success:

1. As the robot shaft rotates, the roll and pitch is read from the robot.

Procedure:

1. Open Arduino IDE
2. Upload code to 3DoT Board
3. Open Arxterra Phone App
4. Connect Phone to 3DoT Board
5. Turn on community mode
6. On Computer, go to Arxterra Control Panel
7. Manually shift the leg to be in 3 different positions
8. Observe the results for each position

Results:

Conclusion:

~~L2-6 Power to External PCB~~

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) MST shall not exceed the current rating of 1 A for the LDO when supplying power to the external PCB.

Type: Will

Method: Test

Test Objective: To verify that the LDO will be protected from overheating.

Responsible Division: All

Tools:

- Arxterra App
- Arxterra Control Panel
- Velociraptor (Th)
- Ammeter

Criteria for Success:

1. During operation, the current will be measured between the Vcc in the 3DoT board and the External PCB 3.3V and be under 1A.

Procedure:

1. Open Arduino IDE
2. Upload code to 3DoT Board
3. Open Arxterra Phone App
4. Connect Phone to 3DoT Board
5. Turn on community mode
6. On Computer, go to Arxterra Control Panel
7. Connect the ammeter in between the 3DoT board Vcc and PCB external 3.3V
8. Observe results

Results:

Conclusion:

L2-7(A-C) Structural Test (1-3)

Level: System

Requirement: 3rd Generation Velociraptor (Th) MST shall support the mass of the robot with a 50% margin, 508g, in three different positions.

Type: Shall

Method: Test

Test Objective: To verify the leg mechanism can stand at different positions of the leg positions

Responsible Division: MFG

Tools:

- Velociraptor (Th)
- Weight equivalent to 508g
- Tiny box

Criteria for Success:

1. The robot is placed upside down and has mass of 508g on its feet
    a. Position A (0 degrees) – Foot steps down on ground
    b. Position B (90 degrees) – Center of foot path on ground
    c. Position C (180 degrees) – Time before foot comes of ground

Procedure:

1. Put robot upside down to where it's back is parallel to the ground
2. Put mass in tiny box
3. Weigh mass and box to be 508g
4. Put leg to Position A
5. Place mass on Position A and record results
6. Put leg to Position B
7. Place mass on Position B and record results
8. Put leg to Position C
9. Place mass on Position C and record results

Results:

Position A

Position B

Position C

Conclusion:

Position A (0 degrees) – The velociraptor successfully sustains the mass of the 508g
Position A (90 degrees) – The velociraptor successfully sustains the mass of the 508g
Position A (180 degrees) – The velociraptor successfully sustains the mass of the 508g

L2-8 Single Servo Control – Head and Tail

Level: Subsystem

Requirement: The velociraptor shall control the head and tail movement with a single servo using gear trains

Type: Shall

Method: Test

Responsible Division: MFG

Tools:

- Tower Pro Micro Servo SG90
- Top layer of velociraptor
- Head and Tail of Velociraptor

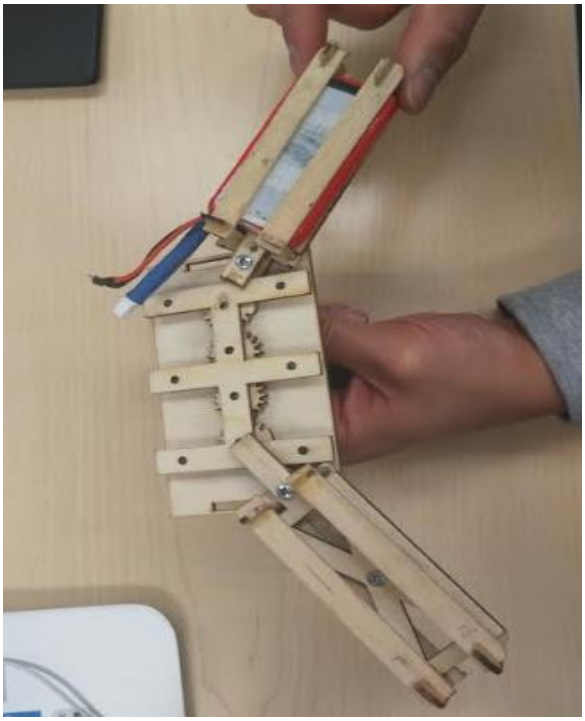
Test Objective: The velociraptor uses a single servo to control the head and tail movement through a gear train

