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One-actuator wheeled robot moving like a snakeboard and its propelling experiments

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The snakeboard is a kind of skateboard with the front and rear passive wheels whose wheel-axis, or steering angle, is adjustable by the foot motion of the boarder. The repetitive waist-twist motions with fixing the steering angle can produce the propelling force. Based on this propelling principle, we are attempting to achieve a wheeled system that can move in the horizontal 2D plane with only one actuator.

In the snakeboard robot, the waist-twists motion is replaced with the rotor rotation whose reaction force generates the propulsion force. Main points of the mechanism we propose are: (1) The steering angle rotations are mechanically coupled so that the wheel direction are rotated in anti-phase. (2) Then the moment driving the rotor is simultaneously transmitted to the rotation of the wheel direction.

Now, one problem arises: The velocity control is applied to the rotor motion in the method we propose. Accordingly, the rotor has to continue to rotate. However, the position control is applied to the wheel direction because the alternative changes between two constant wheel directions can lead the wheeled robot in the straight or curved direction. Namely, if the rotor and the steering rotation are completely connected mechanically, the rotor must stop in order to maintain the wheel direction.

We have solved this problem by introducing the stoppers and the torque limiter. Because the wheel direction can be constant, we control it by means of the mechanical stoppers restricting the range of the steering direction. However, the stoppers will limit the rotor rotation at the same time if we connect them directly. Accordingly, we have to disconnect the force transmission while the stoppers are working. The torque limiter plays this role. It serves as a safety clutch consisting of two parts connected by the friction force. When the large torque is exerted at the torque limiter, these parts slide each other and disconnect the torque transmission. The torque limiter is set up between the rotor and the steering mechanism, i.e., the actuator rotates not only the rotor but also the steering axis through the torque limiter. If the steering rotation is restricted by the stopper, then the torque limiter works and only the rotor rotates.

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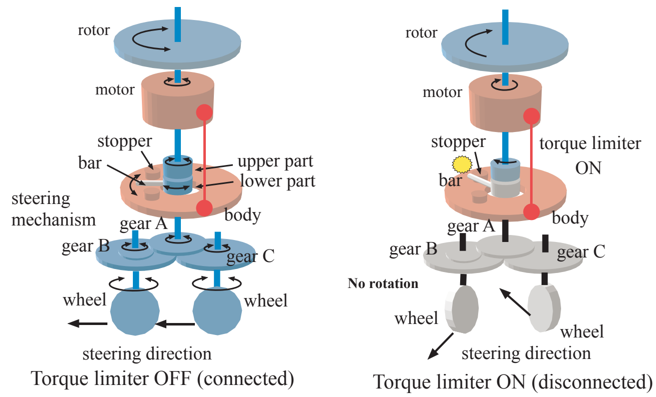

Fig. 1. The proposed mechanism.

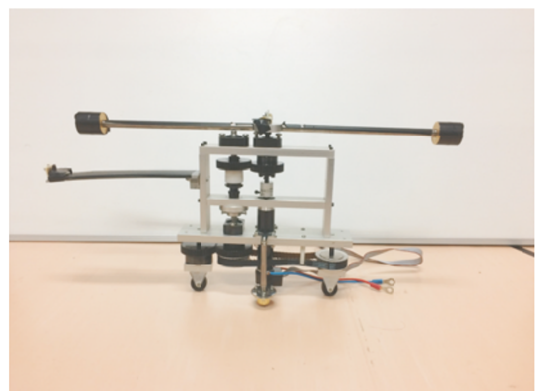

Fig. 2. The manufactured robot.

We constructed a prototype of this robot. It has 250mm height, 500mm length and 3.5kg weight. At first, we conducted some propelling experiments by inputting a sinusoidal input to the sole actuator, DC motor. Then, the robot actually moved forward. Although it had expected to move straight, it was actually not straight due to the slippage of the wheel on the floor. In the second experiments, we attempted to lead the robot to the goal position. Because of the positional feedback by the motion capture system with cameras, the robot managed to reach the goal position, but it takes a long time and its orbit was not the same as the planned one due to the slippage. We should improve this point in our future works.