ABSTRACT

Microgripper is one of the key elements in microrobotics and microassembly technologies for handling and manipulating micro objects such as micro mechanical parts, electrical components, biological cells, micro materials etc. As the trend towards miniaturization continues, microgrippers will become indispensable tools for handling, manipulating as well as assembly of micro components in various application fields (optics, electronics, mechanics, fluidics, chemistry and life sciences).

Interestingly, biological creatures like arthropods (e.g. crabs, lobsters, ants, etc) have simple yet effective gripping mechanism and can regulate their stiffness in their joints quite easily without much sensory information. Therefore, study of arthropods grasping mechanism and the related bio-inspired design is a very promising approach for developing miniature grippers. Implementing them in real devices can enhance the compliance and applicability of microgrippers for several applications (e.g. biological sample handling, precision assembly *etc.*).

In the present work a new concept in the design of a microgripper based on a biologically-inspired approach is developed. A study has been done on the grasping mechanisms with variable stiffness in the joints inspired by arthropods specifically crustaceans like crabs, lobsters *etc*. A systematic design procedure for planar two-fingered microgripper based on the bio-inspired actuation is developed and the geometry of the microgripper is optimized to get maximum displacement subjected to constraints in operation and manufacturing.

A dynamic model of single piezo and dual piezo actuated microgripper is developed and the dynamic performance of the design is studied. The model is simulated using SIMULINK for predicting the dynamics of microgripper mechanism and control schemes are developed for microgripper tip displacement and gripping force control.

Two prototypes of microgrippers (one with a single piezo actuator and the other with four piezo actuators) are manufactured with Wire-Electro-Discharge Machining process from the design models of the microgrippers. These are fabricated to test and validate concepts presented earlier.

Finally a suitable vision based measurement system for microgripper is implemented and experimental setup has been developed for characterization, testing, demonstration and control of the microgrippers.