Reviewers Comments

Student: Bc. Murat Unver

Reviewer: Ing. Peter Mark Beneš

Diploma Work: Study of Incremental Machine Learning Algorithms for 2-2 Linear MIMO System with Prospects to Control Actively Actuated Double Wheel Set Roller Rig

Review:

The topic of this students diploma work significantly contributes to the field of higher order neural unit (HONU) adaptive control as a subclass of model reference adaptive control (MRAC) design. Till this day numerous works have investigated the control loop design and study of fundamental learning algorithms for application to single-input-single-output (SISO) engineering systems, however further study to multiple-input-multiple-output (MIMO) engineering systems remains to be an open topic. Therefore, the originality and scientific contribution is significant, with the main contribution of this diploma work being the derivation and design of a 2-2 MIMO HONU-MRAC control loop along with insight to a practical application the CTU Roller Rig.

Apart from the originality and strong contribution via the topic, the quality of the diploma work lacks in certain areas. A stronger literature review could have been presented, in the introduction section only one reference to SISO application of HONU adaptive control was cited. Further, MIMO adaptive control is a widely published topic, perhaps another page of other control loop designs for MIMO adaptive control in the field of neural networks would enhance the literature review of this thesis. On page 5 the presented plots do not clearly state which particular input/outputs or states of the process are being illustrated, however on page 8-9 this was illustrated in the legend. Further the plot axes are missing labelling which makes it harder for the reader to understand the values being presented. In chapter 3.3.2 the LNU algorithm presented features training via RLS algorithm, however the Table 5-6 states the learning algorithm was GD. Further, following the section on page 27 a comparison in one graph could be added or summary table to also illustrate the differences in performance between the GD and RLS learning algorithms.

Regarding the presented practical application, the actively actuated double wheelset roller rig (CTU roller rig) is a quite complex system to understand and study for application to control, especially as a MIMO configuration. It is admirable that the student took on board the challenge and in spite complications in the provided numerical simulation model of the roller rig being unstable, that a similar dynamical system was studied with connotations to application on the roller rig. However, the mechanical description behind the presented model was lacking in the presented description of the system (chapter 5). This may also have helped to provide a stable, more simplified state-space model for further analysis on control. Further, programming toolboxes as such Matlab could have been utilized for studying pole-placement methods to stabilize the existing plant model. But this is quite an advanced topic beyond the expectations of a Master's level for such order of system. Overall I feel a good contribution was made in deriving and implementing the theory behind MIMO HONUs based on MRAC design further, the student showcased a good understanding of the quite challenging subject and with this work provides a good foundation for other students or researchers who look towards continuing study on the topic. I therefore recommend an overall grade of C (good), provided that the student can answer the below listed questions.

Recommend Grade:

C (Good)

Reviewers Questions:

1) Adaptive control design in the field of neural networks is quite broad and many applications have been studied with focus to MIMO systems. Can you state one or two other methods? What are the advantages behind your presented approach compared to these other methods?

2) It seems in most presented results a fixed sampling interval of dT=0.1 was used. Was this interval fixed for both the plant model sampling and the HONU plant/control loop sampling (i.e. are they the same)? Did you try different sampling of the HONU control loop and standalone plant model sampling? Can you comment on the effect of sampling for the linear oscillation MIMO plant?

3) The application of an actively actuated double-wheel set roller rig in chapter 5 does not detail what physical input variables were used. Was the step response given as an applied yaw torque? Or servo motor position? Can you name the main states of the system which we desire to control from this model?

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