Criteria of Success: A single servo can control the head and tail movements through a gear train

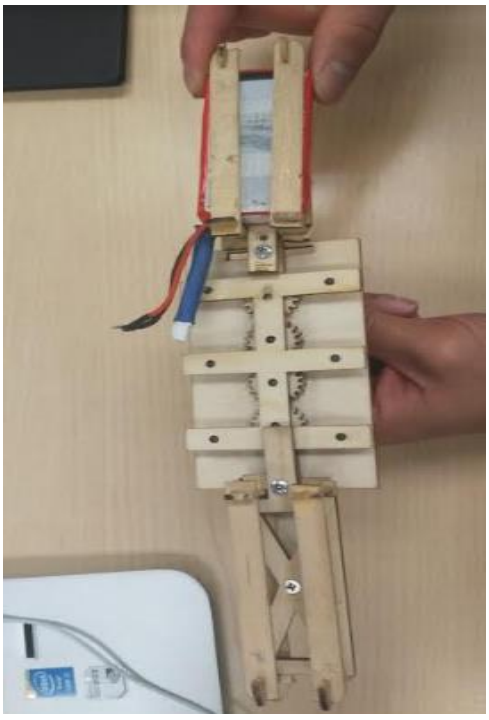
Procedure:

1. Assemble gear train for the head and tail servo
2. Attach battery packs on the slot on top of the head and tail platform
3. Connect the servo on the bottom of the head and tail platform
4. Move the head and tail of the velociraptor manually to see if the gear train works properly

Results:



Picture 1 :Single Servo Control for the Head and Tail (Positon A)



Picture 2 : Single Servo Control for the Head and Tail (Position B)

Conclusion: The single servo for the head and tail can control the movements using the gear train methodologies. Therefore, the Velociraptor successfully passes the test.

L2-9 Torque – Head and Tail

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) shall have a servo that can shift mass of head and tail at 50% margin of 108g.

Type: Shall

Method: Analysis

Test Objective: Verify the servo can support the battery masses on the head and tail

Responsible Division: E&C

Tools:

- Battery Masses
- Program "R"

Criteria for Success:

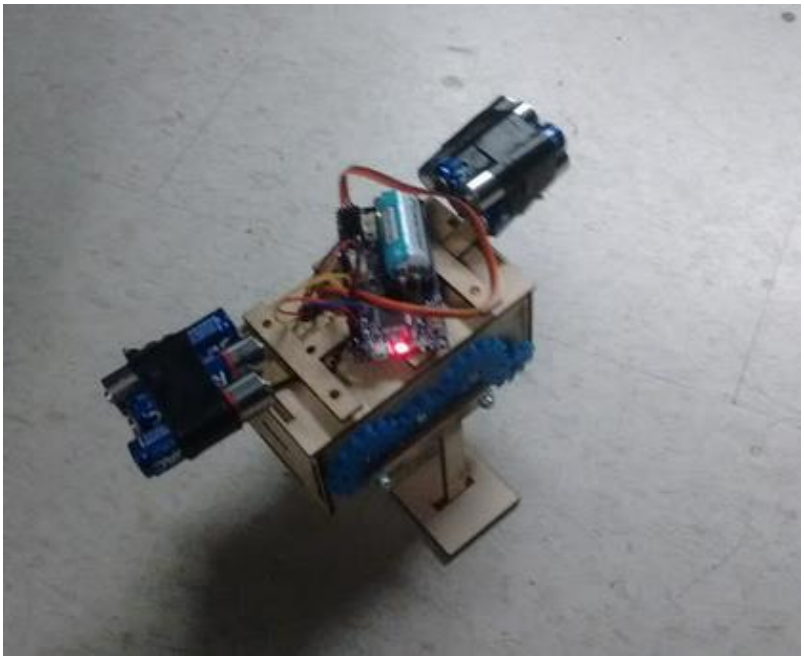
1. The 50% margin of mass torque required is greater than the torque needed to move the head and tail.

