Developing an Online Learning Platform for an Undergraduate Robotics Course

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table1

<table>
<thead>
<tr>
<th>Simulator</th>
<th>Description</th>
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<tbody>
<tr>
<td>V-Rep</td>
<td>Robot Simulator with integrated development environment. It offers an educational license.</td>
</tr>
<tr>
<td>Gazebo</td>
<td>3-D simulator for populations of robots in complex indoor and outdoor environments.</td>
</tr>
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<td>Robotics Toolbox for Matlab</td>
<td>Software package that allows a Matlab user to develop datatypes fundamental to robotics.</td>
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\textbf{Conclusion}

Our Robotics Toolbox problem development and video-based lectures will be important aspects in building the online learning platform for introductory robot kinematics.

\textbf{Future work}

\begin{itemize}
  \item Implement the Robotics Toolbox problems in the next Fall semester.
  \item Connect Robotics Toolbox to a 3D simulator such as V-Rep and Gazebo.
  \item Develop a public online course in a platform known worldwide.
\end{itemize}

\textbf{References}


\textbf{Introduction}

- Teaching robotics using web-based technologies supplements traditional classroom training.
- The use of a robot simulator in a robotics course enables the students to better understand the fundamental concepts by practical application.

\textbf{Proposal:} Development of an online learning platform for an introductory course, Robot Kinematics and Dynamics, based on Robotics Toolbox.

\textbf{Methods}

1. Comparison of open-source robot simulators for teaching robotics.

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   \end{tabular}

2. Supplement the current homework and laboratory assignments using Robotics Toolbox for Matlab.
3. Elaborate new examples for the course based on the Robotics Toolbox.
4. Improve the video-based lectures in terms of quality, educational method, and pedagogical benefits.
5. Analyze surveys conducted with students of the course and develop new assessment methods in form of review and quiz questions.

\begin{figure}

\textbf{Figure 1.} A video-based lecture on the Online Learning Platform.

\textbf{Figure 2, 3.} Workspace of a two link robot. In the figure 2, the second link is bigger than the first link. In the figure 3, the two links have the same size.

\textbf{Figure 4, 5.} Inverse Kinematics Solutions. In the figure 4, there is a right-handed solution. In the figure 5, there is a left-handed solution.

\textbf{Figure 6, 7.} Jacobian solution before and after small changes in one joint coordinates.

\textbf{Figure 8.} Comparison between the total length of new and old videos per week.

\textbf{Figure 9.} Comparison between the average length of new and old videos per week.

\textbf{Robotics Toolbox Problems}

- The programming problems based on Robotics Toolbox explore classical topics in robotics, such as homogeneous transformations, forward and inverse kinematics, differential kinematics, and dynamics.

\textbf{Problem 1: Finding the workspace of a robot using a program rather than inspection.}

\textbf{Problem 2: Finding multiple solutions for the inverse kinematics problem through visualization.}

\textbf{Problem 3: Finding a new way of understanding the columns of the Jacobian through small changes in one joint coordinates that affect the pose of the end-effector.}

\textbf{Video-Based Lectures}

- The lectures are taught in class using PowerPoint slides.
- The course also offers video-based lectures recorded outside the classroom, which are available via Panopto video platform software.
- Some of our pedagogical goals are: avoid making class sessions too redundant with videos recordings and reduce the amount of time students spend watching videos.
- The new videos are 43% shorter, in terms of both average and total length, than the old videos recorded inside the classroom.

\begin{figure}

\textbf{Figure 10.} Comparison among robot simulators.

\textbf{Figure 11.} Video-based learning platform software.

\textbf{Figure 12.} Our Robotics Toolbox problem development and video-based lectures will be important aspects in building the online learning platform for introductory robot kinematics.