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Tokamak Magnetic Control Simulation: Applications for JT60-SA and ISTTOK Operation.

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ABSTRACT

Abstract en ingles

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RESUMO

Abstract em tuga

Palavras-chave:

SOMMARIO

Abstract em italiano

Parole chiave:

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LIST OF ABBREVIATIONS

@TODO: Review variable lists as writing the thesis

- AC - Alternating Current
- ADC - Analog to Digital Converter
- ATCA - Advanced Telecommunications Computing Architecture
- CREATE - Consorzio di Ricerca per l'Energia, l'Automazione e le Tecnologie dell'Elettromagnetismo
- DAC - Digital to Analog Converter
- EO - Electronic Offset
- IST - Istituto Superior Técnico
- LQR - Linear Quadratic Regulator
- MARTe - Multi-threaded Application Real-Time executor
- MIMO - Multiple-Input Multiple-Output
- PCS - Plasma Control System
- PF - Poloidal Field
- PID - Proportional - Integrative - Derivative
- XSC - eXtreme Shape Controller
- WO - Wiring Offset

LIST OF VARIABLES

@TODO: Review variable lists as writing the thesis

VARIABLES:

- I_p - Plasma current
- B_p - Poloidal magnetic field
- μ_0 - Vacuum permeability

INTRODUCTION

1.1 TOKAMAK PLASMA CONTROL

1.2 BEHIND THE PLASMA CURRENT

1.3 THESIS OUTLINE

PLASMA CONTROL SYSTEMS

2.1 OVERVIEW OF CONTROL SYSTEMS

The control of plasma position, shape and current among other parameters is one of the crucial engineering problems for present and future magnetic confinement devices. The Plasma Control Systems (PCS) lead with the overall control of the fusion devices being responsible also for the plasma configuration and scenarios algorithms [1, Chapter 8]. Currently different PCS's are use in the tokamaks around the world. In this chapter will be approach the "DIII-D-like" PCS and the Multi-threaded Application Real-Time executor (MARTe).

2.1.1 *DIII-D Plasma Control System*

Early documentation regarding the PCS in DIII-D reefers to digitalization of analog signals transmitted to a high speed processor executing a shape control algorithm [3]

2.2 MARTE FRAMEWORK

MARTe was developed in order to standardize general real-time control systems for the execution of control algorithms. MARTe framework is based on a multiplatform C++ library. [2]

PLASMA CONTROL SYSTEMS

2.2.1 *MARTe architecture*

2.2.2 *Hardware containers*

2.2.3 *MARTe 2.0*

2.3 EQUILIBRIUM AND CONTROL ALGORITHMS

2.3.1 *PID control*

2.3.2 *Multiple-Input Multiple-Output control*

JT60-SA CONTROL DESIGN

3.1 MACHINE DESCRIPTION

3.2 CREATE TOOLS

3.3 CONTROLLER DESIGNS

3.4 QST TOOLS IMPLEMENTATION

3.5 SIMULATION RESULTS

ISTTOK

4.1 MACHINE DESCRIPTION

4.2 DIAGNOSTICS AND ACTUATORS

4.3 ATCA-MIMO-ISOL BOARDS

4.3.1 *Hardware layout*

4.3.2 *Real-time integration software*

4.4 RETRIEVING THE CONTRIBUTION OF PLASMA CURRENT

The methods of correction of the magnetic error fields due to inaccuracies of tokamak manufacturing and assembly are considered. The problems of the plasma position and shape reconstruction based on magnetic field measurements are discussed.

4.5 PLASMA CENTROID POSITION DETERMINATION

ISTTOK RESULTS

5.1 GENERAL APPLICATION MODULES IMPLEMENTATIONS

5.2 PID CONTROL IMPLEMENTATION

5.3 MULTIPLE-INPUT MULTIPLE-OUTPUT CONTROL IMPLEMENTATION

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CONCLUSIONS

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DEMONSTRATIONS
