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Optical Tomography: The potential of mass flow rate in rice industry

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ABSTRACT

The capability of Optical Tomography (OT) to visualize pipe flow is undeniably beneficial and of utmost importance to solid gas industry. The other striking feature of OT is its ability to measure and analyze real-time mass flow rate (MFR), which enables online monitoring of material weight. This paper addresses the problem posed by online weighing system in rice industry. The current system slows down the overall industrial production by impeding the device operation, and is therefore becoming obsolete. To overcome this drawback, we confirmed that OT has great potential in online weighing process using a polynomial equation. In addition, MFR measurement can gauge weight loss of rice during the enhancement process. Encouragingly, the application of novel MFR technique to accurately monitor weight loss of rice has proven to outperform the existing system in rice industry.

1. Introduction

The expression "tomography" is derived from the Greek word which means a slice of image. Technically, tomography is about obtaining two- or three-dimensional, cross-sectional images of an *N*-dimensional object [1]. Historically, tomography has been adopted in many areas of physical sciences and engineering to measure the distributions ("images") of parameters of interest in various processes [2]. Nowadays, tomography technique has expanded it applications to both industrial and medical fields. For OT in particular, the researchers from Universiti Teknologi Malaysia (UTM) are recognized as the most established group who applies this methodology for industrial purposes. They focus mainly on system development to visualize the solid gas images in the pipeline [3–5].

In solid gas industry, it is necessary to examine the pipeline, detect blockages, and verify whether the measured particles flow as required [6]. Apart from that, another important issue is to monitor the production loss, for instance, in rice industry. Notably, this unique grain sustains two-thirds of the world's population [7]. We hypothesized that the process of weighing rice before and after rice enhancement is essential for tracing losses in the rice industry. We confirmed our conjecture by visiting a leading rice manufacturer in Malaysia—Syarikat Faiza Sdn Bhd [8]. Fig. 1 reveals the position of Intake Weigher pre- and post-enhancement process—that is, before Polisher and after Color Sorter. This step plays a crucial role in checking the loss of rice during enhancement process. Nevertheless, the utilization of this device in weighing procedure slows down the overall process and has thus been abandoned by Syarikat Faiza Sdn Bhd. Besides, the existing system provides only the measurement readings but is unable to observe material distribution and movement in the pipeline [9]. To address these inadequacies, our OT-dependent MFR meter significantly shortens the rice weighing process in addition to enabling visualization of tomographic images inside the pipeline. With the aid of this system, problems such as blockages and unexpected processing results that may affect the flow of solids and reduce the effectiveness can be resolved easily.

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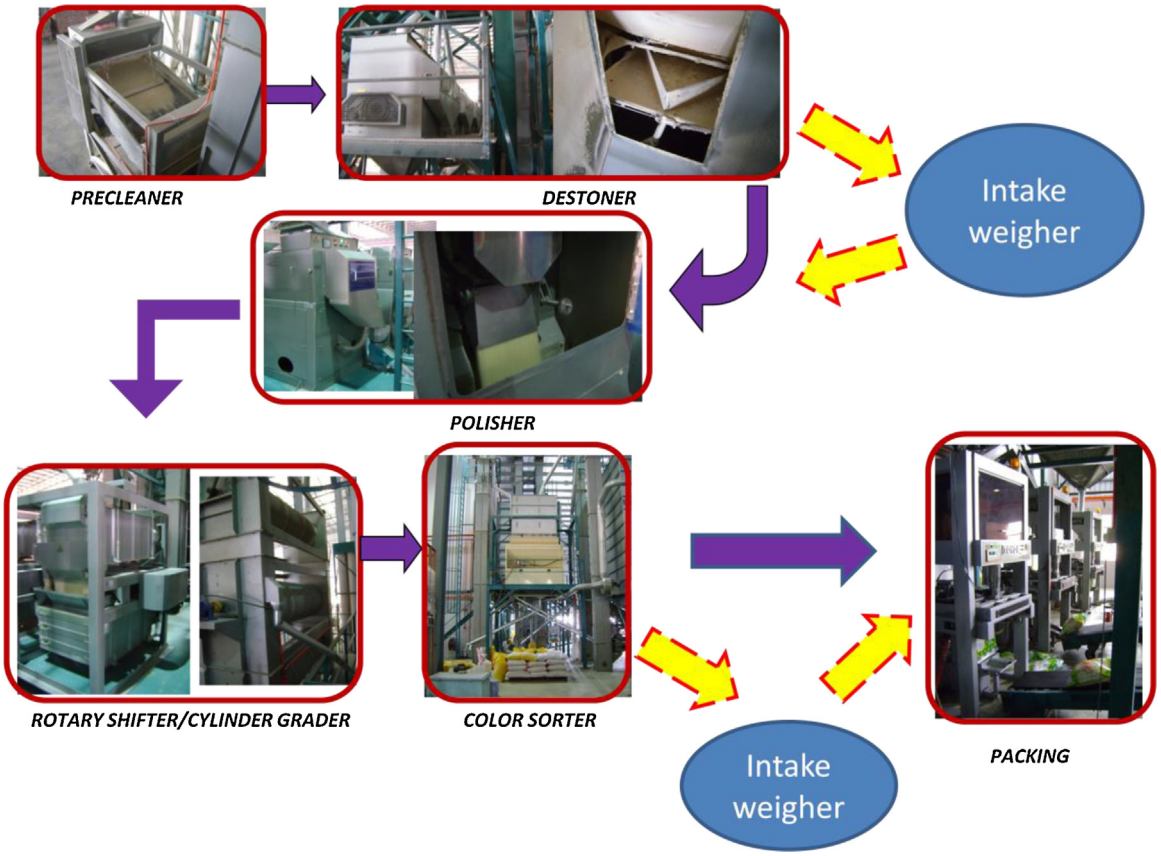

