CONTAINMENT CONTROL BASED ON OUTPUT-FEEDBACK FOR MULTI-AGENTS SYSTEM WITH NON-LINEARITY ELEMENT

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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DEDICATION

This thesis is dedicated to my dearly cherished parents and friends, as well as to the greatness of Allah. Not to mention my wonderful supervisor who never stopped teaching me and who never stopped providing me with guidance and motivation to finish this thesis. Also for my brother and sister, who has never left my side, no matter what the situations have been, and has always been there to lend their support. To all of my roommates who inspire me, assist me, give me ideas, and share their knowledge with me. This research is dedicated to all of the special persons in my life who have a profound impact on me and who have shown me love.

ABSTRACT

This research takes into consideration the containment control problem based on the output feedback for the multi-agents system with non-linearity elements for the continuous time period and numerous different forms of spanning tree forest communication topology. When a multi-agent system is contained by a moving leader, each agent's potential to reach a containment outcome is the main problem. In order to keep the system stable, the containment control leader must have control over the follower's blockade. Since the non-linearity elements were added into the model, we built the containment controller for non-linearity elements system to analyze the stability of a system with and without these non-linearity elements. Using MATLAB, verify the system's performance in a simulation.The Hurwitz stabilization must be applied in order to verify that the system has reached a stable state. It is essential to demonstrate, through stabilisation, that the controller system is capable of containing the follower and that the system itself is stable. Stabilizing the system may be achieved using the methodology. Following that, the network structure will be analysed depending on the structure of the network. System stability could be verified using simulation data as an example given. The goals of this research have been met with great success, as the final result is stable and able to reach containment. Some recommendations to improve the system include adding more non-linearity components and leaders, introducing new controllers, apply switching leaders and others.

ABSTRAK

Penyelidikan ini mengambil kira masalah kawalan pembendungan berdasarkan hasil keluaran untuk sistem berbilang agen dengan elemen bukan leneariti untuk tempoh masa berterusan dan pelbagai bentuk topologi komunikasi perhubungan. Apabila sistem berbilang ejen terkandung oleh pemimpin yang bergerak, potensi setiap ejen untuk mencapai hasil pembendungan adalah masalah utama. Untuk memastikan sistem stabil, ketua kawalan pembendungan mesti mempunyai kawalan ke atas lingkungan pengikut. Memandangkan elemen bukan lineariti telah ditambahkan ke dalam sistem, kami membina pengawal pembendungan untuk sistem elemen bukan linear untuk menganalisis kestabilan sistem dengan dan tanpa elemen bukan linear ini. Menggunakan MATLAB, sahkan prestasi sistem dalam simulasi. Penstabilan Hurwitz mesti digunakan untuk mengesahkan bahawa sistem telah mencapai keadaan stabil. Adalah penting untuk menunjukkan, melalui penstabilan, bahawa sistem pengawal mampu mengawal pengikut dan sistem itu sendiri adalah stabil. Menstabilkan sistem boleh dicapai menggunakan metodologi. Selepas itu, struktur perhubungan akan dianalisis bergantung kepada struktur rangkaian. Kestabilan sistem boleh disahkan menggunakan data simulasi sebagai contoh yang diberikan. Matlamat penyelidikan ini telah dicapai dengan kejayaan yang besar, kerana keputusan akhir adalah stabil dan dapat mencapai lingkungan pembendungan. Beberapa pengesyoran untuk menambah baik sistem termasuk menambah lebih banyak komponen bukan linear, memperkenalkan pengawal baharu, memperkenalkan penukaran ketua dan lain-lain.

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MAS Multi-Agents System.

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L Laplacian Matrix.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The field of control system research has paid a large amount of attention in recent decades to a sort of cooperative control known as consensus control. This type of control has garnered a significant amount of attention in recent years. It is a control action for interconnected multi-agents systems that rely on relevant data of each agent in the network neighbourhood in terms of reaching agreement [1]. This idea comes from the field of computer science. It is based on a notion. The term "network consensus" refers to a situation in which the states or outputs of all agents that are exposed to a particular communication network topology converging to specified quantities of interest [2]. When all of the subsystems are controlled to accomplish the same control objective, a control system has what is also known as consensus control.It was the primary goal of consensus for multi-agent systems to bring them all together in a single state. As a group, they came up with a decision value. The decision making value was not determined by centralised systems, but rather by each agent using its own and neighbouring information [3].Consensus output is another name for the result of such a control system.

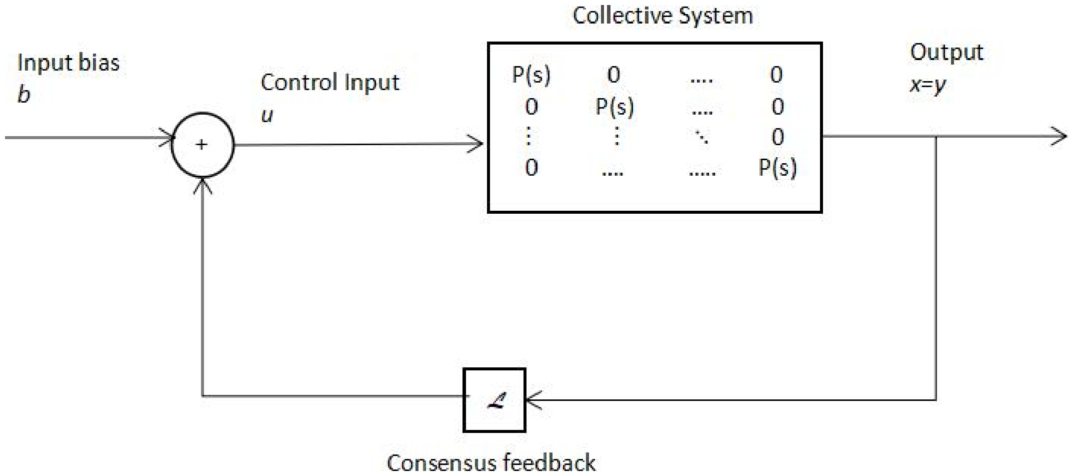

Figure 1.1: The concept of consensus control.

In [4] mentioned that the problem is a result of communication delays between leaders and their subordinates. There are three types of communication delays to recognise: uniform, non - uniform, and time-varying.A great deal of attention has been devoted to the concept of consensus control as a kind of cooperative control over the past decade. Its design typically concentrates on the communication structure, which is indicated by a unique structure known as the Laplacian structure. This is done so that each dynamical subsystem in networks with a swapping or fixed connection can accomplish the same or similar objectives or responsibilities.

When it comes to the design and analysis of consensus control systems, the connections between the subsystems are quite significant. Concepts from graph theory and control theory can be utilised to perform an analysis of the system's stability. A structure that is exclusive to the information flow between subsystems has been modelled after the tree structure of a communication network. When adopting multi-agent consensus control, all of the focus is placed on a single subsystem that has dynamics that are analogous to those of the other subsystems. This causes all of the subsystems to carry out the same action.

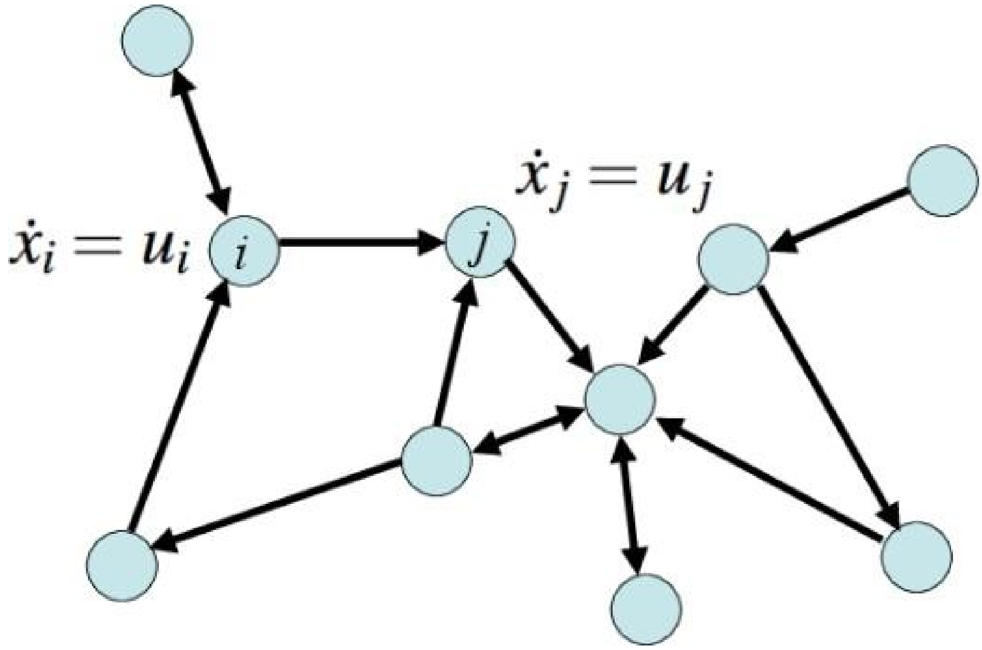

Figure 1.2: The network of Multi-Agents System (MAS).

There are a wide variety of additional applications to make use of consensus methods, including formation control, synchronisation, and others that have been developed more recently. Skills in cooperative control are utilized in various applications including such job, formation control, Cooperative search, air-craft traffic control, swarming, flocking,and another communication system [5]. Other examples of these types of applications include: Flocking and the regulation of flocking are two more instances that come to mind [6]. These applications can be categorised into three distinct kinds of data transfer among both agents: 1^{st}order systems (single-integrator), 2^{nd} order systems (double-integrator), and higher-order systems, all of which have received a significant amount of attention in recent years. Higher-order systems are the most recent type of information transfer between agents to receive a great deal of focus.

Figure 1.3: The flock of birds.

The containment control can be seen as an extension of consensus control. Unlike consensus control,in which multi-agent systems typically operate with a single leader, involves several leaders who work in a forest connection topology. The result of such a control technique is the containment of the followers by the leaders. These controllers make use of the relative state information as well as the relative output information that is provided by each agent or subsystem.

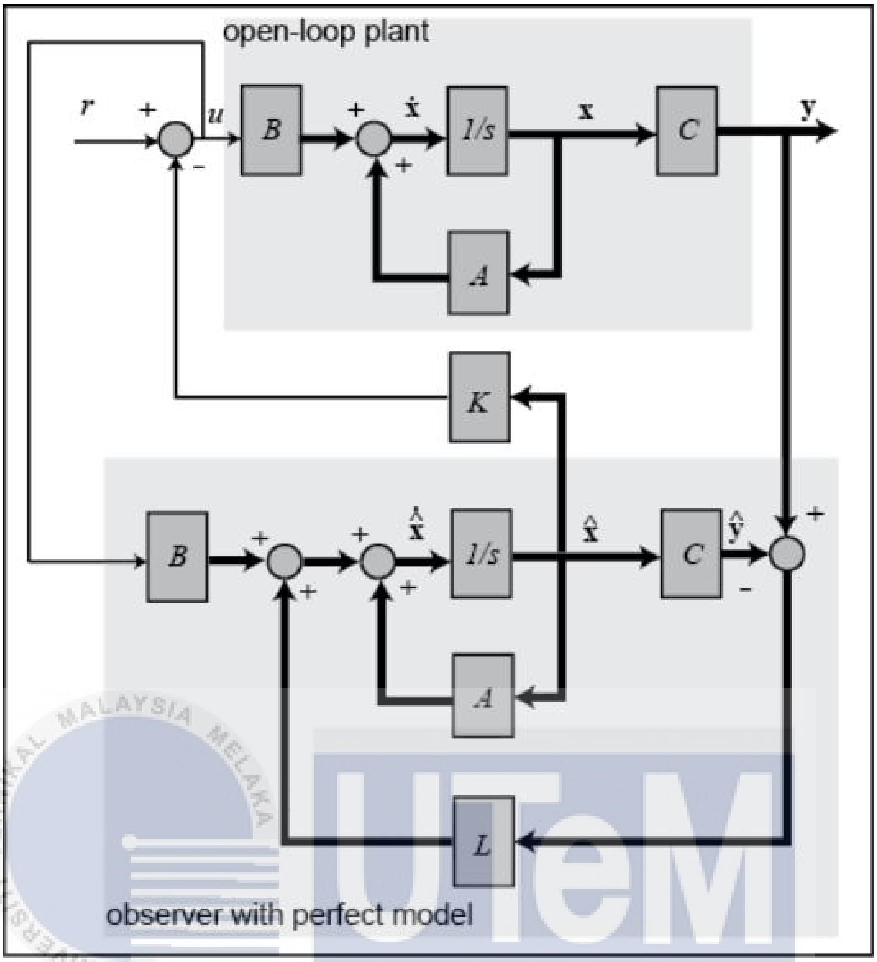

Figure 1.4: Observer model.

While observing only the output , an observer can be constructed to estimate all of the state variables when this isn't possible. There are three new predicted state variables in the magnetic ball scenario.The observer is essentially a duplicate of the plant, which has the same input and nearly a same differential equation [7].The observer is the existence scenario has defined a set of conditions that must be met in order for it to exist, but these conditions are incredibly difficult to meet in practise. To acquire the real transformation function, one must first evaluate a set of simultaneous dynamical systems. Even if these prerequisites are met, building the observer will still be difficult. In order to stabilise a completely linearizable nonlinear system, an observer-based controller is built to make extra assumptions about the plant [8].

1.1.1 Problem Statement

The primary issue arises in the containment control of multi-agent systems when these systems are contained by many leaders who move, hence hindering the ability of individual agents to arrive at a containment result. In order to keep the system from becoming unstable, the leader of the containment control must participate in the blockade of the follower.

1.1.2 Objective

i. To model the multi-agents system with non linearity elements.

ii. To design the containment controller for a multi-agents system with non linearity elements.

iii. To analyze the stability of the system with controller and without controller.

iv. To verify the outcome of the project with simulation in Matlab/Simulink.

1.1.3 Scope of Project

Firstly, the multi-agents system need to be modeled with the state-space methodology and be simulated. Then, the observer and controller been designed Analyzed to check the stability of the system with & without the controller based on the stability condition. The stability of the system will analyzed by using the Lyapunov stability. From this stability analysis, the value of controller gain and obserber gain (k and L) will be determined. To validate the system using value of k and L, the simulation is run using the MATLAB.