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Research on the development of an earthworm type rescue robot

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Recently, damages caused by disaster are getting worse with the concentration of the buildings in cities. In the case of the terrorist's attacks on September 11th, 2001 in the U.S.A, The World Trade Center, whose heights were 420m, were collapsed by the airplane crash. One of the nearby buildings was also collapsed due to that incident. More than 2000 people, including 200 or more firefighters, died in that incident. In another case of the earthquake in Hanshin Awaji area in Japan occurred on January 17th, 1995, a lot of buildings were destroyed all or partially and more than 6000 people died. These disasters appeared that the disaster prevention systems and rescue apparatuses were not well prepared. Although it had become the large disaster in the Hanshin Awaji earthquake, where more than 6000 had people died, not a few lives could be saved if the rescue systems were fully functioned. When the rescue systems were not functioned well, nothing but human hands could rescue the disaster victims buried or confined in the buildings.

Therefore, terrorists attacks on September 11th in the U.S.A, a lot of firefighters passed away by the secondary calamities. Moreover, in the Hanshin Awaji earthquake, disaster victims had to rescue themselves since the rescue teams, such as the Self-Defense Forces and the firefighters, was

difficult to arrive at the disaster area due to the traffic shutdown. The tools that the victims used to rescue each other on that occasion was the daily-used implements, such as a saw, a bar, and a jack for cars. There were no rescue apparatus there. If the rescue apparatus that can support human work is arranged, the human being unfamiliar to rescue activities can also perform more prompt rescue activities, thereby many lives can be saved and the secondary calamity prevented.

We should develop an effective rescue equipment and dispose it in many places in preparation for an urgent disaster. I develop a small earthworm type rescue robot, which has an ability of multi-angle flexible modification and movement. The robot is aimed at discovering and supporting disaster victims in collapsed buildings, and investigating damages inside. The robot proposed in paper time has two bellows, placed in the direction of the axis. The robot use three suckers, which are arranged in both ends and between two bellows. Each bellows and sucker are connected by the hose from the controller. The robot moves by expansion and contraction with air pressure. Moreover the power part is arranged in the controller side, thus it is possible to miniaturize and lighten the robot.

When the previous bellows is used as a frame, the robot cannot obtain the stiffness and it usually bends because the air pressure is not distributed evenly. The original bellows I developed in my research succeeded in making the air pressure even by enclosing the bellows with a film. As the result, the stiffness of the robot got to be as equal as a general film side structure. Combining the bellows and the film side structure, I gave contractibility to film side structure. The proposed bellows dose not have directionality when it expands or contracts, thus it can adapt to the environment. Also, it has a high rate of expansion and contraction as compared with an air cylinder. The conventional earthworm type rescue robot moves only using the friction of the ground. Therefore, the robot was not able to climb a slope. However, the proposed earthworm type robot in this research can climb a slope using the sucker from the result of the experiments, it was shown that the robot was able to climb about 70-degree slope using the proposed Original bellows and sucker mechanism, and move along the 45-

degree curve passively in accordance with the environment by changing the air pressure of the bellows. Moreover, the robot can supply oxygen using the pump connected with a sucker, when disaster victims were discovered.

From the result so far, this paper showed the possibility of the realization of the earthworm type rescue robot.