Drones and Autonomous Systems Lab @ UNLV

Transformer Darwin (#001)

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Technical Design Document

Dawin-OP (Spring/Summer 2017)

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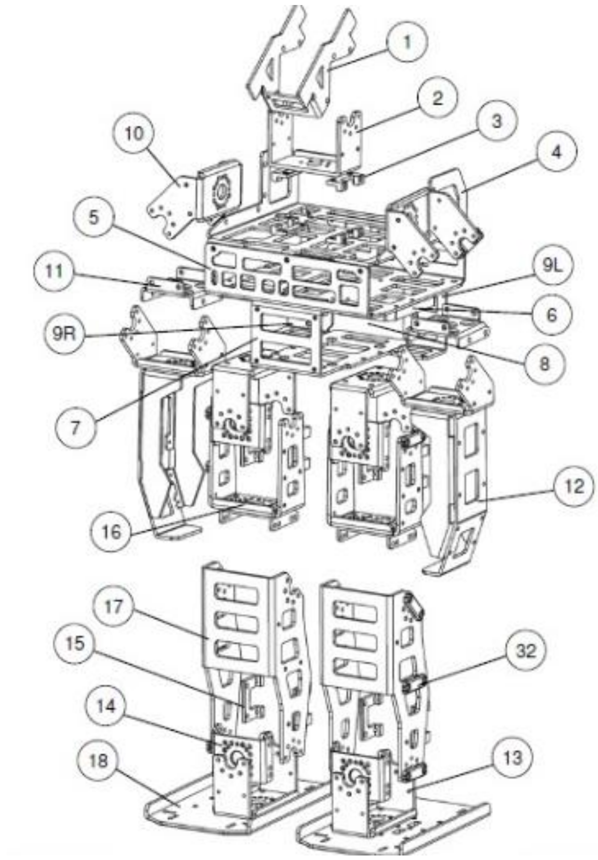
1 INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

This document is a Technical Design Document for use by students from Drones and Autonomous Systems Lab (DASL) at the University of Nevada Las Vegas Projects. It provides guidance to a potential reproduction of the experiments conducted throughout this project.

1.2 SPECIFIC DESIGN CONSIDERATIONS

This project uses DARwIn-OP which is “a Dynamic Anthropomorphic Robot with Intelligence - Open Platform that is an affordable, miniature-humanoid-robot platform with advanced computational power, sophisticated sensors, high payload capacity, and dynamic motion ability to enable many exciting research and education activities.” [Robotis.com]. Therefore, all the attachments designed to transform DARwIn-OP from biped to rolling locomotion humanoid are based upon DARwIn-OP manufacturer’s design.



Part Number	Description
1	Head Bracket
2	Neck Bracket
3	Chest Actuator Connectors
4	Upper Chest Bracket
5	Lower Chest Bracket
6	Mounting Bracket
7	Battery Bracket
8	Battery Cover Bracket
9L	Back Left Pelvic Bracket
9R	Back Right Pelvic Bracket
10	Angled Actuator Bracket
11	Arm Actuator Mount
12	Hand
13	U-Actuator Bracket
14	Leg Actuator Mount
15	Actuator Connector
16	Thigh Bracket
17	Knee Bracket
18	Foot
32	Cable Holder

Fig. 1. DARwIn-OP's parts [http://www.robotsource.org]

1.3 SCOPE

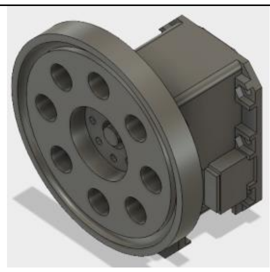
The goal of this design project is to attach wheels onto DARwIn-OP's knees. In order to do that, we shall design parts that can be easily attached to any DARwIn-OP. Moreover the users can further study the advantages and disadvantages between normal bipedal gait locomotion and rolling locomotion. The ultimate goal is to have a similar locomotion capability as DRC-Hubo. Hence, compare the performance between both robots.

