Reading of Operating Values of End Effector During Goods Manipulation

F. Stary, V. Dynybyl, and J. Mrazek

Abstract The article describes methodology of reading of operating values of end effector during goods manipulation. Among read values will be gripping force of end effector jaws, amount of grip distance and weight of manipulated goods. In case of right forming of mathematical model of the end effector, the software should be able to determine actual position of manipulated goods with consideration of acceleration influence.

Keywords End effector • Grip force • Weight • Strain gauge

1 Introduction

This article follow-up to articles [1–3], that describe development of wrapping machine with integrated manipulator. In mentioned articles were described concept designs of wrapping machine and manipulator. This article is focused on manipulator, which is based on concept variant mentioned in [1].

2 Final Design of Manipulator

In article [1] was designed concept variant shown in the Fig. 1. This concept variant was modified to final variant shown in the Fig. 2. Main changes are in mean of drive, where drive with toothed rack was substituted with toothed belt. Another change is configuration of vertical axis of manipulator as telescope. With this change is lowered demand on space above machine. Further was changed method of guiding of axes from linear guides to combination of linear guide and eccentric rollers.

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Fig. 1 Concept design of manipulator

Fig. 2 Final design of manipulator

3 Methodology of Reading Operating Values

Among read values will be gripping force of end effector jaws, amount of grip distance and weight of manipulated goods. In case of right forming of mathematical model of end effector, the software should be able to determine actual position of manipulated goods with consideration of acceleration influence, alternatively evaluate instability (shaking) of end effector.

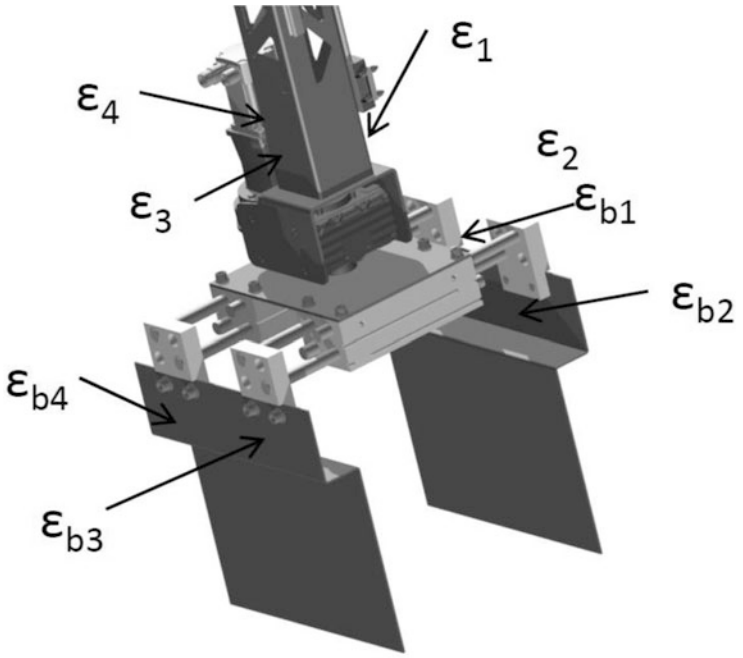

Fig. 3 Detail of end effector with marked measuring points

3.1 Weight Sensing

The tensile tension in profile of vertical axis of manipulator will be used for determination of weight of manipulated goods. Actual weight will be calculated from formula (1) where E means elastic modulus, S is sectional area of vertical beam of manipulator and g is acceleration of gravity. Tensile tension is evaluated from two (four) opposite strain gauges to eliminate flexion strain (2).

$$m = \frac{E \cdot \varepsilon \cdot S}{g} \tag{1}$$

$$\varepsilon = \frac{\varepsilon_1 + \varepsilon_2}{2} \quad or \quad \varepsilon = \frac{\varepsilon_1 + \varepsilon_2 + \varepsilon_3 + \varepsilon_4}{4} \tag{2}$$

3.2 Sensing of Gripping Force

To evaluate the gripping force of jaws will be used flexion strain of jaws (ε_{b1}, ε_{b2}, ε_{b3}, ε_{b4} in Fig. 3) near their attachment to pneumatic motor flange. Evaluation of gripping force is not easy and it necessary to create mathematic model, which will be considering gripping of goods in whole length of jaws, as well as on the right side, in the middle and on the right side of jaws. This model will be created with help of finite element method calculations and experimentally verified.

3.3 Sensing of Instability (Shaking) of End Effector

Shaking of end effector can be easily evaluated from amplitude of flexion strain on the vertical beam of manipulator.

4 Conclusion

In the article is shown, how to evaluate weight of manipulated goods. Further is shown how to measure gripping force of jaws. For calculation of gripping force is necessary to create mathematical model that will be based on finite element method calculations.

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