Hexapod Robot

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***Abstract*—This report presents the design, modelling, control, simulation and analysis of an electromechanical system known as a the hexapod using matlab simulink and solid works software. A modeling procedure is described together with analytical formulas to justify our design specifications for the design specifications of the hexapod robot. Tables containing these specifications can also be found within this report. The results are based on the analysis of the simulation values obtained in matlab. Experimental results are provided for the a servo motor powered hexapod while analytical results are presented from the various calculations performed.**

***Index Terms*—Hexapod, Servo, Torque**

I. Introduction

Group 17 was given the task of designing, modeling, simulating and analysing an electromechanical system that includes different aspects of actuators and power electronics. Our group chose the hexapod robot as our choice for the electromechanical system. A hexapod is a robot with parallel kinematic positioning systems consisting of six independent actuator controlled struts or simply put a mechanical vehicle which walks on six legs. Hexapods offer several advantages over other types of multi-legged walking robots such as being able to maintain statically stable while in motion. A robot is considered to be statically stable when on three or more legs and due to the hexapods legs operating independently of each other it can still operate even when some of its legs become disabled. This combined with the fact that the hexapod acts on a single motion platform helps to eliminate the accumulation of guiding errors and increases precision. Furthermore it means that the hexapod can use its additional legs to gain new foot placements or control a payload. Hexapods are the fastest moving robot with the optimum number of legs for movements as adding more legs does not increase speed. The Hexapod will use a servo motor as its actuating device in order to move the legs. A servo motor is a rotary actuator that allows for precise control of angular position, consisting of a motor coupled to a sensor for feedback, the feedback system increases accuracy and allows the motor to precisely control the rotary motion. The servo motor was selected instead of a stepper because of it's high rate of efficiency, power and torque compared to the stepper, additionally the stepper motor produces high amount of heat when in operation which can lead to issues with the circuitry in the long run. Hexapods are useful for a variety of tasks particularly ones that can be dangerous for humans such as space exploration, undersea cable construction and rescue missions to name just few.

II. Design Specification

A. Problem Description

1) Design of a hexapod robot
2) Design must be statically stable
3) Must maintain dynamic stability when carrying a specified load
4) Modelling and simulation of hexapod robot in matlab.
5) Analysis of finished design.

B. Design Requirements

In this subsection, break the problem description down into the fundamental requirements. Your proposed design should meet each of the criteria you create.

- Robot is a hexapod therefore it should move on six legs
- In order to maintain static stability the robot should be capable of maintaining motion even when up to 3 of its legs have been disabled.
- Robot will use a servo motor as its actuating device.
- Servo motor will meet the following specifications:

TABLE I
Servo Motor Specifications

Frame Size	22.2 x 11.8 x 31 mm
Modulation	Analog
Torque	1.5 kg/cm
Stall Torque	1.2 kg/cm
Mass	9g
Speed	0.1 s/60 deg
Operational voltage	4-7.2 V
Rotational Range	180 deg
Motor Type	3-pole
Driver Input Voltage	DC
Pulse Cycle	20 ms
Pulse Width	500-2400 micro sec
Temperature Range	0-55 deg Celsius
Internal Resistance	0.31 Ohm
Motor Inductance	0.516 mH

III. Modeling and Simulation

In this section you should fully explain your design. Include any schematics, models or diagrams of the system. Show and explain the results of your simulation or model. Prove that your design meets the requirements laid out earlier. To convey this information utilize the tools described in the following subsection.

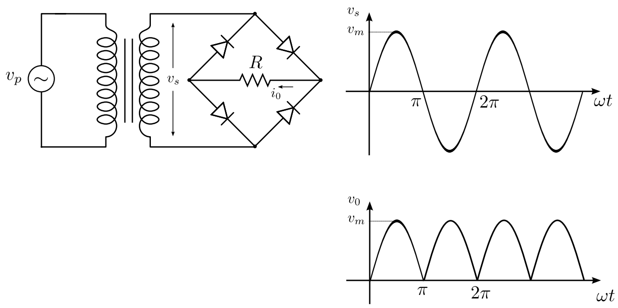

Fig. 1. An example figure. Figure captions should provide sufficient information to understand the image.

A. *Equations, Figures and Tables*

Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$i_0 = \frac{\sqrt{2}V_s}{Z}\sin(\omega t - \theta) + \left(I_0 + \frac{E}{R} - \frac{\sqrt{2}V_s}{Z}\sin\theta\right)e^t \quad (1)$$

$$I_0 = \frac{\sqrt{2}V_s}{Z}\sin(\theta)\frac{1+e^{-(R/L)(\pi/\omega)}}{1-e^{-(R/L)(\pi/\omega)}} - \frac{E}{R} \quad (2)$$

You can reference the equations above in your document by using their defined label, [1] and [2]. Steady-state: $I_0 = i_0(\omega t = 0) = i_0(\omega t = \pi)$. Individual variables can also be called, such as ω_0.

TABLE II
TABLE TYPE STYLES

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
copy	More table copy[a]		

[a]Sample of a Table footnote.

Figure Labels: Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K". See examples Fig. 1 and Fig. 2 in this document.

All figures should be clearly explained in the text. Furthermore, all figures should have a purpose, do not include irrelevant or redundant images. Doing so will only make the document more cluttered.

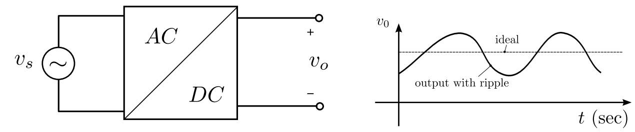

Fig. 2. An example figure. Figure captions should provide sufficient information to understand the image.

B. *References*

The value outlines how to properly include citations in your report. The sources used are only used in an example context.

Please number citations consecutively within brackets [**?**]. The sentence punctuation follows the bracket [**?**]. Refer simply to the reference number, as in [**?**]—do not use "Ref. [**?**]" or "reference [**?**]" except at the beginning of a sentence: "Reference [**?**] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [**?**]. Papers that have been accepted for publication should be cited as "in press" [**?**]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [**?**].

IV. CONCLUSION AND DISCUSSION

The conclusion should be used to address the success of your design. Answer and discuss if your design met the requirements, had good performance, etc. If applicable, suggest future improvements or applications of the design.