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MULTISENSOR-BASED DETECTION OF CONTACT STATE FOR AUTOMATED SHEET METAL ASSEMBLY

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ABSTRACT

Sensor information is important for the control of automated sheet metal assembly. In this paper a multisensor-based system is developed to detect the contact state of a lap joint between two sheet metal workpieces. The contact states detected are: left end, right end, full contact, and no contact. Detection methods are developed based on the use of a Force/Moment Sensor (FMS), novel Strain Gauge equipped Fingers (SGFs) and sensor fusion of the FMS and SGF information. It is shown that a trade-off exists between the detection time and the detection success rate. The methods are verified in 120 robotic assembly trials. The success rate for the FMS method increased from 63 to 88% when the sheet thickness was increased from 0.69 to 1.88 mm (gauge 23 to gauge 15). Under the same conditions the success rate for the SGF method decreased from 90 to 55%. The sensor fusion method surpassed the best individual performances of the other methods by achieving a 100% success rate for the complete set of sheet thicknesses and contact states.

INTRODUCTION

Currently in many industries, including automotive and aircraft manufacturing, specially designed clamping devices known as fixtures are required for sheet metal assembly. These fixtures are used to position the workpieces for joining by welding or riveting. Typically a lap joint is used, and no gap is allowable between the joint surfaces. Since the number of sheet metal workpieces involved is large, between 300-500 per car for example (Majda, 1994), the number of fixtures required is substantial. When a new model is to be manufactured, new fixtures must be designed, built and installed in the plant. This retooling operation is very costly because of the long lead time associated with the design and manufacture of the fixtures and loss of production during their installation.

A possible solution to this problem is the use of two robots to assemble and join the workpieces without fixtures. When workpieces are changed for a new model only the robot's software should have to be modified, with little or no retooling. This approach is referred to as Robotic Fixtureless Assembly (RFA). It is expected that the use of RFA can reduce retooling costs by 80% (Naitoh et al., 1993) However, the development of RFA is still in its infancy. Mills (1992) proposed a discontinuous control approach for RFA to handle the transition from noncontact