Machine Vision Based Non-Magnetic Object Detection and Removal on Moving Conveyors in Steel Industry through Differential Techniques

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ABSTRACT

Intelligent process control technology in various manufacturing industries is important. Vision based non-magnetic object detection on moving conveyor in the steel industry will play a vital role for intelligent process and raw material handling. This paper presents an approach for a vision based system which performs the detection of non-magnetic objects on raw material moving conveyor in a secondary steel making industry. At single camera level, a vision based differential algorithm is applied to recognize an object. Image pixels based differential techniques; optical flow and motion based segmentations are used for traffic parameters extraction, the proposed approach extends those futures into industrial applications. The authors can implement smart control system, since they can save the energy and control unnecessary breakdowns in a robust manner. The technique developed for non-magnetic object detection is having single static background. Establishing background and background subtraction from continuous video input frames forms the basis. Detection of non-magnetic materials which are moving with raw materials and taking immediate action at the same stage as material handling system will avoid the breakdowns or power wastage. The authors achieve accuracy up to 95% with the computational time of not more than 1.5 seconds for complete system execution.

Keywords: Conveyor, Differential Techniques, Dynamic Selection, Ego-Motion Programmable Logic Controllers (Ego-Motion PLC), Flux, Object Detection, Pixel Count, Supervisory Control and Data Acquisition (SCADA)

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1. INTRODUCTION

Machine vision based non-magnetic object recognition and removal has been one of the active research areas in computer vision and industrial smart control. It plays a major role in advanced industrial automation and process control systems. With the aim to recognize non-magnetic moving objects through video monitoring system, it is able to detect and to establish immediate alarm or we can stop the closed loop interlocked system for a moment to remove the non-magnetic material. This can be done in the Programmable Logic Controllers (PLC), by doing suitable preprocessing with Mat Lab platform. Most of the motion pictures analysis presently available, takes considerable computational time, although we have optimized computation technology. Here in this work an attempt is made to introduce a robust, simple and statistical solution to this problem. To reduce the number of frames used for analysis, dynamic selection of images was made. Hence normalized frame to frame difference is obtained and threshold has been fixed to register a subset of images to be used for analysis. The selected subset is compared with reference template which is nothing but the image taken when there is no non-magnetic material on the conveyor. Multiple reference backgrounds have been established to accommodate different illumination conditions. In the second phase of work, reference frame is constantly subtracted from dynamically selected subset. This leads the separation of non-magnetic object pixels, which is corresponding to moving object and the background pixels which are not altered. Counting object pixels and background pixels leads to the flux estimation. To make the design illumination invariant, a section of background is taken as a reference, which will not be affected by the conveyor flow. Comparing illumination of that block of reference with present picture will decide which background must be considered for the purpose of analysis. Discrimination of non-magnetic object pixel and background pixel has show good repeatability over many real sequences of images. Threshold is fixed and used to discriminate low, medium, and big size non-magnetic material on the conveyor. There is plot for object pixel count; it is basically number of white pixels versus frame number. Basically object detection is carried out by using this plot and as well as this object pixels count.

Suppose if there is non-magnetic object on the conveyor or in the scene except raw material means, there is drastic change in the white pixel count accordance with the object size. By analyzing this pixels count in various cases, we can detect the non-magnetic object on moving conveyor. Suppose if there is drastic in light illumination and reflectance due to weather change means the background will be changed automatically as per the error. Actually the camera will be fixed inside the shed which preferably closed at the top or we can place the camera at suitable point where there no disturbance. Here we checked up with normal day light and cloudy weather. At the final stage threshold value will be fixed for white pixel count and if the count exceeds the threshold value means, the conveyor will stop by giving an alarm in Supervisory Control and Data Acquisition (SCADA) or Distributed Control Systems (DCS). This paper not only concentrates on the accuracy of non-magnetic object detection but emphasizes on the time and computational complexities of the developed single algorithms as there is a need to detect the object in the real time. Pixel count estimation critically depends on the changes in the intensities of \textit{I}^{th} image with respect to the reference image at all spatially uniformly spread pixels. One of the assumptions in the present work is that the intensities of the moving objects are preserved during the movement in the view path.

2. RELATED STUDIES

The review of the literature pertaining to the present topic is presented to the readers. In Spina, Canero, & Gonzalo (2011) authors worked on image processing based edge inspection and defect detection in the steel rolling mills and they have incorporated twin line camera. Pixel based early fire smoke detection based on im-
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