FUZZY LOGIC CONTROL SYSTEM OF THE FEEDER FOR THE STONE CRUSHING LINE

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Abstarct: *This paper presents the control system in the stone crushing line and its model devel0ped using Matlab-Simulink software. The simulation was performed using a fuzzy controller, which includes fuzzification block., an inference block and a defuzzification block.*

Keywords: *Fuzzy logic, fuzzy control, Matlab-Simulink*

1. INTRODUCTION

Unlike classical logic, fuzzy logic does not assume that there can be only two values of a given logic sentence, i.e. 0 or 1, but it allows other values between 0 and 1. The principle of excluded middle is denied here. Thus a logical sentence can be true to some extent.

Use of fuzzy logic is justified in cases where it is difficult to determine value of some quantity. It is used in such fields of science like information technology, automatic control engineering and bio-engineering.
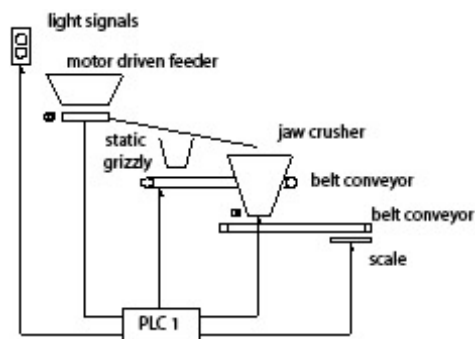

Figure. 1 The stone crushing line.

2. THE STRUCTURE OF THE SYSTEM

This paper describes application of fuzzy logic in automatic control, more specifically, fuzzy logic control of the stone crushing line feeder. The speed of material conveyed on the belt conveyor is important in that case. When material consists of fine stones mainly, speed of its movement is relatively high as it can be almost defined as sand and its further crushing is not necessary. The belt drive motor operates at high gear. Whereas, when the belt is covered with rock, it moves slowly as the crusher needs more time to appropriately crush the material. Then the belt drive motor operates at low gear. How can we apply fuzzy logic to that system? The idea of fuzzy logic application in that system is based on two reasons. First, changes of the material mass conveyed on the belt are random. Secondly, the signal sent by the scale to the controller is significantly delayed – about 20s. The course of the process was shown in Figure 1. The system consists of three parts: the stone crushing section, the stone sorting section and the belt conveyor section. Individual sections are controlled by separate controllers (this results from the size of the entire system – about 300 metres). Information on the controlled process is transmitted from each PLC through Ethernet network to PC and between controllers. TCP/IP, OPC and ETCP protocols are used for communication.

3. SYSTEM MODEL

The model of the process was developed using Matlab-Simulink software. It was assumed that 2- or 4-gear motor would be used. The drawing below shows the model developed using the aforementioned tool. The "Fuzzy Logic Controller with Ruleviewer" block is available in Matlab software. That block allows easy development of such models. Apart from the fuzzy controller, the figure also shows "standardised error – motor gear".
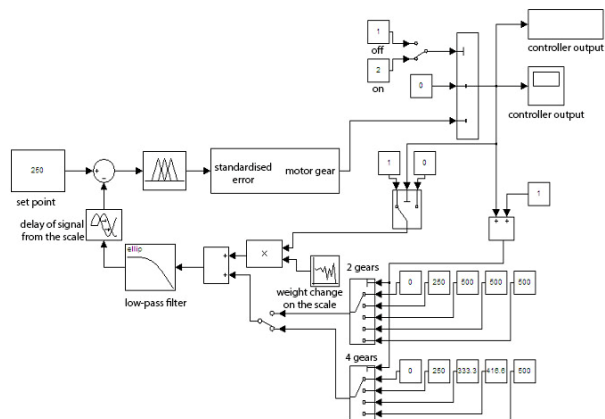

Figure. 2 The stone crushing line model developed using Matlab-Simulink software.

It was created in order to average output values of the controller and to minimize number of motor gear shifts. Moreover, the figure shows the set point block, "2 gears" block and "4 gears" block (this is determined by the engine used for simulation), the "weight change on the scale" block (which is, in principle, the generator of pseudo-random numbers – used to simulate weight changes on the scale), the "low-pass filter" block (signal smoothing) as well as "scale signal delay" block. The set point is expressed in tons per hour and it represents the average output. The figure 3 shows the structure of "standardised error – motor gear" block, which is in fact a simple counter - the gear shift signal occurs when upper or lower counter limit value is achieved. Then signal of gear shift into upper or lower gear is appropriately generated.
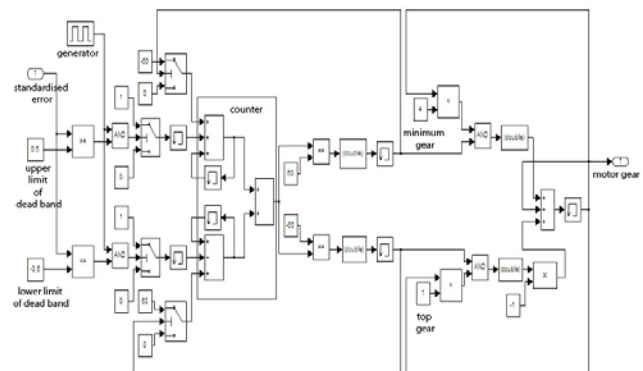

Figure. 3 The stone crushing line model developed using Matlab-Simulink software.

4. FUZZY CONTROLLER

The „Fuzzy Logic Controller with Ruleviewer" block provides possibility to develop models of three blocks: fuzzification, inference and defuzzification. The control error signal is fed to the fuzzification block input. While the output from the block represents the degree of membership in individual fuzzy sets.
Then the output signal of the fuzzification block is fed to the input of the inference block, where the following 3 simple rules were formulated (where u- the capacity, y – error):

IF (u indicates high capacity) THEN (y is the standardised error = -0.5).
IF (u indicates fair capacity) THEN (y is the standardised error = 0).
IF (u indicates low capacity) THEN (y is the standardised error = 0.5).

Then the output signal of the inference block is fed to the defuzzification block input. There are several defuzzification methods, e.g. the smallest of max (SOM) method, the largest of max (LOM) method, the middle of max (MOM) method, the centre of gravity method, bisector of area and of heights. The middle of max method was used in the study.

5. SUMMARY

The simulations confirmed that fuzzy controller yields satisfactory results. However, earlier simulations performed using PID controller yielded slightly better results. Nevertheless, fuzzy logic is still used in different fields of science.

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