

# Control Relevant Identification of a Compact Disc Pick-up Mechanism

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## Abstract

This paper discusses the control relevant parametric identification of a servo system present in a Compact Disc player. In this application an approximate closed loop identification problem is solved in order to come up with a linear multivariable discrete time model, suitable for control design. This identification problem is handled by a recently introduced two stage method. It yields an explicit and tunable expression for the bias distribution of the model being estimated, clearly showing the dynamics of the closed loop system in the (asymptotic) approximation criterion. This result will be exploited to identify the model in a control relevant way by additional data filtering. The recently introduced method in [23] for model uncertainty quantification is used to construct an upper bound for the corresponding model error.

## 1 Introduction

Compact Disc players use an optical decoding device to reproduce high quality audio from a digitally coded signal, recorded as a spiral track on a reflective disc, see also [2]. An increasing amount of equivalent optical devices will be used in portable applications, having severe shock disturbances. The track following properties of a CD player, operating in these conditions, could be improved by designing an enhanced multivariable controller. The intention of this paper is to estimate a (nominal) multivariable FDUT (Finite Dimensional Linear Time Invariant) dynamical model, obtained from closed loop experiments, which can be used for control design. Additionally, the procedure presented in [20] is used for a quantification of the resulting model error by estimating a non-parametric additive model uncertainty.

There is a growing interest in merging the problems of control design and identification. On the one hand this is caused by the fact that from a robust control design point of view we require expressions for model uncertainty that have to be used in robust control design procedures. On the other hand the (nominal) models used to design control systems very often will have to be gathered by experimental methods.

Practically it is impossible to exactly characterize all phenomena that describe the dynamical behaviour of a physical system and the corresponding models will necessarily be approximative. Furthermore, control design methods can get unmanageable if they are applied to models of high complexity. Since the validity of any approximate model hinges on its intended use, the identification procedure being applied will be subjected to several requirements, in order to provide estimated models that are suitable for control design. These considerations have resulted in the statement that the best model for control design cannot be derived from open loop experiments alone [1, 16].

A control relevant identification requires that the relevant dynamical behaviour of the system is estimated while it operates in a closed loop configuration with the controller to be designed.

Since the controller obtained from the control design is (yet) unknown, this will generally lead to an iterative scheme of identification and control design, using the controller of step  $i-1$  to estimate a model for step  $i$ . This has led to study several different types of iterative schemes of identification and control design, see [6, 10, 11, 15, 17, 24].

In this paper we concentrate on one identification step in such an iterative procedure. Within the framework of prediction error identification [12] we will identify a multivariable control relevant approximate model, employing a number of recently introduced methods. An indirect (two-stage) method [18] will be employed to perform the approximate closed loop identification. The basic advantage of this approach is that an overall approximate identification results, in which the asymptotic bias distribution of the identified model becomes an explicit and tunable expression that is independent of the (unknown) noise disturbance on the data. Additional data filtering is applied to tune the approximation criterion to become a control relevant criterion.

The outline of this paper is as follows. First a concise description of the Compact Disc pick-up mechanism and the experimental set up is given in section 2. Next some preliminary notation is discussed. In section 4 we pay attention to the specific two-stage identification procedure, while in section 5 we discuss the use of orthonormal basis functions that are employed in the first stage of the procedure. Next, the control relevance of the identification approach is given attention and in section 6 we will present the experimental results.

## 2 Compact Disc Mechanism

The CD mechanism consists of a turn table DC-motor for the rotation of the Compact Disc and a radial arm in order to follow the track of the disc. Furthermore, an OPU (Optical Pick-up Unit) is mounted on the end of the balanced radial arm to read the digitally coded signal, recorded on the disc. Schematically the CD mechanism is given in figure 1.

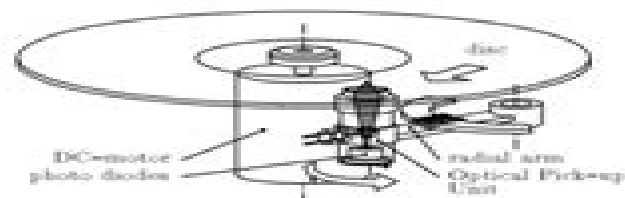


Fig. 1: Schematic view of CD mechanism

A diode generates a laser beam that passes through a series of optical lenses in the OPU to give a spot on the disc surface.

<sup>1</sup>The work of Raymond de Callafon is sponsored by the Dutch "Systems and Control Theory Network".

# Identification For Control Design With Application To A Compact Disk Mechanism

**Anthony S. Fauci**



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annual visit rate 1581 1000 of any age group for all sources of family planning services combined Visit rates declined sharply with age from 1447 at ages 15 24 to 479 at ages 35 44 Similar declines with age also were found in the visit rates for white and black women separately Nevertheless the annual visit rate for black women 1334 1000 was significantly higher than that for white women 1033 The highest overall visit rate was for black women 15 19 years of age 1867 1000 Nearly 2 3 of all family planning visits were to private medical sources Teenagers of all races had higher family planning service visit rates to clinics than to private medical sources as did black women age 15 24 White women age 20 and older had higher visit rates to private medical services than to clinics Never married women had higher visit rates to clinics than currently or formerly married women Data were also collected in 1982 on use of medical services for infertility by women who had difficulty in conceiving or carrying a pregnancy to term About 1 million ever married women had 1 or more infertility visits in the 12 months before the interview During the 3 years before interview about 1 9 million women had infertility visits For all ever married women as well as for white and black women separately infertility services were more likely to be secured from private medical sources than from clinics The survey design reliability of the estimates and the terms used are explained in the technical notes

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