Fig. 1. The fresh rice processing to enhance its quality before goes to the market.

2. Overview of Optical Tomography and its operation

OT is one of the techniques that can replace Intake Weigher to accurately and instantaneously measure the weight as well as to visualize the material inside a pipe. By this, the output and quality of product are enhanced respectively. Fig. 2 shows the OT main operating system which consists of three vital sub-systems—sensor array, signal conditioning unit, and data acquisition unit. In brief, the master unit controls the slave by activating it to send a signal to the light projection circuit. Then, the receiver (see Fig. 3) responds to the signal, converts it into voltage, and the resulting voltage value will subsequently loop back into the slave. The slave in turn converts the analog voltage value into a digital datum that will be stored in its buffer until the user clicks on the GUI in the PC to activate the master and assemble all data based on I2C protocol. Once the data are received by the master, they will be

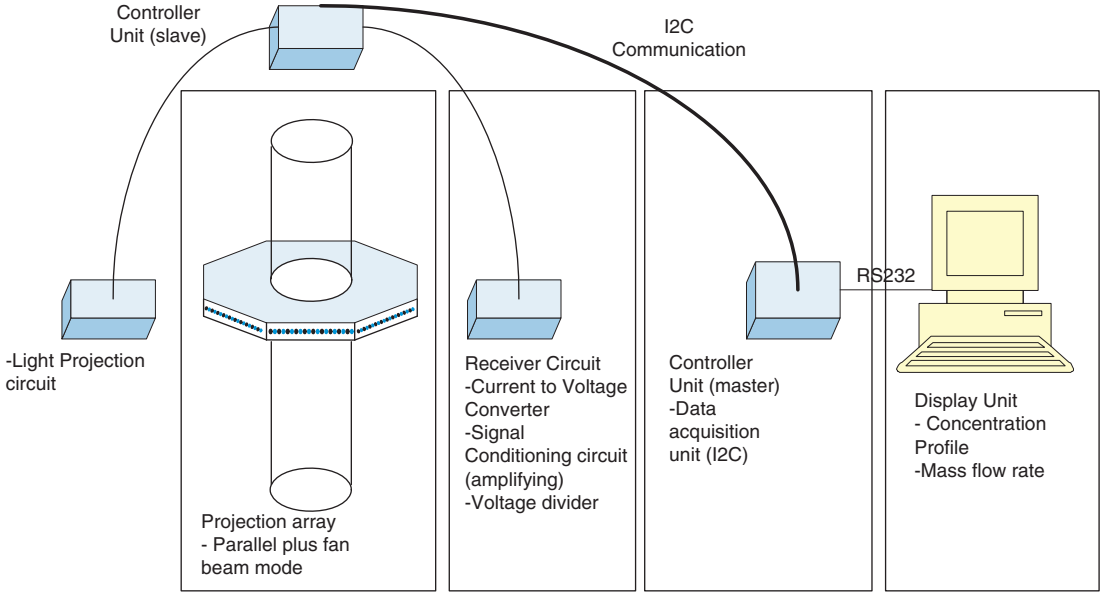

Fig. 2. The OT main operating system.