PRACTICAL ASSIGNMENT FOR THE COURSE
FILTERING AND IDENTIFICATION (SC4040)

1 Introduction

This assignment is part of the course *Filtering and Identification (SC4040)*. It is intended to be solved by a group of two students. The goal is to identify LTI models from data collected from a flexible beam structure. You are given:

- The description of the assignment and the system that generated the data sets (which you are reading now).
- Seven data sets of input and output measurements.

The data set can be downloaded from the Blackboard site for SC4040. You need to use the computer program MATLAB and the LTI Toolbox to solve this exercise. A short report should be written on the results.

2 Prerequisites

It is assumed that you:

- understand the course material of *Filtering and System Identification*,
- have some experience in the use of the computer program MATLAB and the LTI Toolbox.

To familiarize with the LTI Toolbox, refer to its documentation (Companion.pdf). See the section on 'Course material' below for more details.

3 Objectives

After solving this exercise you can identify an LTI state-space model from a finite set of input and output measurements. You have an idea on how to choose a suitable input when you are going to identify a real life system. You are also able to evaluate the quality of this model and motivate its suitability.

4 Description of the assignment

The assignment is intended to put into practice the "identification cycle" which is treated in the last chapter of the course book. Since there is too little time to let each group do their own experiment(s) we provide a number of different datasets, which each relate to the guidelines and conditions in the identification cycle in a certain way.
Consider the flexible beam structure depicted in Figure 1. Six piezos are bonded to the beam, three of which are visible in the photograph and three of which are located at the rear of the beam. These piezos can either be used to develop a strain when a voltage is applied to them (causing the beam to bend) or they can detect a strain by emitting a voltage when the beam is bent. In the setup used here, piezos 1 and 3 are used as actuators, whereas piezos 2, 4, 5 and 6 are used as sensors. For this system the maximum voltage that can be supplied is 250 Volt before the actuators saturate. The constraint on the

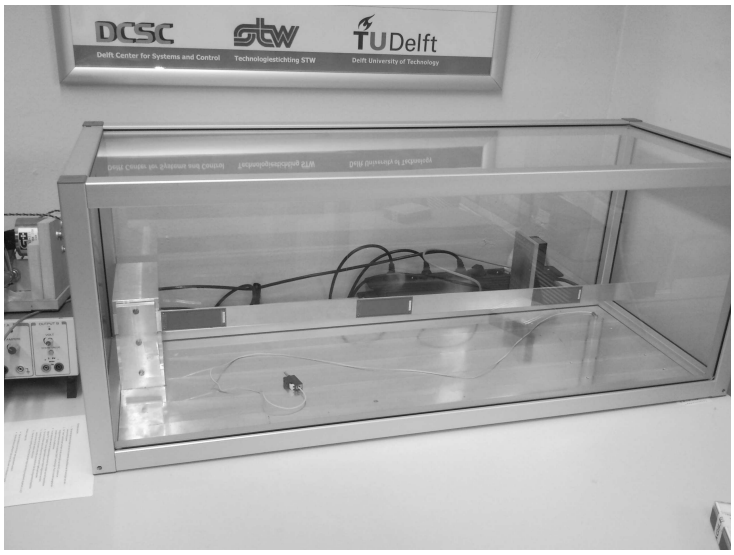

Figure 1: The flexible beam setup.

sensor outputs is 10 Volt before the electronic amplifiers saturate.
You are given 7 different input sets with corresponding output sets collected from the flexible beam structure. You will identify the real life system with a data set of your choice. The channels (rows) in the data sets are defined as:

- 1 – time (seconds);
- 2-5 – measurements from piezos 2, 4, 5 and 6 (Volts);
- 6-7 – signals sent to piezos 1 and 3 (Volts).
- 8 – sample counter (not used).

You will need to consider all data sets. This means you are supposed to start the identification cycle with 7 sets and end with one or several which you think are most suitable. Any time during the identification process you are allowed to dismiss a set when you find it is unsuitable. You have to clearly state when during the cycle and why you dismiss a certain set. Evaluate the quality of your resulting LTI-state model and motivate why you think it is a good model. To find the best model you may need to try identifying different models per input/output set and compare their performance.

5 Desired output

One short (**max. 25 pages**), but clearly structured and written, report must be written by each group that contains:

- a description of the identified model (which input/output set did you use?).
- a description of the input/output sets you did not use, when did you dismiss them and for what reason?
- a description of the steps that were taken to identify the model.
- a motivation of the steps that were taken to identify the model.
- an evaluation of the quality of the identified model.
- a motivation of the suitability of the identified model.

The cover page of the report must at least list the following information:

- names of the students.
- student numbers.
- date.

The report must be handed in on paper no later than the deadline stated on Blackboard in the mailbox of the DCSC department (Wing E, second floor, next to the secretariat) or in Edwin van Solingen's office (room E–4–330).

6 Grading

You will receive a grade between 1 and 10. To pass the course *Filtering and Identification* your grade for this assignment must be larger or equal to 6.

7 Course material

In solving this assignment you are encouraged to use the following material:

- Course book: *Filtering and System Identification: A Least Squares Approach*;
- MATLAB software: *LTI toolbox*, available for download from the Blackboard site.
- Software manual of the LTI toolbox: *Filtering and System Identification: An Introduction to using Matlab Software*, available from same location as the LTI Toolbox (Companion.pdf).

The book describes several identification methods. It also describes the different steps that need to be taken to identify a model from measured data. The MATLAB software can be used to perform the numerical computations that are needed. The software manual describes the use of the MATLAB functions and their relation to the methods presented in the book.

For this practical exercise you need access to a computer running MATLAB. Students that do not have access to MATLAB can contact a member of the teaching team.

Note that there is another toolbox, the 'System Identification' toolbox, available for MATLAB. *Please do not use this toolbox, use the LTI Toolbox as described above.*

8 More information

For questions regarding this assignment you can contact:

- ir. Edwin van Solingen (not available 23-12-2013 until 03-01-2014)
  `E.vanSolingen@tudelft.nl`