Design and Control of a LaTeX Thesis Template

A Thesis

Presented to the

Graduate Faculty of the

University of Louisiana at Lafayette

In Partial Fulfillment of the

Requirements for the Degree

Masters of Science

Forrest Montgomery

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Design and Control of a $\LaTeX$ Thesis Template

Forrest Montgomery

APPROVED:

Joshua E. Vaughan, Chair
Assistant Professor of Mechanical Engineering

Charles E. Taylor
Assistant Professor of Mechanical Engineering

Paul Darby
Assistant Professor of Electrical Engineering

Mary Farmer-Kaiser
Dean of the Graduate School

DEDICATION

To all the poor souls using Word, one day you will see the light.

EPIGRAPH

"If you optimize everything, you will always be unhappy."

— Donald Knuth

ACKNOWLEDGMENTS

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INTRODUCTION AND BACKGROUND

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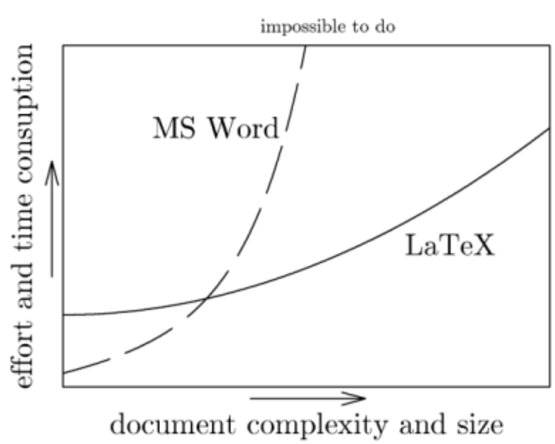

Figure 1: From Marko Pinteric

Table 1: Impulse Amplitudes and Spacing for Two Input Shaper

	Impulse Amplitudes	
Impulse Times	Input f_1	Input f_2
0	0.50	0.07
0.84	0.09	0.94
1.69	0.41	0.00

1.1.1 SUBSECTION

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II

DYNAMIC MODEL

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EXPERIMENTAL TRIALS

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V

CONCLUSIONS

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APPENDIX A

SYMPY MODELING

The computer algebra system Sympy was used to model and simulate the dynamic properties of each model. This Python library requires the model frames, points, constants, and dynamic variables to be explicitly defined. These variables are then wrapped in either a Lagrangian or Kane's method function, and the equations of motion are calculated. The code structure is generally the same for all systems modeled in Sympy and is as follows:

1. Dynamic variables and constants definitions: The variable names for the system positions, speeds, and forces are defined as varying with time. The constants are defined without varying with time.

2. Frame definitions: The global coordinate frame for each model are created. These are then used to define the subsequent frames which rotate about the fixed global frame.

3. Point definitions: The important points of the system are defined with either time varying variables or constants. Vectors are created between the points to compute the relative velocities and point accelerations.

4. Inertial definitions: The rigid-bodies or point masses of the system are created with the center of mass defined as one of the aforementioned points. The rigid-body also includes the inertial tensor, which for these planar models only has an I_y component. For Lagrange's method the potential energy of the bodies is also included.

5. Force definitions: Forces acting on the system are defined here. For Kane's method this includes all spring and damper forces. This is where the boolean operator's are defined. Rotational forces can also be applied to a frame to limit rotational motion.

6. Differential equations are created and used to simulate the model's motion.

APPENDIX B

EQUATIONS OF MOTION

Provided are the equations of motion for the 2-1 CSPM, developed from Sympy. They are written as a system of first-order differential equations.

B.1 2-1 CABLE MANIPULATOR

$$\begin{aligned} \dot{x} &= M_1^4 \\ \dot{z} &= M_1^5 \\ \dot{\beta} &= M_1^6 \end{aligned} \tag{1}$$

