IDENTIFICATION OF QUALITY CONTROL CHART PATTERNS USING NEURAL NETWORKS

by

Ahmed Shaban Shaban Khalifa

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

in

MECHANICAL DESIGN AND PRODUCTION

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Under the Supervision of

Prof. Dr. Mohammed A. Shalaby

Professor of Industrial Engineering,
Mechanical Design and Production
Department, Faculty of Engineering,
Cairo University

Dr. Ehab A. Abd Elhafiez

Assistant Professor,
Mechanical Design and Production
Department, Faculty of Engineering,
Cairo University

Dr. Ashraf S. Youssef

I E Manager, EEIC, Saudi Arabia
(former Assistant Professor, Fayoum University)

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Control chart is an important tool in Statistical Process Control (SPC). The exhibited patterns on a control chart are classified as either natural or unnatural patterns. The presence of unnatural patterns is an evidence that a process is out of control and requires further technical investigation. The accurate identification of the unnatural patterns helps the quality practitioners to solve the quality problems quickly.

This research devises neural networks as an intelligent tool to automate the identification of the different control charts patterns, and to accurately estimate the parameters of these patterns. Two Neural Networks, named “NN-1” and “NN-2”, are integrated together to perform the identification and the parameter estimation. The first stage “NN-1” is developed to identify the existing pattern in the control data, and the second stage “NN-2” is devoted to accurately estimate the parameters of that pattern.

NN-1 is developed to identify five basic control chart patterns; namely: natural, upward shift, downward shift, upward trend, and downward trend patterns. This identification is in addition to the classical statistical detection of data runs. NN-1 is designed to response "unidentified pattern" as it fails to positively identify one of the above basic patterns. The network NN-1 is designed to employ five output neurons; where each neuron is assigned to a specific pattern. Several data sets are randomly generated with known pattern and parameter values to train and test NN-1. A basic assumption is that a process starts in control (with natural pattern) and then may undergo only one out-of-control pattern at a time. The second Neural Network "NN-2" is designed, trained, and tested to specify the parameter (attribute) of the already identified pattern. Also, the average number of observations needed before the first detection of the proper pattern is investigated.

The probability of success in identifying the correct control charts pattern and its proper parameters is used to evaluate performance of both NN-1and NN-2. Several sets of test problems are randomly generated to cover the diversity of the unnatural and natural patterns. Performance results of NN-1 and NN-2 are compared with other reported leading research work in the literature. Comparisons show that the proposed Neural Network approach yields better probability of success than the others when comparable assumptions are valid.