Activities Report

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| Literature revision | | |
| Goals | : | * Study the basic concepts of Robotics. * Learn more about the HyQ project. |
| Status | : | Finished |
| Realized | : | * Reviewed several concepts that I was not familiar before coming here like a Jacobians, Lagrangian equations, forward and inverse kinematics, and so on. * Reviewed the process and conception of the HyQ robot based on Claudio’s Thesis. |
| Issues | : | None |
| Required resources | : | Thesis and books. |
| Bibliography | : | 1. C. Semini, "HyQ - Design and Development of a Hydraulically Actuated Quadruped Robot," Doctor of Philosophy PhD Thesis, Advanced Robotics Department, University of Genoa, Genoa, Italy, 2010. 2. B. Siciliano, L. Sciavicco, L. Villani, and G. Oriolo, *Robotics: Modelling, Planning and Control*. London, Great Britain: Springer, 2009. |
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| C++ code for hydraulic cylinder dynamics simulation | | |
| Goal | : | Programming a C++ code in order to simulate the dynamic behavior of a hydraulic cylinder. |
| Status | : | Ongoing (85%) |
| Realized | : | I already write the code including all the differential equations that represent the hydraulic system in a space state form. However, the integration process in order to obtain the output responses is still missing. |
| Issues | : | I downloaded a library of ODE integrators (ODEINT) and tried to implement in the code without success. I think that the problem should be something simple but I am stuck here now.  My first idea was to found some examples of dynamic systems made in C++ and modify them for my case, but I did not found any good example.  After that, I tried to understand the procedures and functions used into components of AMESim software, all of them made in C++. Therefore, my second idea was to make something similar to AMESim but in a very small scale. However, many questions were emerging when I was reading the code of that software. As more I read the tutorials, in order to solve my doubts, the more time that I spent trying to figure out how to make this code for my case. At the final, I decided to make something simple initially and then I should improve it until reach my goal.  I am not too familiar with various commands for programming in C++, so I spent some time reading about the commands that I could use, seeing examples and learning how to use it. That was and still is my particular deficiency. |
| Required resources | : | Softwares:   * Ordinary Differential Equations Library (ODEINT), available at <http://headmyshoulder.github.io/odeint-v2/> * Eclipse software.   C++ Tutorials. |
| Bibliography | : | 1. <http://www.cprogramming.com/tutorial/c++-tutorial.html> 2. <http://www.tutorialspoint.com/cplusplus/cpp_operators.htm> 3. <http://www.cplusplus.com/doc/tutorial/> |
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| LINUX & GIT | | |
| Goals | : | * Install and use Linux. * Learn how to use the GIT commands. |
| Status | : | Finished |
| Realized | : | * Installed LINUX in my computer and read about text commands used in the shell. * Read, learn and familiarize with GIT commands. |
| Issues | : | As a windows user I am also new with the Linux, but the learning was very fast. The same happens with the GIT, I never used a versioner before. My knowledge about repositories was basic. Now I know that is a very powerful tool, mainly for source code programming. I am using this tool for other projects too and appreciate the fact that I learned this here. |
| Required resources | : | Linux Ubuntu software & GIT Tutorials. |
| Bibliography | : | 1. <https://www.atlassian.com/git/tutorials/> 2. <http://www.ubuntu.com/download> |
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| Hydraulic Leg modeling | | |
| Goals | : | * Simulate the HyL in Simulink in order to obtain responses that help me to select new hydraulic components. |
| Status | : | Finished |
| Realized | : | * Modeling process in Maple: based on the information of Claudio’s thesis I developed the mathematical model of the HyL using Maple software. * Implementation of Marco’s model in Matlab: Marco Frigerio transfer me his model of HyL that can be implemented in Roy’s soft. * Installation and familiarize of Spatial Vector and Rigid-Body Dynamics software of Prof Roy Featherstone. * Read and learn the spatial vector theory. |
| Issues | : | Initially I tried and obtained my own model of HyL, however, that was a fixed base, and the HyL model need to have a floating base. After studying more about floating base modelling, I obtained my new model using Maple soft.  Seeing that I was spent too much time, Marco Frigerio transfer me his model of HyL that should work with Roy’s software, but he never used before because not too much people works with Matlab/Simulink having a most powerful tools like SL or Gazebo. My deficiency, again, is that I am not familiar with both of these softs, so I needed something more familiar for me. I installed the Roy software, read his tutorials, and tried to be familiar with the functions that he uses in his software. Roy helps me to understand several things and the final I obtained a final version of the HyL.  I modified the code of Marco in order to make it more understandable for me and maybe other people in the future. Additionally, I incremented the visual components to see the HyL on Showmotion simulator. |
| Required resources | : | Spatial Vector and Rigid-Body Dynamics software V2.0.  Matlab/Simulink. |
| Bibliography | : | 1. <http://royfeatherstone.org/spatial/v2/index.html> 2. R. Featherstone, "A beginner's guide to 6-d vectors (part 1)." Robotics & Automation Magazine, IEEE 17.3 (2010): 83-94. 3. R. Featherstone, "A Beginner's Guide to 6-D Vectors (Part 2)." IEEE robotics & automation magazine 4.17 (2010): 88-99. 4. R. Featherstone, *Rigid body dynamics algorithms*. Springer, 2008. |
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| Hydraulic actuation system implementation | | |
| Goals | : | * Implements the hydraulic cylinder dynamic and pump dynamic working with the HyL model in Simulink. |
| Status | : | Ongoing (80%) |
| Realized | : | * Actuation system modeled in Simulink using real data of the test bench. * Read about and model the pump dynamic. |
| Issues | : | I obtained some unexpected responses when I joined my hydraulic cylinder model with the leg; I am looking for the root of the problem. On the other hand, I am still modeling the pump dynamics.  Initially, various parameters are considered fixed. After obtain reasonable responses I will introduce other nonlinear equations in order to obtain a better model. Example of this kind of parameters:   * bulk modulus: considered fixed along the simulations, but its value depends of the pressure inside the system. The pressure is always changing, so the bulk modulus should be change, however is considered fixed for simplification purposes due to in high pressure its value does not change too much; * volumetric expansion of the hoses: its value depends on the pressure and also affects the bulk modulus of the system; * friction forces: is considered only the viscous friction, however its behavior is nonlinear;   I have some questions about the signs used in the lever arm equation used by Claudio and Thiago. I know that the actual model corresponds to the Front Leg of the HyQ, and has a defined the signs of the angles according to the movement. However, seeing the code used by Thiago:  %Hip  Y1 = pi/2 + f1 + e11 + e12;  c1 = sqrt(a1^2 + b1^2 - 2\*a1\*b1\*cos(Y1));  %Knee  Y2 = pi - (f2 + e21 + e22);  c2 = sqrt(a2^2 + b2^2 - 2\*a2\*b2\*cos(Y2));  where f1 and f2 are the join angles of the hip and the knee respectively. According to my analysis and seeing the Standard Definitions of the HyQ (pdf file), the first equation should be:  Y1 = pi/2 - f1 + e11 + e12;  resulting in other response. |
| Required resources | : | Standard Definition of the HyQ (documentation).  Matlab/Simulink. |
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