The 2010 IEEE/RSJ International Conference on
Intelligent Robots and Systems
October 18-22, 2010, Taipei, Taiwan

# Robotic Jerboa: A Compact Bipedal Kick-and-Slide Robot powered by Unidirectional Impulse Force Generators

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*Abstract*— **In this video, we propose the robotic jerboa which is a compact bipedal kick-and-slide robot powered by unidirectional impulse force generators. The robotic jerboa moves fast not only running forward but also turning right and left by kicking and sliding on the ground repeatedly. The robotic jerboa kicks toward the direction which the horizontal component is large by its legs in order to jump forward effectively. The robotic jerboa is composed as its legs are protruded out of the side of its body respectively for realization of the quick turning. We show that the palm-top size robotic jerboa whose weight is of only 70[g] achieves the velocity of 1.5[m/s] and the turning angular velocity of 11.5[rad/s] instantaneously.**

## I. INTRODUCTION

Small animals such as jerboas run too fast to be caught by humans. The agility of such small animals is derived from not only the fast moving velocity but also the quick turning. We focus on this biological fact. By applying such turning motion to small mobile robots, moving motions of robots achieve the animal-like quickness. The purpose of this research is to realize a palm-top mobile robot achieving the agility comparable to small animals.

Recently, many biologically-inspired palm-top robots with high agility have been developed. Fearing et al. developed the small, lightweight, power autonomous robot capable of running at speeds up to 15 body length per second [1]. However, the turning motion of this robot is not good as its straightforward motion. The turning angular velocity of this robot is less than 1[rad/s]. Quinn et al. developed the highly mobile small robot with special rotational legs [3]. However, the turning angular velocity of this robot which is estimated as this robot turns at its maximum speed within its minimum turning radius is at most 5[rad/s]. Kovac et al. developed a surprising miniature 7[g] jumping robot which leaps up to 1.4[m] like locusts [2]. Scarfogliero et al. developed compact jumping robot inspired by frog locomotion [4]. However, these robots can't achieve quick turning.

On the other hand, many robots achieving rapid motions using elastica technologies have been developed. Hirai et al. developed spherical deformable robots which jump by using the elastic energy [5]. Yamada et al. developed jumping robot using the snap-through buckling of elastic strip [8]. Kovac et al. and Scarfogliero et al. use torsion springs and cams for their robot, respectively [2][4]. Authors developed a compact kick-and-bounce mobile robot powered by unidirectional impulse force generators [7]. However, these robots don't turn actively.

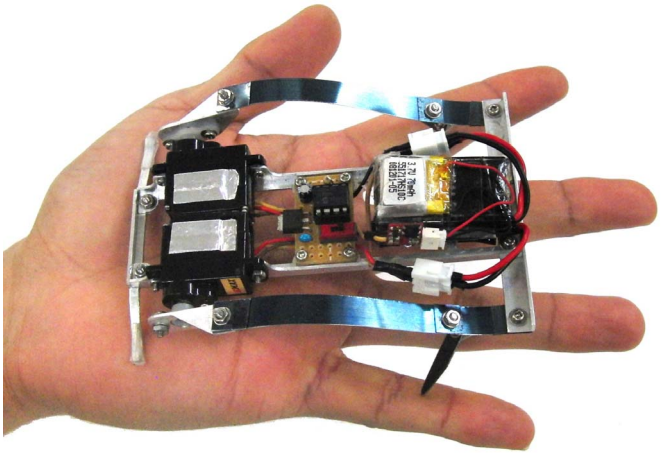

Fig. 1. The robotic jerboa on a palm

In this video, we propose the robotic jerboa which is a compact bipedal kick-and-slide robot (Fig.1). The robotic jerboa is the latest type of a compact bipedal kick-and-bounce robot powered by unidirectional impulse force generators. The robotic jerboa moves fast not only running forward but also turning right and left by kicking and sliding on the ground repeatedly. The robotic jerboa kicks toward the direction which the horizontal component is large by its legs in order to jump forward effectively. The robotic jerboa is composed as its legs are protruded out of the side of its body respectively for realization of the quick turning. We show that the palm-top size robotic jerboa whose weight is of only 70[g] achieves the moving velocity of 1.5[m/s] and the turning angular velocity of 11.5[rad/s] instantaneously.

## II. ROBOTIC JERBOA

The robotic jerboa is a compact bipedal kick-and-bounce robot powered by unidirectional impulse force generators. The unidirectional impulse force generator is a device that generates impulse forces toward a certain direction repeatedly utilized by snap-through bucklings of its elastic strip. Legs are fixed to elastic strips of unidirectional impulse force generators respectively. The robotic jerboa is composed as

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This study was supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan (No. 20760159).