Procedure:

1. Open Program R
2. Run code for R to find max Torque calculation
3. Run code for R to find Torque calculation for 50% margin of mass
4. Record results

Results:
A blog post for the H/T servo is located on Arxterra. The post shows that for a mass with a margin of 108g, the torque needed to move it is 15.54mN-m. The stall torque is 130.57mN-m.

Also, the head and tail had attached 80g masses on each end and could have their masses tested during the motor torque test.



Head and Tail Shifting Masses

Conclusion:
The servo is calculated to operate the head and tail with a 50% margin of mass at 108g. Therefore, the Velociraptor successfully passes the test.

L2-11 Single Servo Control – Platform

Level: Subsystem

Requirement: The velociraptor should control the body platform movement with a single servo using gear trains.

Type: Should

Method: Test

Responsible Division: MFG

Tools:

- Tower Pro Micro Servo SG90
- Top layer of velociraptor

Test Objective: The velociraptor uses a single servo to control the platform movement through a gear train

Criteria of Success: A single servo can control the platform movements through a gear train

Procedure:

1. Assemble gear train for the head and tail servo
2. Connect the servo on the bottom of the head and tail platform
3. Tilt the platform of the velociraptor manually to see if the gear train works properly

Results:

Conclusion:

L2-12 Torque – Body Platform

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) should have a servo that can shift mass of body platform at 50% margin.

Type: Should

Method: Analysis

Test Objective: Verify the servo can support the battery masses on the head and tail

Responsible Division: E&C

Tools:

- Battery Masses
- Measure mass of body platform piece

Criteria for Success:

1. The 50% margin of mass torque required is greater than the torque needed to move the head and tail.

Procedure:

1. Measure mass of body platform
2. Calculate torque required to move mass of movable platform
3. Determine results

Results:

Conclusion:

L2-14 Leg Test

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) shall have a leg design that can support the mass at 505.5g at different positions for standing, bent, and crouching.

Type: Shall

Method: Test

Test Objective: Apply extra mass to the robot to be equivalent to 505.5 grams.

Responsible Division: MFG

Tools:

- Velociraptor (Th) Robot

Criteria for Success:

1. The leg design supports the robot at different positions of standing, bent, and crouching and does not fall over

Procedure:

1. Manually set leg position of robot into standing position
2. Add additional weight and see if robot stands
3. Manually set leg position of robot into bent position
4. Add additional weight and see if robot stands
5. Manually set leg position of robot into crouching position
6. Add additional weight and see if robot stands

Results:

Conclusion:

L2-15 Static Foot Test

Level: System

Requirement: 3rd Generation Velociraptor (Th) shall have a foot design that maintains stability of robot during static walking.

Type: Shall

Method: Test

Test Objective: Apply extra mass to the robot to be equivalent to 505.5 grams.

Responsible Division: MFG

Tools:

- Velociraptor (Th) Robot
-

Criteria for Success:

1. The foot design supports the robot at different positions of the walking path
2. When the robot stands on one foot, the head and tail shift CoG to planted foot

Procedure:

1. Manually set leg positions of robot to be where one is planted and the other raised
2. Manually shift Head and tail to the end with the planted foot
3. Observe results

Results:

Conclusion:

L2-16 Power to External PCB

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) MST will not exceed the current rating of 1 A for the LDO when supplying power to the external PCB.

Type: Will

Method: Test

Test Objective: To verify that the LDO will be protected from overheating.

Responsible Division: All

Tools:

- Arxterra App
- Arxterra Control Panel
- Velociraptor (Th)
- Ammeter

Criteria for Success:

1. During operation, the current will be measured between the Vcc in the 3DoT board and the External PCB 3.3V and be under 1A.

Procedure:

1. Open Arduino IDE
2. Upload code to 3DoT Board
3. Open Arxterra Phone App
4. Connect Phone to 3DoT Board
5. Turn on community mode
6. On Computer, go to Arxterra Control Panel
7. Connect the ammeter in between the 3DoT board Vcc and PCB external 3.3V
8. Observe results

Results:

Conclusion:

L2-17 Custom Telemetry

Level: System

Requirement: 3rd Generation Velociraptor (Th) MST shall create custom telemetry to be used with Arxterra Control Panel.

