Mini Project

Elevator Drive System

The elevator system shown in Fig.1.a is driven by a permanent magnet excited brushed DC machine. The characteristics of this system are as below:

- The empty weight of the cabin, M_c = 1000 kg
- Maximum load capability of the system: $M_{load-max}$ = 500 kg
- Mass of the counterweight, M_{cw} = 1250 kg
- Elevation: 10 m
- The maximum speed of the cabin: $v_{cabin-max}$=2 m/s
- The acceleration and deceleration of the cabin: $|a_{cabin-max}|$=1 m/s
- Gear box ratio (ω_{em} /ω_{drum}) = 5
- Diameter of the drum: D_{drum} = 0.4 m
- Inertia of the DC machine + gear box referred to machine shaft: J_{em} = 0.2 kgm^2

As shown in Fig.1.b, the elevator has a speed controller with a cascaded current controller. The mechanical brakes are activated when the elevator reaches to the desired location. The speed vs. time characteristics of the elevator for moving upwards and then downwards is shown Figure.1.c. The permanent magnet excited brushed DC machine has the following parameters.

- Rated armature voltage, V_a^{rated} = 200 V
- Rated armature current, I_a^{rated} = 75 A
- Armature resistance, R_a = 0.1 Ω
- Armature inductance, L_a = 2 mH
- Torque constant, K_t = 1.75 Nm/A
- Back EMF constant, K_b = 1.75 Vs/rad

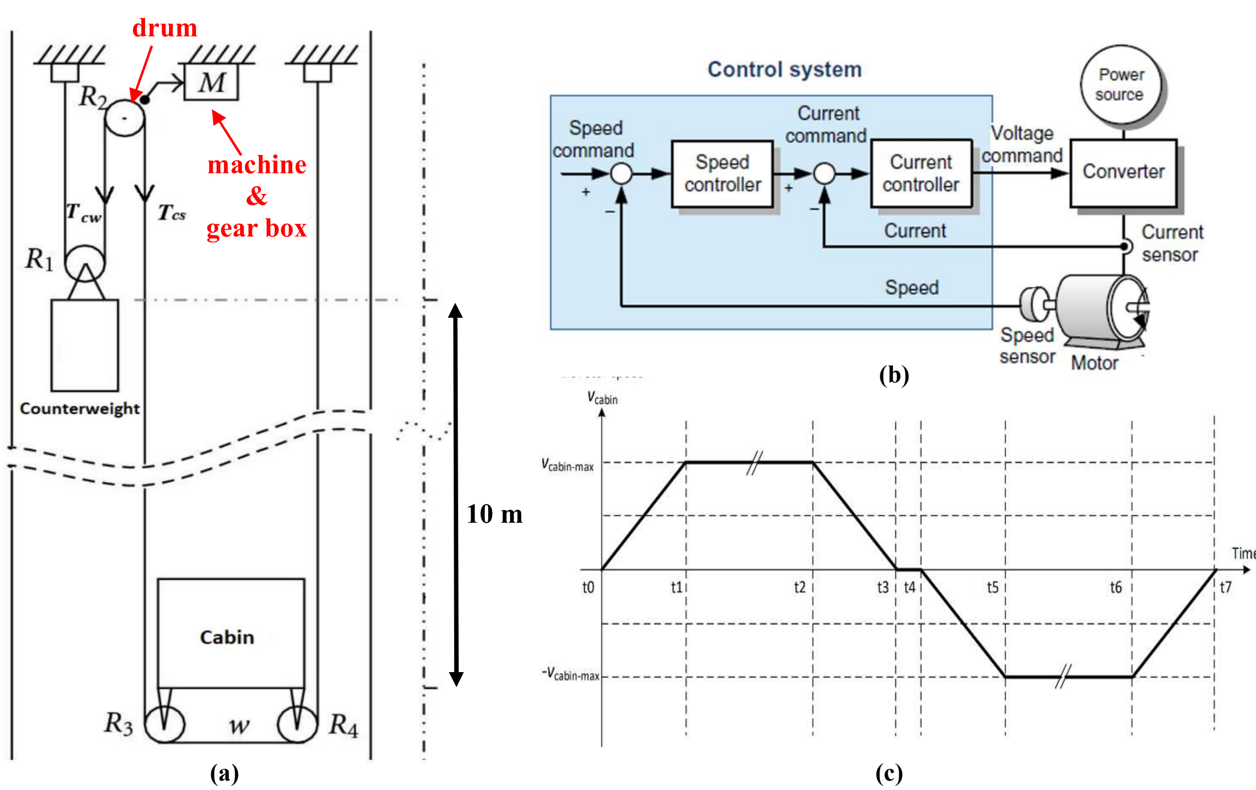

Fig.1. (a) Considered elevator system, (b) Control system schematic diagram, (c) Speed vs. time graph of the cabin

1. Design the control system. Ignore all the losses and friction in the system. Assume ropes, pulleys and drum to be massless. You can use PI regulators for both outer speed and inner current controls.
2. Simulate the system using a simple Simulink model for various loading conditions and comment on the performance of the controller. Some of performance assessment criteria are as follows:
   - Deviation from desired speed-time characteristics given in Fig.1.c,
   - Deviations from the maximum speed, maximum acceleration, and desired travelling time,
   - Maximum cabin speed at mechanical breaking instant.

   Based in the simulations, improve your design (if necessary).
3. Suppose that, the viscous friction coefficient of the DC machine + gear box referred to machine shaft, bem = 0.05 Nms/rad. Does the controller performance deteriorate when this friction is accounted?
4. Build a detailed Simulink model of the system that contains the full bridge DC-DC converter.

   The converter and DC machine will be modelled at electrical side, whereas the converter control and mechanical system will be modelled at control side in Simulink.

The project report will be written in IEEE conference format (MS Word template is available at https://www.ieee.org/conferences/publishing/templates.html). The report will consist of

- Introduction which briefly explains elevator drive systems,
- Description of the considered elevator system,
- Proposed controller and design details (including the simple Simulink model used for preliminary performance evaluation),
- Detailed Simulink simulations for validation.
- Conclusion.

This project can be conducted in groups (consists of two students).

Submission deadline: 16 June 2024