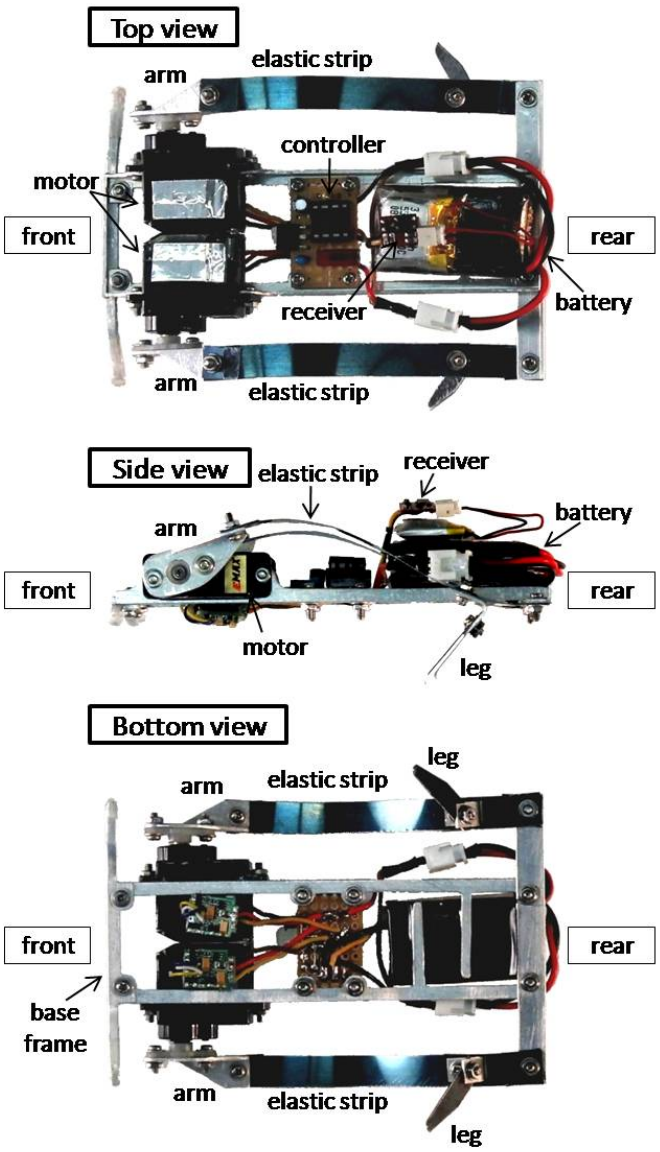


Fig. 2. The top, side and bottom views of the robotic jerboa that is a compact bipedal kick-and-slide robot based on unidirectional impulse force generator

its legs are protruded out of the side of its body unlike our previous robot in order to realize the turning motion. Fig.2 is the top, side and bottom views of the robotic jerboa. The robotic jerboa is almost symmetric, and consists of a pair of elastic strips, arms, active rotational joints, legs, in addition to a single base frame, a battery, a controller, and an infrared receiver. The size of the robotic jerboa is compact enough to be inside of the palm top (Fig.1). The weight of the robotic jerboa is almost same as the weight of three AA size batteries.

## III. LEG MOTION

The leg is fixed to the elastic strip of the unidirectional impulse force generator. The leg changes the direction of the impulse force generated by the unidirectional impulse force generator using the rotation of the fixed point of the leg. The robotic jerboa kicks toward the direction which the horizontal component is large by its legs in order to jump forward effectively. The robotic jerboa achieve the repeated kicking motion of the leg at the maximum frequency of 3.7[Hz].

## IV. RUNNING MOTION

The robotic jerboa moves forward by kicking to the ground repeatedly with both its legs simultaneously. The robot achieves the velocity of 1.5[m/s] instantaneously, which corresponds to 13[BL/s] (BL/s: body length per second).

## V. TURNING MOTION

The robotic jerboa turns clockwise direction or counter-clockwise direction on the ground repeatedly by kicking to the ground with the right leg or the left leg, respectively. The robot achieves the turning angular velocity of 11.5[rad/s] instantaneously.

## VI. RUNNING AROUND

The robotic jerboa moves fast not only running forward but also turning both directions by kicking and sliding on the ground repeatedly. The robotic jerboa jumps low in the air for high moving efficiency. We made an analysis of that moving strategy and showed the effective region of that locomotion [6]. The robotic jerboa achieves the agility comparable to small animals like jerboas. We have succeeded to develop a compact mobile robot with jerboa-like agility which is difficult to be caught.

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