Type: Should

Method: Test

Test Objective: To verify that telemetry not built into the Arxterra Control Panel can be received to the robot.

Responsible Division: MST

Tools:

- Arxterra App
- Arxterra Control Panel
- 3DoT Board
- CoolTerm
- Computer

Criteria for Success:

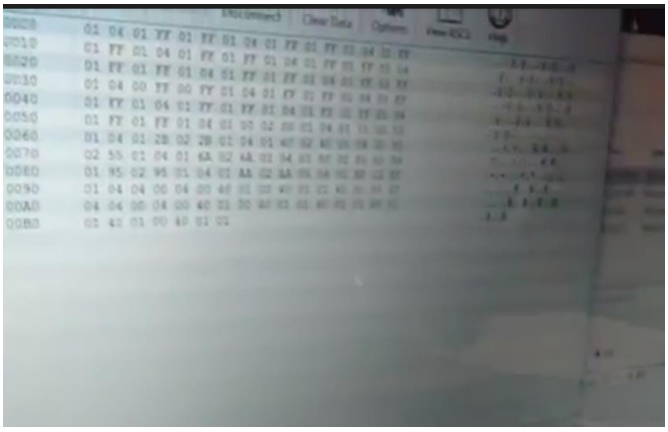
1. Telemetry sent from 3DoT board is read through the Arxterra Control Panel

Procedure:

1. Open Arduino IDE
2. Upload code to 3DoT Board
3. Open Arxterra Phone App
4. Connect Phone to 3DoT Board
5. Turn on community mode
6. On Computer, go to Arxterra Control Panel
7. Observe Telemetry Results

Results:

Dynamic Push Button That is Pressed Repeatedly



Results on Coolterm of Dynamic Button Being Pressed

Conclusion:

The command bytes being sent for Dynamic Button are read on CoolTerm. This shows that the 3DoT board is connected to the phone, the phone is connected to the Control Panel, and the Control panel can send commands. The Velociraptor successfully meets the custom command requirement.

~~L2-18 Motor Torque~~

Level: Subsystem

Requirement: 3rd Generation Velociraptor (Th) shall have a motor that can drive the mass of the robot with a 50% margin at 505.5 grams.

Type: Shall

Method: Test

Test Objective: Apply extra mass to the robot to be equivalent to 505.5 grams.

Responsible Division: E&C

Tools:

- Velociraptor (Th) Robot
- Arxterra App
- Masses equivalent to 168.5 grams
- Tape

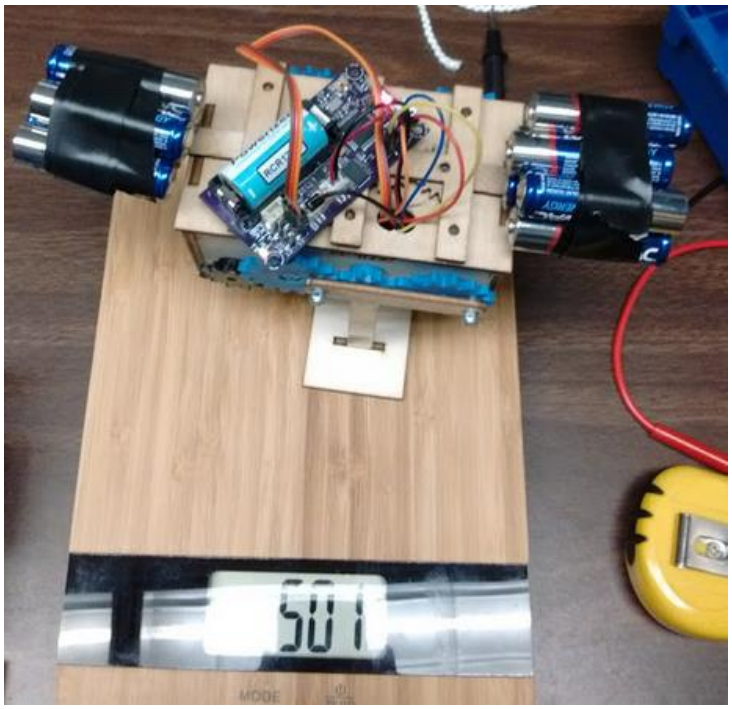
Criteria for Success:

