Use of Tails in Amphibious Locomotion

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Robotic salamanders are bio-inspired mechanisms whose locomotion involves synchronized motion of all its body parts in a similar manner than their biological counterparts. Most of the salamander species are organisms well adapted to unstructured and media changing environments in which their amphibious capabilities excel. This is the most important feature we want to provide to some of our robots, in order to make them useful for tasks in complex environments like in the search and rescue scenario.

We work in decoding the underlying mechanisms of locomotion in salamanders by using mathematical models and robots [3]. These studies so far, have demonstrated a coordinated interplay between limbs, spine and tail movements required to propels the animal and its robotic analogue, in amphibious environments. For this, swimming and walking gaits are among others the most important locomotion mechanisms used by salamanders.

Bio-mechanically speaking, in salamanders the function of the tail is closely related to swimming gaits. Working with salamander robots in our lab., we notice that in fact, the benefits of the tail are in the generation of thrust due to hydrodynamic interactions with the fluid [1]. A combination of active (i.e. motorized joints) followed by a passive compliant fin have proven to provide enough thrust on the robots to match (after scaling) the swimming patterns present in the living organism. Although, for walking gaits the results are significantly different. The tail, in this case, acts more like a dead weight that drags the robot as the walking gait progresses. Figure 1 shows a salamander robot moving in several complex terrains (i.e. stairs, with holes and random unevenness). The image suggest that the tail is nothing but impeding the displacement that the limbs are producing while providing ground clearance to the spine.

In this workshop, from the robot design point of view, we want to discuss the relationship between robot multi-modal capabilities, in contrast with the detriment in performance that a dragging tail induces to specific gaits like walking [2]. On the other hand, from the control point of view, we would like to present some recent attempts of use of the tail as a fifth limb, to aid the walking locomotion in unstructured terrains. With our contributions, we look forward to generate a discussion focused in the trade-off between the use or not of a tail in these robotic platforms.

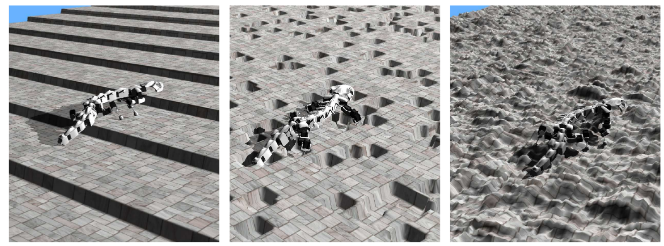

Fig. 1. Example of Salamander robot dragging its tail in several terrains. Several experiments were conducted in simulation as well as in real hardware to test the effects of the tail in ground locomotion.

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