Methods and materials

Software methodology

Materials

Compliant and elastic materials are commonly used in the construction of soft robots. Three specific silicon-based rubbers that are readily accessible and affordable were characterized by (Ellis). These rubbers are outlined with basic material properties in Table below.

Mold-Star 15 was selected as the primary material modeled and manufactured. Mold Star 15’s stiffness lies between EcoFlex and Smooth Sil’s.

Validation

Validation of simulated results generates confidence in the simulation approach. Future simulations do not need to be extensively verified if the method has been proven to be consistent and accurate. Constant verification of simulations is cumbersome, expensive and lengthy. It is desirable to avoid this where possible. To this end, validation of select units was carried out.

Units were selected according to their performance ranking, with better-performing units being more likely to be selected. Units were also selected according to manufacturability and testability. The casting process and testing process are outlined in the following sections.

Casting

Standard material casting was carried out as outlined in Section.

Modular moulds were designed to allow for the reuse of the moulds for different unit layouts. This reduces the complexity of manufacturing as well as the number of components required to be manufactured. Modular moulds consisted of a mould base, large mould cells and small mould cells. The mould base is a flat sheet of aluminium with a square depression 4mm deep. Large and small mould cells are 10 mm square aluminium blocks, 4mm and 2mm thick respectively. Figure illustrates the mould components. Aluminium was selected due to its availability, hardness, manufacturability and relatively low density.

To cast a unit, the mould cells are arranged according to the unit layout. Large mould cells are placed where elements have been removed from the unit. Small mould cells are placed where it is necessary for elements to be cast. Figure illustrates the unit layout, the mould packed according to the layout, and the mould with the cast material in.