3. The motors of the robot do not stall when receiving a forward command while driving the 50% margin of mass

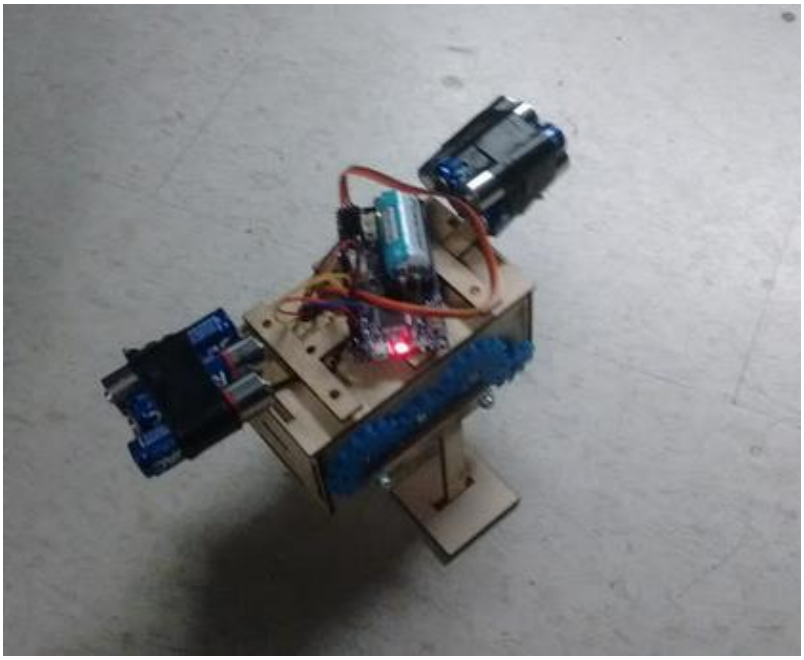
Procedure:

1. Separate mass into equivalent halves of 168.5 grams
2. Tape masses to head and tail
3. Connect Arxterra phone to 3DoT Board
4. Put app into RC mode
5. Press forward button

Results:



Robot with Additional Mass at 501 Grams



Robot Walking with Additional Mass

Conclusion:

The motors do not stall and continue walking with the additional mass of 501 grams. The motors successfully drive the robot mass of 337 grams with a 50% margin.

L1-S1 Static Walk – Flat Surface

Level: System

Requirement: The 3 rd generation velociraptor shall statically walk on a flat surface of linoleum

Method: Test

Type: Shall

Test Objective: The velociraptor will be able to demonstrate static walking on a flat surface of linoleum after it receives a move command from the Arxterra application

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- Flat surface

Criteria for Success: The velociraptor performs static walking on a flat surface of linoleum

Procedure:

1. Open 3DoT firmware code with Arduino IDE
2. Upload 3DoT firmware code to the 3DoT board on Velociraptor
3. Turn on phone and turn on Bluetooth
4. Open Arxterra App on the smartphone
5. Connect phone to Arxterra Control Panel on computer through community mode
6. Connect Bluetooth Module on 3DoT board to phone
7. Send move commands to robot and observe walking for 30 seconds
8. Observe if the velociraptor can static walking on a flat surface

Results:

Walking on a Flat Surface

Conclusion:

The Velociraptor successfully walks statically on a flat surface.

L1-S2 Static Walk – Surface Texture

Level: System

Requirement: The 3 rd generation velociraptor shall statically walk on a flat surface of cardboard.

Method: Test

Type: Shall

Test Objective: The velociraptor will be able to demonstrate static walking on a flat surface after it receives a move command from the Arxterra application.

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- cardboard surface

Criteria for Success: The velociraptor performs static walking on a flat surface of cardboard

Procedure:

9. Open 3DoT firmware code with Arduino IDE
10. Upload 3DoT firmware code to the 3DoT board on Velociraptor
11. Turn on phone and turn on Bluetooth
12. Open Arxterra App on the smartphone
13. Connect phone to Arxterra Control Panel on computer through community mode
14. Connect Bluetooth Module on 3DoT board to phone
15. Send move commands to robot and observe walking for 30 seconds
16. Observe if the velociraptor can static walking on a texture surface

Results:

Walking on a Surface Texture

Conclusion:

The Velociraptor successfully walks statically on a surface texture of cardboard.

