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Feasibility Study on Two-speed Transmission using Selectable One-way Clutch

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The spread of electric vehicles is required in response to the demand for carbon neutral society. Therefore, it is desired to reduce the cost of electric powertrains. In response to such demands, we verified the possibility of a simple two-speed transmission mechanism that can bring out driving performance while constructing a powertrain with an inexpensive drive e-motor and inverter. Selectable One-way Clutch (SOWC) is used for the two-speed transmission. This paper describes the principle of shifting mechanism, e-motor speed control method while shifting, and the experimental results of the prototype.

SOWC is a component that can realize the following three engagement states by controlling the position of the selector cam piston: (A) Lock state (B) Onw-way clutch state (C) Free rotation state. The authors proposed a two-speed transmission mechanism with a simple structure using two SOWCs. Fig. 1 shows cross section view of the proposed transmission. The switching cam pistons of the two SOWCs are connected to the shift actuator in a state of being connected by the shift fork, and can be operated in the axial direction in conjunction with each other. By synchronizing the rotation speed of the drive motor with the output shaft rotation speed while Lo-SOWC is in the OWC state and Hi-SOWC is in the free state, it is possible to shift gears without causing a shock.

The authors built an experimental device for the 2-speed transmission mechanism with the configuration shown in Fig. 1 and conducted an experiment. Servo motors were connected to the input shaft and output shaft, respectively, and the rotation speed of the motor on the input shaft side was controlled according to position of the shift actuator. Figure 2 shows the experimental result of shifting from Lo-mode (reduction ratio = 2.0) to Hi-mode (reduction ratio = 1.0). From Fig. 2 (a), it was confirmed that a shock-free shift was achieved by synchronizing the rotation speed of the drive motor with the output shaft rotation speed at an appropriate timing. On the other hand, if the timing of the change in the rotation speed of the drive motor was not appropriate, a shock occurred as shown in Fig. 2 (b).

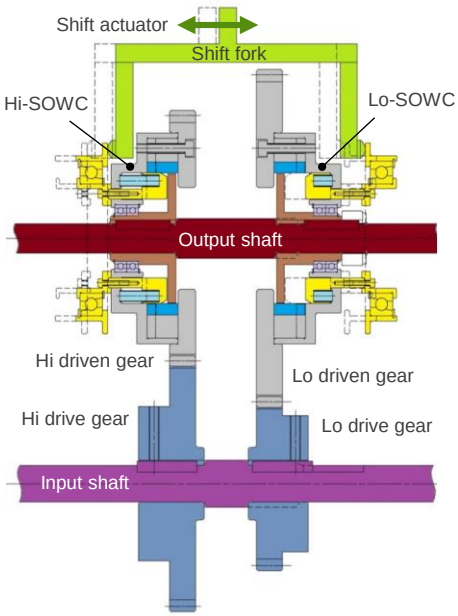
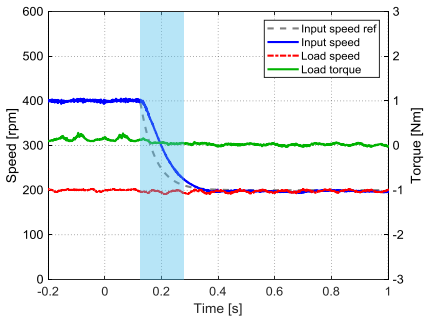
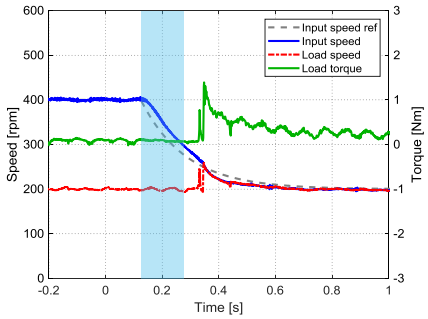


Fig. 1Cross section view of the proposed transmission



(a) Shift succeed



(b) Shift NG

Fig. 2 Experimental result