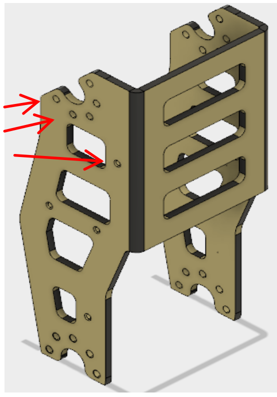
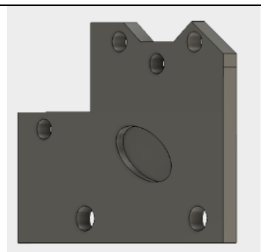
1.4 TECHNICAL DESIGN REQUIREMENTS (TDR)

a. *The first table shows the specific requirements regarding the wheel's design advantages. Such as, power requirements, slope limitations, roll-over obstacles, speed and range.*

b. *Table 2 illustrates the technical design requirements in terms of assembly and standard tools. For instance, how easy the mounting and replacement of the attachments actually are?*

c. *Table 3 represents few ideas for future studies concerning sensor data. In other words, the sensors shall be used to improve navigation.*

Task	Requirements	Objectives	Reason	Photo
Wheel's placement	Wheels need to be attached to the knee. Using the knee frame.	That way the user won't have to change DARwin-OP's original frame.	We can use the Knee's frame design as reference to develop an attachment for the wheel.	
Roll-over objects	A rubber gripper ought to be added to the plastic(3D printed) wheel, in order to roll over small objects (approximate 1cm height).	The humanoid should be able to roll over certain objects.	Most of the time there is an uneven terrain. In other words the surface will not always be smooth as we want it to be.	
Speed	DARwin-OP must roll at least 2 times faster than walk(24 cm/s).	Transform DARwin-OP into a more motion-wise humanoid. Vibration is one of the issues during bipedal gait. Therefore reduce vibration while moving is crucial.	In real life humanoids should be able to choose when to walk and when to roll. Rolling mode will increase significantly the robot's overall motion speed.	
Battery Life	The battery is one of the most important component, and saving energy is a constant issue. 1000mAh battery runs about 10 minutes with all Dynamixel operating. Therefore, using the battery for 2 Dynamixel would increase DARwiin's usage time.	Save as much energy as possible by using only 2 Dynamixel to move the entire humanoid.	By using 2 servos to locomotion saves energy, hence the humanoid can operate for a longer time.	

Task	Requirements	Objectives	Reason	Photo
Wheel's Torque/ Force	The wheels will be powered by the MX-28T Dynamixels. The torque applied by the servo can be controlled throughout DARwIn's Dxl code. Which is the code responsible for the Dynamixels.	Have at least 80% of the Torque out of the servos converted into motion.	Based on manufactures specifications: MX-28T operating on 12V has a Stall Torque of 55 N.m.	
Standard Tools usage	Make sure that the entire assemble can be done using an ordinary "*1.5mm allen hex tool*" and "*Phillips Screw Driver SD-01*". Both tools come with DARwin-op/OP2 package.	This will make the assembling easy and quick, once advance tools are not needed.	The user won't have to buy extra tool. Furthermore, we do not have to provide common tools.	
Fixture plate	The flat plate will hold the Dynamixel+wheel and attach itself to the knee frame.	Design a CAD model to support Dynamixel + knee frame. This ought to be design so it can be easily attached to DARwin.	The user can easily attach all the components together using the standard screws provided (BOLT BHS M2.5*8)	
Standard Screws	The screw ought to be from the RObotis family screw.	Have any extra attachment needed from ROBOTIS.	Easy and cheap to purchase.	
Dynamixel MX-28T	The Servo has to be the same as the others already in DARwin-OP.	Use two extra MX-28T Dynamixel to provide the torque to spin the wheel and eventually make the humanoid to roll.	Since DARwin OP already has 20 MX-28T add two extra is convenient in terms of software. In other words, it is better to program two extra MX-28T to	

			DARwin than other Dynamixels	
Plow plates	They need to be attached to the front of the humanoid.	Design in the way that the plates do not alter standard movement.	Plow plates must be attached to the front of Darwin-op so it can remove residues while rolling forward. **Focus**: debris-clearing	

Task	Requirements	Objectives	Reason	Photo
Xbox Kinect Sensor	Kinect should be attached to DARwin-OP's upper body .	The mapping and object detection is vital for navigation.	Darwin-op does not have powerful capture sensors. Thus, add a Kinect sensor to DARwin's head would increase DARwin's potential.	

1.2 SCOPE

#1 This section should:

a. identify the products to be produced;

b. explain what the proposed system will do (and will not do, if necessary);

c. define relevant benefits, objectives and goals as precisely as possible;

d. define any security risks associated with the system;

e. be consistent with similar statements in higher-level specifications, if they exist.

1.3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

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