System description

The system is composed by:

* A DC direct drive brushed motor
* Three carts
* Three springs
* A damper
* Several weights
* Three encoders for the position
* An encoder for the motor
* A PoliArd board

The mechanism consists of up to three mass carriages interconnected by bi-directional springs. The mass carriage suspension is an anti-friction ball bearing type with approximately ± 3 cm of available travel. The linear drive is comprised of a gear rack suspended on an anti-friction carriage and pinion coupled to the motor shaft. Optical encoders measure the mass carriage positions.

Three springs can be attached between the carts or between the first cart and the base plate. A damper can be implemented in various position and finally the mass of all the carts can be adjusted using the weights provided (500 ± 5 g each).

The encoder type is CP-850-4000-ECP: it is an optical incremental digital rotary shaft encoder. The number 4000 indicates the line counter (i.e the number of equally spaced radial lines per 360 mechanical degrees on the incremental encoder code disk). A low power light source is used to generate two 90 degrees out of phase sinusoidal signals on the detectors as the moving plate rotates with respect to the stationary plate. The moving plate rotates by means of an iron string wound up in it and then attached to the cart. The position is measured by calculating the angular displacement of the disk.

The motor encoder is used to transmit both voltage and current to the Arduino board.

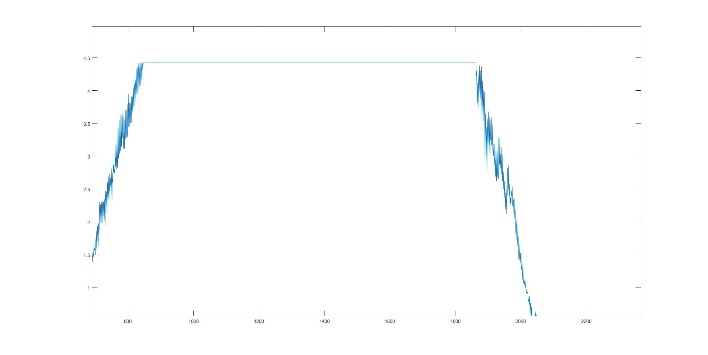
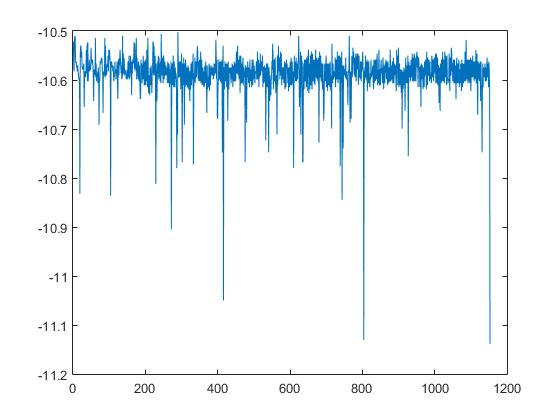
The 24 Volt DC motor has a case diameter of 63 mm and 194 Watts of output power. It has a nominal speed of 3700 rpm and a nominal Torque of mN/m. The DC motor has nominally a resistance of 0.7 Ω and an inductance of 1.05 mH.

The poliArd board mounts an Arduino Due board. The board has a 24 V power supply and it’s capable of measuring up to 5 A current. It has two motor drivers and four encoder interfaces. The board is programmable and the control strategy can be implemented using Matlab 2015a.

Issues

-Motor saturation

From simple test it’s easy to see that the motor current saturates. What it’s interesting is that the motor is able to generate only a given amount of positive current and another one for the negative values. In particular, we can see from Figures (specificare numero!!!) that the motor saturates to 4,42 A and almost -10 A. (!!! Prendere i valori da saturazione.m)



In any case the Arduino Due cannot measure more than 5A current as the datasheet specifies so from this point onward we will limit all test currents to 5A in both directions. Even in this way a difference remains between positive current and negative.

-Encoder signal

Another problem is the one of the signal given by the encoders. This signal is a voltage impulse given to the Arduino. Unfortunately, the measure showed by Poliscope is not in centimetres so we had to convert it. The idea was to give a reference signal in an open loop configuration. Once the transient is passed we measured both Poliscope value and the real displacement of the car. The Tables (!!!numero) show the values of the various measurements. The final column shows the ratio between the Poliscope value and the displacement. This ratio has a mean value of 560(!!! facciamolo bene) so is the value we used to convert all the measurements for our experiments from now on.

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| |  |  |  |  | | --- | --- | --- | --- | | **High stifness spring** | | | | | Input (Volt) | Poliscope | Length (cm) | Ratio | | 1,5 | -120 | -0,2 | 600 | | 2 | -233 | -0,4 | 582,5 | | 2,5 | -266 | -0,5 | 532 | | 3,5 | -430 | -0,8 | 537,5 | | 4 | -500 | -0,9 | 555,5555556 | | 4,5 | -550 | -1 | 550 | | 5,4 | -650 | -1,2 | 541,6666667 | | 7,2 | -1030 | -1,8 | 572,2222222 | | 9 | -1350 | -2,4 | 562,5 | | |  |  |  |  | | --- | --- | --- | --- | | **Medium stifness spring** | | | | | Input (Volt) | Poliscope | Lenght (cm) | Ratio | | 1 | -60 | -0,1 | 600 | | 1,5 | -310 | -0,55 | 563,63636 | | 2 | -530 | -1 | 530 | | 2,5 | -680 | -1,2 | 566,66667 | | 3 | -880 | -1,55 | 567,74194 | | 3,5 | -990 | -1,8 | 550 | | 4 | -1170 | -2,1 | 557,14286 | |  |  |  |  |  |  |
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| |  |  |  |  | | --- | --- | --- | --- | | **Low stifness spring** | | | | | Input (Volt) | Poliscope | Lenght (cm) | Ratio | | 1,5 | -510 | -0,9 | 566,667 | | 2 | -900 | -1,6 | 562,5 | | 2,5 | -1050 | -1,9 | 552,632 | | 3 | -1335 | -2,4 | 556,25 | |  |  |  |  |  |  |  |

System protection