Pan Tilt Design report

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Abstract

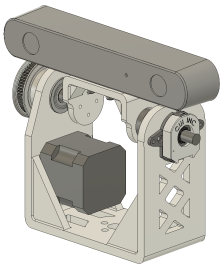
The aim of this project is to develop a 2 degree of freedom purely rotational pan-tilt mechanism which can provide stable rotation about the Yaw(for Pan) and Pitch(for Tilt) axes. This mechanism can be used for application such as terrain mapping (using a limited FOV stereo/ RGB-D camera), object tracking and as a gimbal (for stable camera feed).

1 Introduction

In this design report, the following parts are going to be covered in detail:

1. Design and fabrication
2. Component description and BOM
3. Mathematical model of system (state variable matrix, transformation matrix)
4. HSM control equations with driver
5. First step towards developing system architecture

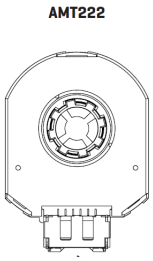
2 Design and Fabrication



3 Components used in the Tilt mechanism-

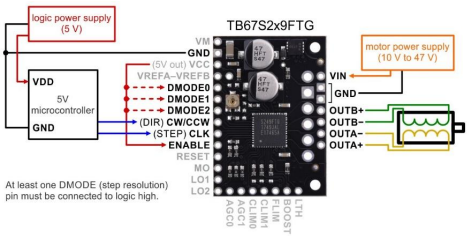
1. Stepper motor
    - Step angle = 1.8 degree/pulse or 200 pulse/revolution
    - Rated voltage = 12V
    - Rated current = 0.4A
    - Phase resistance = 30Ω
    - Phase Inductance = 60mH
    - Holding torque = 4.2kg-cm
    - Detent torque = 220g.cm
    - Rotor inertia = $54g.cm^2$
    - Weight = 0.28kg
2. CUI AMT22 MODULAR ABSOLUTE ENCODER
    - Full duplex Serial Peripheral Interface (SPI)
    - 12-bit absolute position
    - Checksum bits for error detection
    - Digitally settable zero position

PINOUT CONNECTOR	
#	Function
1	+5 V
2	SCLK
3	MOSI
4	GND
5	MISO
6	CHIP SELECT



3. IMU (accelerometer and gyroscope) -
   6-axis Gyroscope and Accelerometer used to acquire the angular velocity and linear acceleration of the camera frame w.r.t. the ground frame.

4. Stepper motor driver

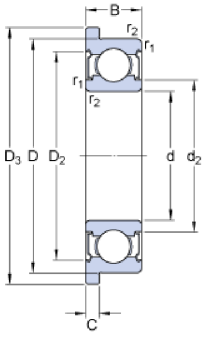


5. Timing Pulley and Belt

   - Driver pulley properties-
     - No. of teeth: 15
     - Pitch diameter: 9.70mm
   - Driven pulley properties-
     - No. of teeth: 60
     - Pitch diameter: 38.81mm
   - Timing belt properties-
     - No of grooves: 90
     - Centre-to-centre distance: 51.4 mm

6. Flanged ball bearings -

Dimensions



d		8	mm
D		22	mm
B		7	mm
d_2	≈	10.5	mm
D_2	≈	19.03	mm
D_3		25	mm
C		1.5	mm
$r_{1,2}$	min.	0.3	mm

4 Mathematical model of system

We can *emphasis* some words, i.e., make them *italic*, and we can make some words **bold**. Note how using a new line in the code does not correspond to a new line in the output file. Same if we have a large white space.

Instead, if we want a new line/new paragraph, you need to press enter twice, or use
which starts a new line but not a new paragraph.

4.1 lists

Lists can be numbered or ununmbered, and you can have sub-list inside a list.

1. This is the first item in a numbered list.
2. And the second
3. (a) Here the third item is in fact a numbered sub-list.
   (b) item 2 of the numbered sub-list
4. - Here the fourth item is an unnumbered sub-list.
   - item 2 of the unnumbered sub-list

4.2 Definitions and theorems

Definitions, theorems, lemmas and so on, are 'enviroments' (like documents and lists). They need to begin and end.

Definition 4.1. A *label* allows the user to tell Latex 'remember the numbering of that definition/theorem/equation'

Lemma 4.2. *If something has a label, then we can refer to it, without knowing what number it is*

Proof. For example, by calling up Definition 4.1. This works even if the ordering of things move. Note that the end of proof square box is already there □

Theorem 4.3. *And a final theorem*

Proof. Combining Definition 4.1 with Lemman 4.2 we get Equation 2 below. □

Figure 1: The logo for the University of Bristol

5 Hybrid Stepper Motor Control equations-

Some maths, like $\varepsilon > 0$ or $a_{23} = \alpha^3$, is written in-line. More important or complex maths is displayed on its own line. For example,

$$\lim_{x \to \infty} f(x) = \frac{\pi}{4}.$$

Sometimes you need multiple lines of maths to line up nicely:

$$\begin{aligned} f(x+y) &= (x+y, -2(x+y)) \\ &= (x, -2x) + (y, -2y) \\ &= f(x) + f(y), \end{aligned}$$

and sometimes you want to number lines in an equation

$$A^T = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}^T \tag{1}$$

$$= \begin{pmatrix} 1 & 3 \\ 2 & 4 \end{pmatrix} \tag{2}$$

6 First step towards system development-

LaTeX [1] also allows you to cite your sources. For more details on how this can be done, we refer the reader to [2, sec: Embedded System]. But once you have a bibliography, you can use the cite command easily. Finally we add Figure 1 to show how to add graphics. Note that we first need to make sure to have the graphic uploaded to Overleaf or saved in the same folder as your tex file (whichever is relevant to your case). Notice how the picture was resized using the scale command and that LaTeX determine that the picture looks better above.

References

[1] Leslie Lamport, *LaTeX: a document preparation system*, Addison Wesley, Massachusetts, 2nd edition, 1994.

[2] Wikibooks, *LaTeX/Bibliography Management*, [0nline], Accessed at https://en.wikibooks.org/wiki/LaTeX/Bibliography_Management, (DATE ACCESSED).