L1-S3 Static Walk – Incline/Decline

Level: System

Requirement: The 3 rd generation velociraptor shall statically walk on an incline and decline surface of 6.5 degree maximum

Method: Test

Type: Shall

Test Objective: To see if the velociraptor can go up or down slopes while statically walking.

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- Incline Surface

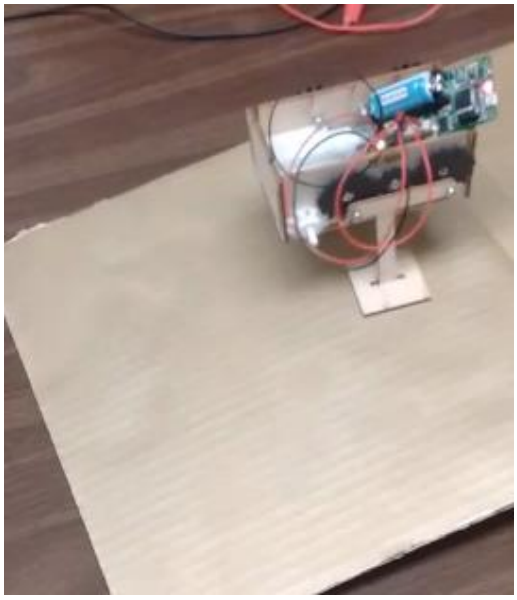
Criteria for Success:

1. The velociraptor performs static walking on an incline of 6.5 degrees
2. The velociraptor performs static walking on a decline of 6.5 degrees

Procedure:

1. Open 3DoT firmware code with Arduino IDE
2. Upload 3DoT firmware code to the 3DoT board on Velociraptor
3. Turn on phone and turn on Bluetooth
4. Open Arxterra App on the smartphone
5. Connect phone to Arxterra Control Panel on computer through community mode
6. Connect Bluetooth Module on 3DoT board to phone
7. Turn off dynamic walking mode and intiate static walking
8. Send move commands to robot and observe walking for 30 seconds
9. Observe if the velociraptor can demonstrate static walking on an incline
10. Observe if the velociraptor can demonstrate static walking on a decline

Results:



Going Down Decline

Going up Incline

Conclusion:

The Velociraptor successfully navigated inclines/declines of 6.5 degrees.

L1-S4 Static Walk – Step

Level: System

Requirement: The 3 rd generation velociraptor should perform static walking while on a step of .5cm.

Method: Test

Type: Shall

Test Objective: To see if Velociraptor can go up a step of .5cm.

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- Step Surface

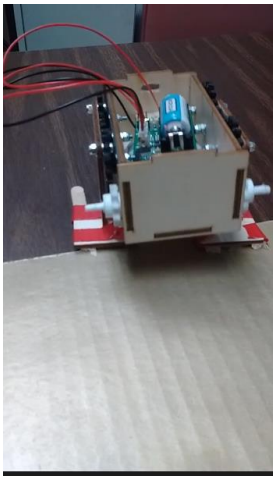
Criteria for Success: The velociraptor performs static walking on a step and climbs up to the uneven surface.

Procedure:

1. Open 3DoT firmware code with Arduino IDE
2. Upload 3DoT firmware code to the 3DoT board on Velociraptor
3. Turn on phone and turn on Bluetooth
4. Open Arxterra App on the smartphone
5. Connect phone to Arxterra Control Panel on computer through community mode
6. Connect Bluetooth Module on 3DoT board to phone
7. Turn off dynamic walking mode and intiate static walking
8. Send move commands to robot and observe walking for 30 seconds
9. Observe if the velociraptor can demonstrate static walking on a step of .5cm

Results:

Step of .5cm



Getting over a step of .5cm

Conclusion:

The Velociraptor successfully got onto an uneven surface of .5 cm.

