Proposition and Implementation of Imaginary Membrane Locomotion:
omni-directional crawling locomotion for shape changing robot

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I. INTRODUCTION

A versatile locomotive system for uncertain rough terrain is one major challenge of mobile robotics, and Shape changing locomotion by shape changing robots have recently been focused as one answer towards it.

The three popular types of shape changing robots include Tensegrity, Side Actuating, and Spiny Multipedal (Fig. 1).

![Fig. 1. 3 types of shape changing robots](image)

Through IML, we have managed to increase the degree of freedom in its path from one to two. In the former
approach, the path of robot was constrained highly by shape of robot’s primitive. Let’s take the robot with primitive of regular icosahedron (Fig 3 (a)) as an example. As it’s surface is triangle, from the resting stopped position it can only move in 3 direction, and once its out of resting phase it can not change the direction until it reaches the next resting phase. Also, its whole path has to be defined by combination of such movement, resulting in low resolution path which can not even draw a straight line. In contrast, IML can move to any direction in any point of time. As it does not have transition phase, its movement is much smoother and free. The improvement of the locomotive freedom can be seen clearly from Fig. 3.

III. OUR CONTRIBUTION

In order to prove this concept, we have developed a Spiny Multipedal robot with primitive of rhombic triacontahedron (Fig. 1, (a)). Although IML is applicable to all three different shapes of shape changing robot, we chose the Spiny Multipedal as it required the minimum extension rate of an actuator. This robot consists of 32 legs with actuators, and all the actuation and power supply systems are self contained with a microcomputer which receives signal from outer simulator.