$$
\begin{aligned}
M_1^4 = {} & \frac{D^2 g m}{4I}\sin(\beta)\cos(\beta) \\
& - \frac{D^2}{4I}\sin(\beta)\cos(\beta) \Bigg(\frac{Dm}{2}\dot{\beta}^2\cos(\beta) + gm + \frac{k_{cable} z}{\sqrt{x^2+z^2}} \left(L_1 - \sqrt{x^2+z^2}\right) \Big(\sqrt{x^2+z^2} \\
& \geq L_1\Big) + \frac{k_{cable} z}{\sqrt{z^2+(-H+x)^2}} \left(L_2 - \sqrt{z^2+(-H+x)^2}\right) \Big(\sqrt{z^2+(-H+x)^2} \\
& \geq L_2\Big) + \frac{z}{\sqrt{z^2+(-H+x)^2}} \Bigg(-\frac{c\dot{x}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\Big(\sqrt{z^2+(-H+x)^2} \\
& \geq L_2\Big) - \frac{cz\dot{z}\left(\sqrt{z^2+(-H+x)^2} \geq L_2\right)}{\sqrt{z^2+(-H+x)^2}} \Bigg) + \frac{z}{\sqrt{x^2+z^2}} \Big(-\frac{cx\dot{x}}{\sqrt{x^2+z^2}} \Big(\sqrt{x^2+z^2} \\
& \geq L_1\Big) - \frac{cz\dot{z}}{\sqrt{x^2+z^2}} \Big(\sqrt{x^2+z^2} \\
& \geq L_1\Big)\Big)\Bigg) \\
& + \left(\frac{D^2}{4I}\cos^2(\beta) + \frac{1}{m}\right) \Bigg(\frac{Dm}{2}\dot{\beta}^2\sin(\beta) + \frac{k_{cable} x}{\sqrt{x^2+z^2}} \left(L_1 - \sqrt{x^2+z^2}\right) \Big(\sqrt{x^2+z^2} \\
& \geq L_1\Big) + \frac{k_{cable}}{\sqrt{z^2+(-H+x)^2}} (-H+x) \left(L_2 - \sqrt{z^2+(-H+x)^2}\right) \Big(\sqrt{z^2+(-H+x)^2} \\
& \geq L_2\Big) + \frac{x}{\sqrt{x^2+z^2}} \Big(-\frac{cx\dot{x}}{\sqrt{x^2+z^2}} \Big(\sqrt{x^2+z^2} \\
& \geq L_1\Big) - \frac{cz\dot{z}}{\sqrt{x^2+z^2}} \Big(\sqrt{x^2+z^2} \\
& \geq L_1\Big)\Big) + \frac{1}{\sqrt{z^2+(-H+x)^2}} (-H \\
& \qquad\qquad + x) \Bigg(-\frac{c\dot{x}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\Big(\sqrt{z^2+(-H+x)^2} \\
& \geq L_2\Big) - \frac{cz\dot{z}\left(\sqrt{z^2+(-H+x)^2} \geq L_2\right)}{\sqrt{z^2+(-H+x)^2}} \Bigg)\Bigg)
\end{aligned}
\tag{2}
$$

$$
\begin{aligned}
M_1^5 = &-\frac{D^2 g m}{4I}\sin^2(\beta) \\
&-\frac{D^2}{4I}\sin(\beta)\cos(\beta)\left(\frac{Dm}{2}\dot{\beta}^2\sin(\beta)+\frac{k_{cable}x}{\sqrt{x^2+z^2}}\left(L_1-\sqrt{x^2+z^2}\right)\left(\sqrt{x^2+z^2}\right.\right. \\
&\geq L_1\Big)+\frac{k_{cable}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\left(L_2-\sqrt{z^2+(-H+x)^2}\right)\left(\sqrt{z^2+(-H+x)^2}\right. \\
&\geq L_2\Big)+\frac{x}{\sqrt{x^2+z^2}}\left(-\frac{cx\dot{x}}{\sqrt{x^2+z^2}}\left(\sqrt{x^2+z^2}\right.\right. \\
&\geq L_1\Big)-\frac{cz\dot{z}}{\sqrt{x^2+z^2}}\left(\sqrt{x^2+z^2}\right. \\
&\geq L_1\Big)\Big)\Big)+\frac{1}{\sqrt{z^2+(-H+x)^2}}(-H \\
&\qquad\qquad +x)\left(-\frac{c\dot{x}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\left(\sqrt{z^2+(-H+x)^2}\right.\right. \\
&\geq L_2\Big)-\frac{cz\dot{z}\left(\sqrt{z^2+(-H+x)^2}\geq L_2\right)}{\sqrt{z^2+(-H+x)^2}}\Bigg)\Bigg)+\left(\frac{D^2}{4I}\sin^2(\beta)+\frac{1}{m}\right)\left(\frac{Dm}{2}\dot{\beta}^2\cos(\beta)\right. \\
&\qquad\qquad +gm+\frac{k_{cable}z}{\sqrt{x^2+z^2}}\left(L_1-\sqrt{x^2+z^2}\right)\left(\sqrt{x^2+z^2}\right. \\
&\geq L_1\Big)+\frac{k_{cable}z}{\sqrt{z^2+(-H+x)^2}}\left(L_2-\sqrt{z^2+(-H+x)^2}\right)\left(\sqrt{z^2+(-H+x)^2}\right. \\
&\geq L_2\Big)+\frac{z}{\sqrt{z^2+(-H+x)^2}}\left(-\frac{c\dot{x}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\left(\sqrt{z^2+(-H+x)^2}\right.\right. \\
&\geq L_2\Big)-\frac{cz\dot{z}\left(\sqrt{z^2+(-H+x)^2}\geq L_2\right)}{\sqrt{z^2+(-H+x)^2}}\Bigg)+\frac{z}{\sqrt{x^2+z^2}}\left(-\frac{cx\dot{x}}{\sqrt{x^2+z^2}}\left(\sqrt{x^2+z^2}\right.\right. \\
&\geq L_1\Big)-\frac{cz\dot{z}}{\sqrt{x^2+z^2}}\left(\sqrt{x^2+z^2}\right. \\
&\geq L_1\Big)\Big)\Bigg)
\end{aligned} \tag{3}
$$

