A Practical Position Estimation for Semiconductor Chip Mounter

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Our newly constructed image processing system is specialized for semiconductor chip mounter. It has features of high-speed and high-precision measurement of chip position by using the feedback of X/Y/θ correction values calculated from the relative position between the pattern on the chip and reference marks located on the head. A mounter for mounting the chip on the PCB board is semiconductor manufacturing equipment which adsorbs the chip from chip supplying cassette by the suction mechanism, called head, and mounts it to the predetermined position on PCB board. There are thousands of Sn-Ag-Cu based solder ball (Bump) placed on the surface of chip for electric connection between the devices. They should be accurately positioned to the electrode on the PCB board, called PAD. Fine pattern requires the accurate positioning. On the other hand, decrease of throughput is not permitted due to the requirement of high productivity. Therefore, after absorbing chip by the head, mounting position on the PCB board is corrected based on the estimated result calculated from the bump Image on the chip taken by the camera during the travel of head toward the PCB board (called flying vision, Fig.1). High-speed and high-precision estimation of position from the line camera image is required for high precision, high productivity mounting. Bump position is calculated from the gravity center in the predetermined area (Fig.2). Defining the weight wi for each bump position,which are used for position estimation, a method of increasing the precision of position estimation is introduced.

$$\text{Error} = \sum_{i=1}^{N} w_i \varepsilon_i = \sum_{i=1}^{N} w_i \left\{ \left(a_0 x + b_0 y + c_0 - (a_2 x + b_2 y + c_2)x'\right)^2 + \left(a_1 x + b_1 y + c_1 - (a_2 x + b_2 y + c_2)y'\right)^2 \right\}$$

where a0, b0, c0, a1, b1, c1, a2, b2, c2 : Affine coefficient of chip position,

(x,y) : Bump design pos,

(x',y') : Bump Image estimation pos,

N : Number of bump.

Solution of partial differentiation of transformation coefficient being zero will be calculated so that the SumError becomes minimum. Result of experiment showed that the estimation accuracy was +/- 3 um (Max-Min in 20 times repetition) and mounting accuracy was +/- 5um when using the chromium deposit glass chip at the speed of 4m/s with its acceleration of 10G. In the result, mounting error is estimated using the PCB board detection camera (PCBCamera). Correlation of mounting error measured by PCBCamera and stereoscopic microscope was also confirmed (Fig. 7, Fig. 8). Usage of weighting is confirmed to be improved of its accuracy by 20% comparing with absence of weighting (Fig. 9).

[Reference]

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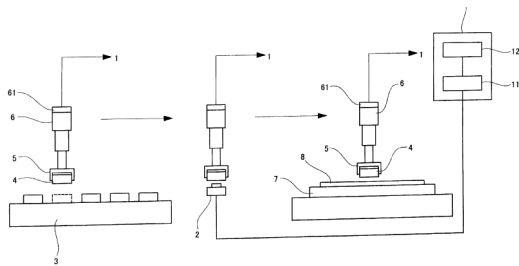
[6]Patent JP 2013-123020

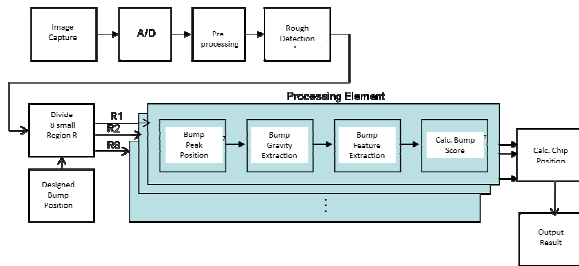Fig.1 Overview of jisso machine

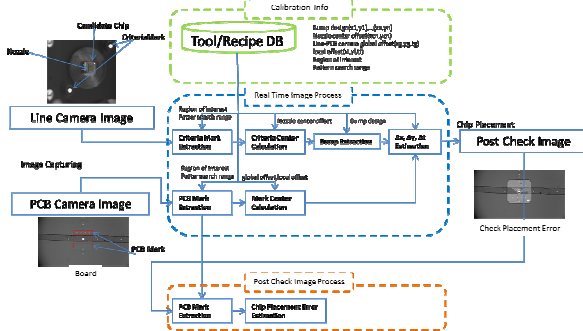Fig.2 Processing diagram of bump position detection
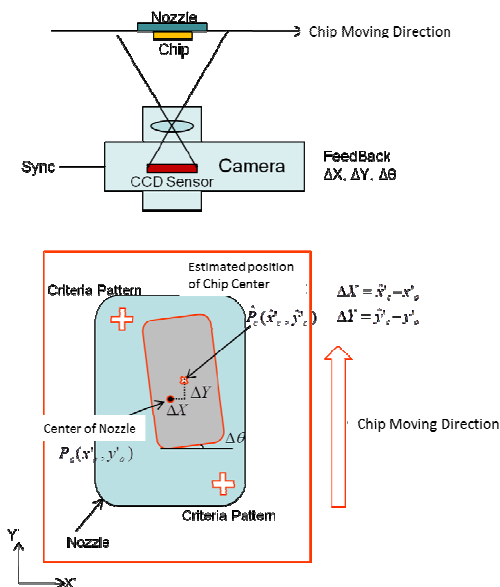

Fig.3 Vision S/W block diagram

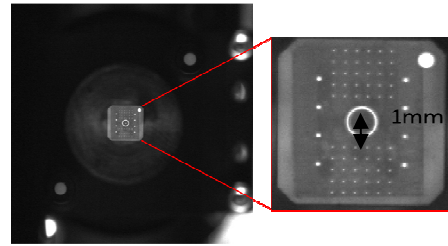Fig.4 Image capturing by line camera
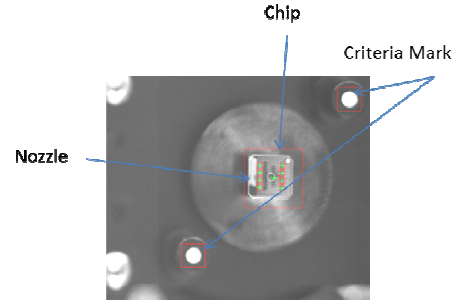

Fig.5 Chip capturing images (flying vision)

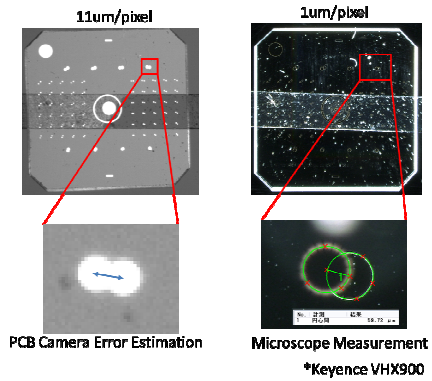Fig.6 An example result of chip recognition

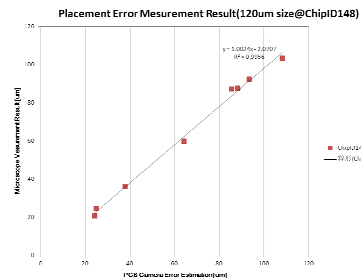Fig.7 Chip placement error by PCB camera and microscope

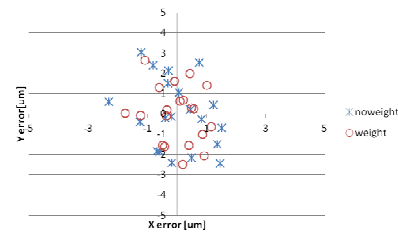Fig.8 Chip placement error correlation between PCB camera and microscope

Fig.9 Comparison of accuracy to weight and absence of weighting （real chip）