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Advanced Control Strategies for Mold Level Process

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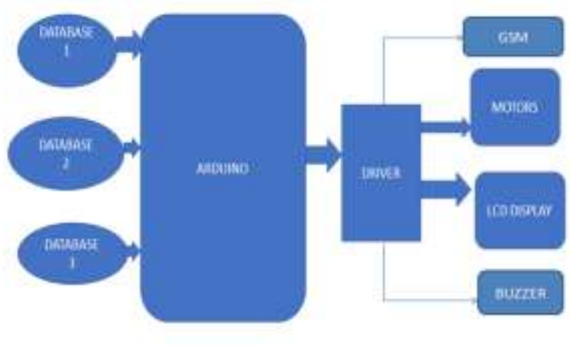
Abstract - *This paper deals with the problem of molten metal level control in continuous casting. Under normal circumstances, proportional integral derivative (Arduino) control performs quite well, but abnormal conditions (in particular nozzle clogging/unclogging) require manual intervention. Indeed, when the flow of matter into the mold increases suddenly, the Arduino controller is not always able to prevent large level variations that can even lead to mold overflow. So, a fuzzy controller has been designed using the expert knowledge of the operators for controlling the process during disturbed phases. The paper discusses both the design of the fuzzy segmentation and its integration with the Arduino in global control architecture. Results from simulation and successful online implementation are presented.*

Key Words: **Image processing, Image segmentation, Image classification, fuzzy controller, MATLAB, Arduino Uno**

1. INTRODUCTION

To control the mold level using image processing. Through fuzzy segmentation techniques time consumption and complex manual processes can be reduced.From this image processing, it can manually operated without human intervention and it reduces power consumption. Innovative combination with good generalization properties which tends toward the "no human casting" principle. Using median filter to remove noises for image segmentation which extracts the molding part in an image. Image processing is a subset of the electronic domain where in the image is converted to an array of small integers, called *pixels*, representing a physical quantity such as scene radiance, stored in a digital memory and processed by computer or other digital hardware.

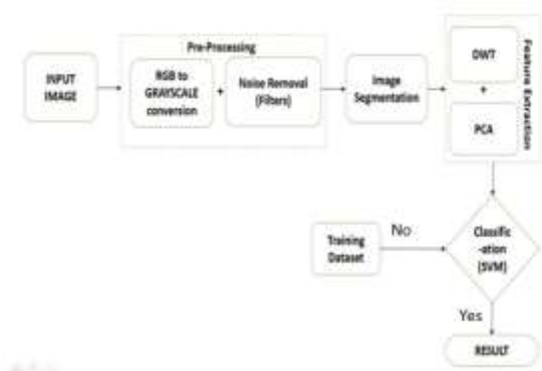
1.1 BLOCK DIAGRAM



2. HARDWARE AND SOFTWARE COMPONENTS

- Arduino Uno
- Large AC motors
- Buzzer
- Liquid crystal display(LCD)
- GSM(global system for communication)
- MATLAB

3. WORKING



3.1 IMAGE PREPROCESSING

Image preprocessing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging.

3.1.2. MEDIAN FILTER

The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

3.2. IMAGE SEGMENTATION

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection).

3.2.1. FUZZY CONTROLLER

Fuzzy clustering is simple and computationally faster than the Hierarchical clustering. And it can also work for large number of variable. But it produces different cluster result for different number of number of cluster. K-Means is a least-squares partitioning method that divide a collection of objects into K groups. The algorithm iterates over two steps: Compute the mean of each cluster. Compute the distance of each point from each cluster by computing its distance from the corresponding cluster mean. Assign each point to the cluster it is nearest to. Iterate over the above two steps till the sum of squared within group errors cannot be lowered any more.

3.3. IMAGE CLASSIFICATION

Image classification refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps. Depending on the interaction between the analyst and the computer during classification, there are two types of classification: supervised and unsupervised. The result of the classification is a theme map directed to a specified database image channel. A theme map encodes each class with a unique gray level. The gray-level value used to encode a class is specified when the class signature is created. If the theme map is later transferred to the display, then a pseudo-color table should be loaded so that each class is represented by a different color.

3.3.1. SUPPORT VECTOR MACHINE

Support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification sand regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on.

4. CONCLUSION

Continuous casting of steel is a complex industrial process, involving many factors and mechanisms. For steelmakers it is very difficult to control the process parameters optimally to obtain a product free from defect i.e. a quality with the best possible return. Automation of the mold level control during these critical casting phases greatly varies throughout the world but steel makers generally acknowledge its benefit. It prevents overflows and down-times and improves the global quality due to more reproductive actions without human decision processes. Finally, it tends toward the “no human casting” principle. As illustrated in this paper, fuzzy logic control is specially suitable for the control of transient phenomena. Several reasons justify this statement. First, the transient behavior of the process is difficult to modelize, is time-varying and depends on parameters which are usually not known. Then, the design of efficient classical control laws is difficult. Human operators know how to control these phenomena and can be considered as experts The knowledge acquisition is made easier by the links existing between the human language and the symbolic representation of the fuzzy rules. Finally, fuzzy controllers are relatively simple to design and implement. Every control engineer can design a nonlinear fuzzy controller without any advanced knowledge in automatic control theory. Besides, the simple hardware configuration needed is compatible with most casting installations.

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