$$
\begin{aligned}
M_1^6 = &-\frac{Dgm}{2I}\sin(\beta) \\
&+\frac{D}{2I}\sin(\beta)\Bigg(\frac{Dm}{2}\dot{\beta}^2\cos(\beta)+gm+\frac{k_{cable}z}{\sqrt{x^2+z^2}}\left(L_1-\sqrt{x^2+z^2}\right)\Big(\sqrt{x^2+z^2} \\
&\geq L_1\Big)+\frac{k_{cable}z}{\sqrt{z^2+(-H+x)^2}}\left(L_2-\sqrt{z^2+(-H+x)^2}\right)\Big(\sqrt{z^2+(-H+x)^2} \\
&\geq L_2\Big)+\frac{z}{\sqrt{z^2+(-H+x)^2}}\Bigg(-\frac{c\dot{x}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\Big(\sqrt{z^2+(-H+x)^2} \\
&\geq L_2\Big)-\frac{cz\dot{z}\left(\sqrt{z^2+(-H+x)^2}\geq L_2\right)}{\sqrt{z^2+(-H+x)^2}}\Bigg)+\frac{z}{\sqrt{x^2+z^2}}\Big(-\frac{cx\dot{x}}{\sqrt{x^2+z^2}}\Big(\sqrt{x^2+z^2} \\
&\geq L_1\Big)-\frac{cz\dot{z}}{\sqrt{x^2+z^2}}\Big(\sqrt{x^2+z^2} \\
&\geq L_1\Big)\Big)\Bigg)-\frac{D}{2I}\cos(\beta)\Bigg(\frac{Dm}{2}\dot{\beta}^2\sin(\beta)+\frac{k_{cable}x}{\sqrt{x^2+z^2}}\left(L_1-\sqrt{x^2+z^2}\right)\Big(\sqrt{x^2+z^2} \\
&\geq L_1\Big)+\frac{k_{cable}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\left(L_2-\sqrt{z^2+(-H+x)^2}\right)\Big(\sqrt{z^2+(-H+x)^2} \\
&\geq L_2\Big)+\frac{x}{\sqrt{x^2+z^2}}\Big(-\frac{cx\dot{x}}{\sqrt{x^2+z^2}}\Big(\sqrt{x^2+z^2} \\
&\geq L_1\Big)-\frac{cz\dot{z}}{\sqrt{x^2+z^2}}\Big(\sqrt{x^2+z^2} \\
&\geq L_1\Big)\Big)+\frac{1}{\sqrt{z^2+(-H+x)^2}}(-H \\
&\qquad\qquad\qquad +x)\Bigg(-\frac{c\dot{x}}{\sqrt{z^2+(-H+x)^2}}(-H+x)\Big(\sqrt{z^2+(-H+x)^2} \\
&\geq L_2\Big)-\frac{cz\dot{z}\left(\sqrt{z^2+(-H+x)^2}\geq L_2\right)}{\sqrt{z^2+(-H+x)^2}}\Bigg)\Bigg)
\end{aligned}
\tag{4}
$$

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Montgomery, Forrest Bachelor of Science, University of Louisiana at Lafayette, Spring 2015; Masters of Science, University of Louisiana at Lafayette, Summer 2017
Major: Mechanical Engineering
Title of Thesis: Design and Control of a LaTeX Thesis Template
Thesis Director: Dr. Joshua E. Vaughan
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ABSTRACT

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BIOGRAPHICAL SKETCH

Forrest Montgomery was born in Lafayette, Louisiana for all intents and purposes. He began his academic career at the University of Louisiana with an internal struggle between majoring in Mechanical Engineering or Industrial Design. This thesis is evident of the choice he made. After earning his Bachelor's degree at the University of Louisiana at Lafayette in the Spring of 2015, he joined the CRAWLAB and conducted research in dynamics, controls, and robotics under the tutelage of Dr. Joshua Vaughan. This research culminated with earning a Master's degree in Mechanical Engineering again at the University of Louisiana at Lafayette in the Summer of 2017.