Browser-based 3D simulation of a Robotic Arm

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Version 1.2

Project Description

Extract from the proposed project description:

‘As part of the Space Robotics module, students learn about the forward and inverse kinematics of a robotic arm, such as might be used on a planetary rover. Although the equations are taught and examples worked through, there is currently no physical robotic arm to test their solutions on.

This project is to develop a portable simulator of a 5 or 6 Degrees of freedom robotic arm, that can be visualised in 3D in a web browser and which can be used to try out solutions to kinematics problems.
The arm and its environment will be visualised in a 3D window with a moveable viewpoint, and as a minimum will accept joint angles as input (for a forward kinematic solution), or a desired 3D target coordinate (for an inverse kinematic solution), with an indication of the end-point coordinates of the arm's effector and its distance from the desired target after movement has taken place.’

The initial brief also includes extra optional functionality for the Robotic Arm
Simulator including, the ability to select the configuration of the robotic arm (e.g. length of the arm and number of joints.),
selecting the sequences of joint movement and motor speeds to allow smoother and more complex arm movement,
the addition of physics and collision to the simulation, using a generalised kinematic model to allow multiple arm types to be simulated and the calculation of torque and power required to move the arm and hold positions.

The main use for the final product is to help students who are learning about robotic manipulators during the year 3 Space Robotics module. The final software will need to be easily accessible for students, helpful as a teaching aid and interesting for students to use.
As the final product needs to be accessible for students and staff I have opted to build the project in JavaScript as the simulator can be web hosted for easy access to students and staff. JavaScript also has a number of 3D libraries and frameworks to allow me to create the 3D simulation for the robotic arm, I will be using the Three.js framework to create the 3D models and animations for the robotic arm.

Proposed Tasks

So far my planned tasks for completing the project are:

- **Investigation into the relevant languages and frameworks required for the project.** This task will look into the options for using Three.js to create 3D models and a 3D environment to be used to represent the Robotic Arm within the simulator. Also I will be looking into other frameworks for JavaScript to help me create a kinematic library for the application logic.

- **Setting up a local workspace with version control.** Depending on what frameworks I decide to adopt I will need to set up and configure a local environment to work in. I will also be using git for version control as I already have a Github account and I have experience using both Github and git.
- **Development.** Development of the project will include.

- **Creating a JavaScript kinematic library.** Firstly I will need to create a library for handling the kinematic calculations. This will make up the core controlling logic for the application.

- **Creating a 3D environment for the robotic arm using Three.js with user controls.** Next I will need to create a system to visualise the robotic arm and a GUI system to allow users to make adjustments to the arm configuration and to move the arm in 3D space.

- **Robotic Arm Generation system.** Making a robotic arm using Three.js that can be generated dynamically from user configurations. Possible to use an XML file to hold configuration data for arm to be created.

- **Animation for the robotic arm movements.** Using Three.js or other extensions to allow the arm to move based on user inputs.

- **Looking into extra functionality such as physics, collisions, arm joint motions.** Adding extra functionality to the application would increase functionality of the Simulator Application, but these features are based on development time available.

- **Project Meetings and Daily Diary.** During the project I will attend weekly supervisor meetings to discuss the progression of the project. Also I will keep a daily project diary which will help me keep track of what I have worked on during the project and allow me to give a better report during weekly meetings. The diary will be in the form of an online document in my Github project workspace or on Google Docs.

- **Project Presentations.** During my time working on my major project I will expected to give two demonstrations. One is before Easter for my Mid-Project review, and the other following the final submunition of my project report and technical work. For my Mid-Project presentation I will need to have my basic forward kinematic application logic and 3D interface working and for my Final I will need to have reverse kinematic logic and extra features working.

Project Deliverables

Mid Project Demonstration – A set presentation slides or notes will be produced to explain and summarise what will be presented at the demonstration. This will also be referenced as an appendix in my final report.

Simulator Application software – The application code will include all the necessary libraries and frameworks to run. The application will be hosted on a server either my personal server or on the university network. A self contained version of the code files will be submitted for assessment and these files will be made available through my Github repository. This will be included as part of the technical submission.

Testing Code – Tests for the logic library and for the 3D Three.js application will be made available for the technical submission. These tests will be in the form of automated tests and some manual

tests and will use a testing framework such as Mocha or Selenium, although the exact framework is yet to be decided.

CRC Cards – A set of documents will be created to summarise the stories for the features of the application. This will be referenced in the final report.

Final Report – The final report will include the report itself and any associated appendices. The report will discuss the work I have done over the project and will acknowledge any 3rd party tools, framework and code used during the project.

Project Progress Blog Diary – Detailing the daily progress on the project in a personal diary which will be made available on my Github account.

Initial Annotated Bibliography

[1] - GitHub (2017) *Build software better, together.* Available at: https://github.com/ (Accessed: 9 February 2017).

[2] - *Three.js - Javascript 3D library* (2017) Available at: https://threejs.org/ (Accessed: 9 February 2017).