L1-D1 Dynamic Walk – Flat Surface

Level: System

Requirement: The 3 rd generation velociraptor shall dynamically walk on a flat surface of linoleum

Method: Test

Type: Shall

Test Objective: The velociraptor will be able to demonstrate dynamic walking on a flat surface of linoleum after it receives a move command from the Arxterra application

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- Flat surface

Criteria for Success: The velociraptor performs dynamic walking on a flat surface of linoleum

Procedure:

17. Open 3DoT firmware code with Arduino IDE
1. Upload 3DoT firmware code to the 3DoT board on Velociraptor
2. Turn on phone and turn on Bluetooth
3. Open Arxterra App on the smartphone
4. Connect phone to Arxterra Control Panel on computer through community mode
5. Connect Bluetooth Module on 3DoT board to phone
6. Send move commands to robot and observe walking for 30 seconds
7. Observe if the velociraptor can dynamic walking on a flat surface

Results:
Conclusion:

L1-D2 Dynamic Walk – Surface Texture

Level: System

Requirement: The 3 rd generation velociraptor shall dynamically walk on a flat surface of cardboard.

Method: Test

Type: Shall

Test Objective: The velociraptor will be able to demonstrate dynamic walking on a flat surface after it receives a move command from the Arxterra application.

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- cardboard surface

Criteria for Success: The velociraptor performs dynamic walking on a flat surface of cardboard

Procedure:

1. Open 3DoT firmware code with Arduino IDE
2. Upload 3DoT firmware code to the 3DoT board on Velociraptor
3. Turn on phone and turn on Bluetooth
4. Open Arxterra App on the smartphone
5. Connect phone to Arxterra Control Panel on computer through community mode
6. Connect Bluetooth Module on 3DoT board to phone
7. Send move commands to robot and observe walking for 30 seconds
8. Observe if the velociraptor can dynamic walking on a texture surface of cardboard

Results:
Conclusion:

L1-D3 Dynamic Walk – Incline/Decline

Level: System

Requirement: The 3 rd generation velociraptor shall dynamically walk on an incline and decline surface of 6.5degree maximum

Method: Test

Type: Shall

Test Objective: To see if the velociraptor can go up or down slopes while dynamically walking

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- Incline Surface

Criteria for Success:

3. The velociraptor performs dynamic walking on an incline of 6.5 degrees
4. The velociraptor performs dynamic walking on a decline of 6.5 degrees

Procedure:

11. Open 3DoT firmware code with Arduino IDE
12. Upload 3DoT firmware code to the 3DoT board on Velociraptor
13. Turn on phone and turn on Bluetooth
14. Open Arxterra App on the smartphone
15. Connect phone to Arxterra Control Panel on computer through community mode
16. Connect Bluetooth Module on 3DoT board to phone
17. Turn off dynamic walking mode and intiate static walking
18. Send move commands to robot and observe walking for 30 seconds
19. Observe if the velociraptor can demonstrate dynamic walking on an incline
20. Observe if the velociraptor can demonstrate dynamic walking on a decline

Results:
Conclusion:

L1-D4 Dynamic Walk – Step

Level: System

Requirement: The 3 rd generation velociraptor should perform dynamic walking while on a step of .5cm.

Method: Test

Type: Shall

Test Objective: To see if Velociraptor can go up a step of .5cm while dynamically walking

Tools:

- A computer with Arxterra Control Panel
- Computer with Arduino IDE software
- USB to micro-USB cable
- 3DoT firmware code
- Velociraptor Robot
- Step Surface

Criteria for Success: The velociraptor performs dynamic walking on a step and climbs up to the uneven surface of .5 cm.

Procedure:

1. Open 3DoT firmware code with Arduino IDE
2. Upload 3DoT firmware code to the 3DoT board on Velociraptor
3. Turn on phone and turn on Bluetooth
4. Open Arxterra App on the smartphone
5. Connect phone to Arxterra Control Panel on computer through community mode
6. Connect Bluetooth Module on 3DoT board to phone
7. Turn off dynamic walking mode and intiate static walking
8. Send move commands to robot and observe walking for 30 seconds
9. Observe if the velociraptor can demonstrate dynamic walking on a step of .5cm

Results:

Conclusion: