CHAPTER 1

INTRODUCTION

2.1 Research Motivations

Statistical process control (SPC) is a well-recognized technique for process monitoring. The main assumption of traditional SPC is that successive quality characteristic values should have no correlation with each other. However, modern manufacturing processes exhibit quality data that are serially correlated over time. These traditional control charts will give misleading results in the form of too many false alarms if the data are correlated. To address this problem, an approach called engineering process control (EPC) or automatic process control (APC) is widely used in the chemical and processing industries for variation reduction. The EPC scheme refers to an algorithm that describes how the manipulating variable of a process needs to be adjusted from observation to observation.

Recently, the run-by-run feedback control algorithms called the EWMA controllers were popular in semiconductor manufacturing, particularly in the chemical mechanical polishing (CMP) process. The performance of the controlled process output under the EWMA controllers depend on setting EWMA gains, which means that incorrectly selecting the weight will have the opposite effect on the controlled process output. When the process environment is static and the system parameters are determined, the perfect controller parameters can be obtained by mathematical modeling technology. Unfortunately, a process environment is usually dynamic in a real manufacturing world. In order to achieve a better performance in the dynamic system, developing methods of on-line tuning of the EWMA controller parameters are important issues.

1.2 Research Objectives

This study will develop and discuss time-varying weights tuning methods for the EWMA controllers. The performance of these methods will be evaluated. Finally, we will make comparisons between the proposed algorithms and the previous works. More specifically, the objectives of this research are:

(1) This study will first develop a neural-based adaptive algorithm for the single-EWMA controller. The proposed methodology could update the EWMA gain automatically, which would reduce the needs for operators to tune recipes in the process. We will make a comparison between the proposed algorithm and the Patel-Jenkins adaptive algorithm (2000).

(2) We will also develop an enhanced neural adaptive algorithm for the single EWMA controller. The proposed adaptive algorithm will be programmed in the software of Matlab/Simulink. We will also make a comparison between the proposed algorithm and the Patel-Jenkins adaptive algorithm.

(3) Due to the single-EWMA controller cannot compensate for the drifting process, a double-EWMA controller was proposed to enhance the capability for controlling the drifting process. In the literatures, the solution about the double-EWMA controller, only the “trade-off” solution weights are used to tune the controller. However, it is the fix weight tuning method. Therefore, this study aims to develop a time-varying weights tuning method for the double-EWMA controller. We will make a comparison between the time-varying algorithm and the fix trade-off solution weights control scheme that was proposed by Del Castillo (1999).

(4) A dynamical double EWMA controller will also be developed in this study. The relevant research has seldom been mentioned before. The objective of the

proposed controller is to real-time compensate for the wear-out process in responding to the disturbance changes

1.3 Framework and Organization

The research framework is shown in Figure 1.1. In the past, the EWMA statistic was successfully used in statistical process control (SPC) and time-series forecasting. Recently, EWMA statistic was widely used in the semiconductor run-to-run control. There are two types of EWMA controllers: single and double. Many researches focus on analyzing the single EWMA controller in a static way. However, the manufacturing environment is usually dynamic. Therefore, we attempt to develop the neural network (NN) based adaptive algorithms for the single EWMA controller. The proposed controllers will compare with previous work.

In the topic of double EWMA controller, Del Castillo (1999) analyzed the stability condition and developed a trade-off tuning strategy for the double EWMA controller. However, the trade-off tuning strategy will produce a higher initial transient offset. Thus, we will develop a time-varying weights tuning strategy for the double EWMA controller. Further, we will develop the dynamical double EWMA controller that was not mentioned before.

The rest of this study is organized as follows. Chapter 1 presents the research motivations and objectives. Chapter 2 reviews the literatures of past researches about EWMA controllers. Beside this, some knowledge about EWMA controllers and neural network techniques are presented. Chapter 3 presented the proposed approaches: neural-based adaptive algorithm for the single EWMA controller, enhanced neural adaptive algorithm for the single EWMA controller, a time-varying weights tuning strategy for the double EWMA controller, dynamical double EWMA controller. Chapter 4 implements the proposed adaptive algorithms, including neural-based and enhanced neural adaptive single EWMA controller. Chapter 5 implements the proposed time-varying weights tuning strategy and the proposed dynamical double EWMA controller. Finally, conclusion and future works are described in Chapter 6.

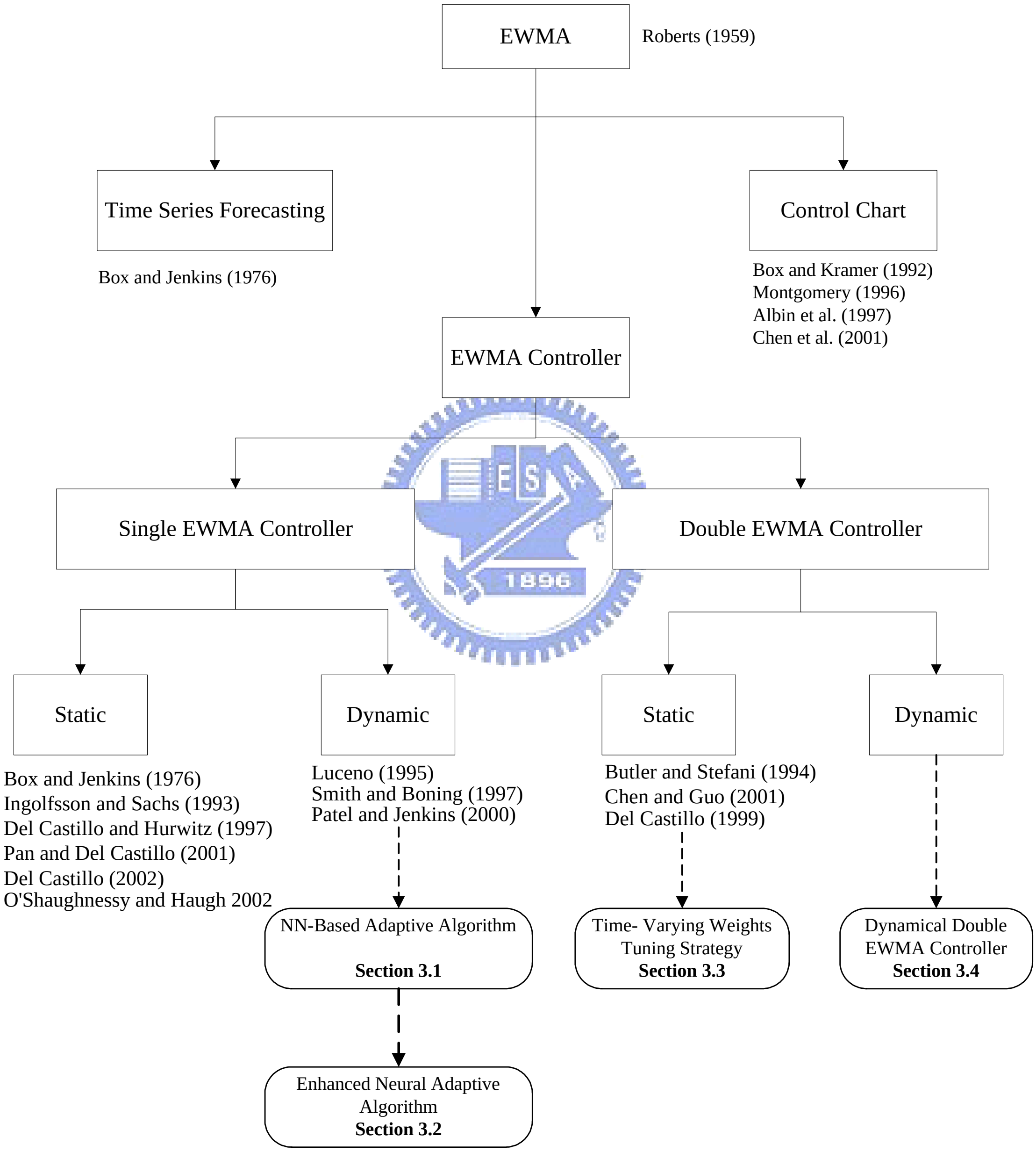

Figure 1.1 Research Framework