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Fast scale prototyping for folded millirobots

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***Abstract*— We present a set of tools and a process, making use of inexpensive and environmentally friendly materials, that enable the rapid realization of fully functional large scale prototypes of folded mobile millirobots. By mimicking the smart composite microstructure (SCM) process at a 2-10X scale using posterboard, and commonly available polymer films, we can realize a prototype design in a matter of minutes compared with days for a complicated SCM design at the small scale. The time savings enable a significantly shorter design cycle by allowing for immediate discovery of design flaws and introduction of design improvements prior to beginning construction at the small scale. In addition, the technology eases the difficulty of visualizing and creating folded 3D structures from 2D parts. We use the example of a fully functional hexapedal crawling robot design to illustrate the process and to verify a scaling law which we propose.**

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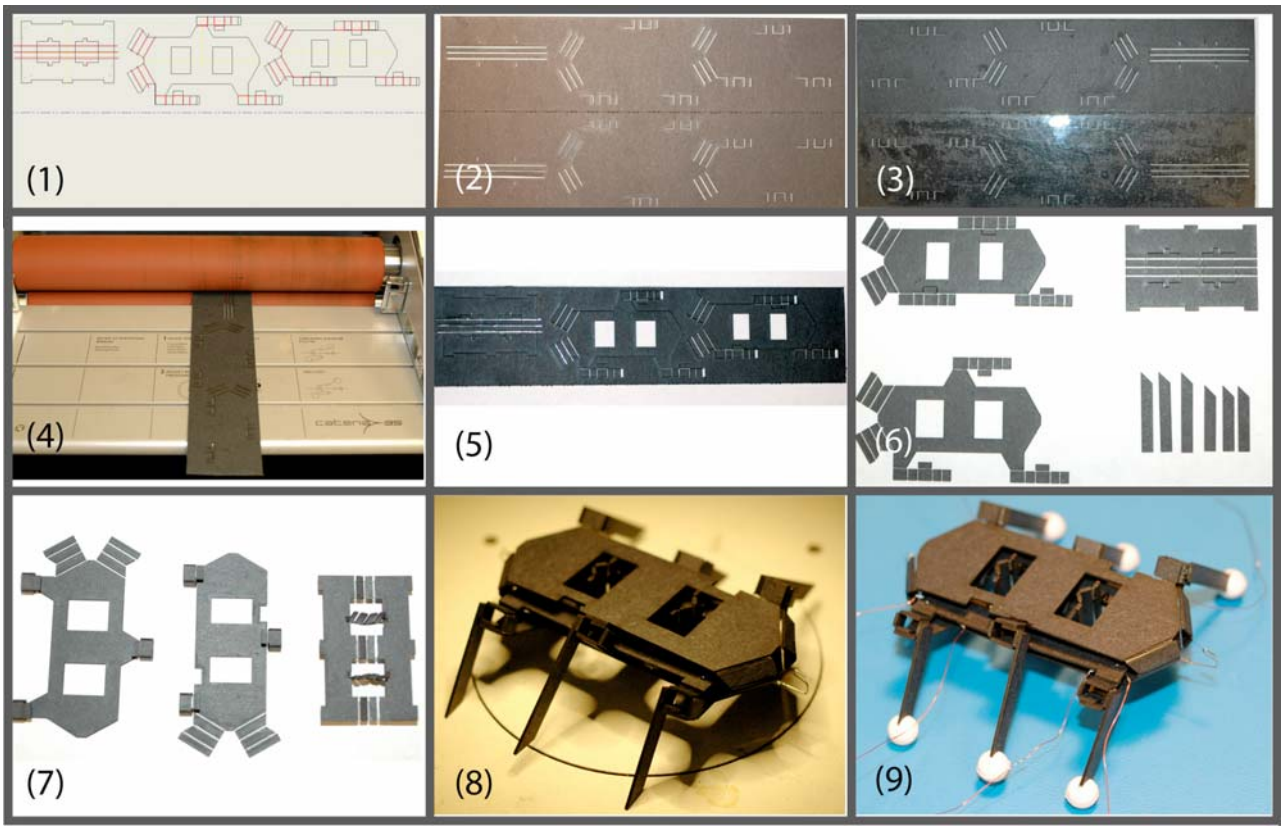

Fig. 1. Steps for prototyping a hexapod crawling robot: **(1)** A 2-dimensional drawing is made in a vector-based illustration program (we use Solidworks). **(2)** A blank piece of posterboard with a pre-cut fold line is folded and placed in a laser cutter, and the flexure cuts are made in both layers. **(3)** The workpiece is removed and adhesive is applied to both sides inside the fold. A 50μm film of PET is sandwiched between the two sides of the fold. **(4)** The workpiece is fed through heated rollers at 230°F at a low speed (approx. 5mm/sec). **(5)** The workpiece is placed back in the laser cutter and outlines of the parts are cut out. **(6)** Parts are released from the workpiece. **(7)** Indiviual linkages can be folded up in place. The three joints on the two leftmost pieces are fourbars used as hips. The joints in the rightmost piece form two Sarrus linkages when two are folded and glued out of plane. **(8)** The three plates are joined such that the hips for one tripod sit above the central plate while the hips for the other sit below, and the legs are attached to the hip fourbars. **(9)** SMA actuators are attached and wired in place and spherical PDMS feet are added.