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P2.56: Automatic inline defects inspection of lithium-ion battery cells using parallel-triple detection filtering (PTDF) algorithm

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As a demand for lithium-ion battery (LIB) cells in industry continues to grow, more accurate inspection techniques are required for ensuring quality assurance (QA) during production. Detecting defects accurately, such as metallic foreign matters and crack, is important for inline QA testing, where both fast-processing speed and high accuracy are essential. Particularly, in the post-packaging step, X-rays are usually used for the inspection of LIB cells. Although several detection algorithms have been applied for the inline QA testing, those methods are often difficult to satisfy the requirements of the inline QA testing, mainly because of the computational cost and accuracy. In this study, to overcome this challenge, we proposed an effective method, the so-called parallel-triple detection filtering (PTDF) algorithm. Figure 1 shows the simplified flowchart representing the proposed PTDF algorithm that consists of two processes of the defects detection through the triple filtering consecutively and image fusion. By combining the filtered images with different sensitivity and specificity, the proposed algorithm can improve the detection accuracy of the defects in the LIB cells, saving the processing time. To demonstrate the feasibility of the proposed method, we performed an experiment using a table-top setup that consisted of an X-ray tube (70 kV_P and 1.4 mAs) and a CMOS flat-panel detector (49.5 μm pixel resolution). Figure 2 shows the experimental setup, battery cell used in the experiment and its radiograph, and the defects detection maps obtained using the Ostu, adaptive thresholding, k-means, and proposed methods. According to our preliminary results, the proposed algorithm effectively detected the abnormal structures in LIB cells and outperformed the existing algorithms in terms of accuracy and time. More quantitative experimental results will be presented in the paper.

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