

Bari-bari-II: Jack-up Rescue Robot with Debris Opening Function

Hideyuki Tsukagoshi, Ato Kitagawa, Masayuki Ito, Kuniaki Ooe, Ichiro Kiryu, and Takumi Kochiya,
Tokyo Institute of Technology, Japan

Abstract— This paper proposes a novel type of rescue robot which is aimed to open narrow spaces, move under heavy debris, and search and save out survivors at disastrous site. Unlike most of the conventional mobile robots to move through opened spaces, the proposed robot has the ability of cultivating spaces by its own so as to be able to pass through. The key of the robot is the step structure on its head which enables it to open 10 mm gap up to 250 mm gradually under 600kg load by oil hydraulic power, synchronizing with the mobile behavior to go forward. Such kind of mobile method with jack-up function can be realized by switching two modes alternately discussed in this paper. The validity of the proposed design and behavior is experimentally verified by the developed model named Bari-bari-II.

I. INTRODUCTION

WHEN the buildings are collapsed due to the heavy earthquake or the terrorism, how to rescue the survivors buried under debris is crucial task. Heavy debris is very difficult to lift up for human power, especially when there is not enough space to insert the jack. As one of the conventional rescue operations under such condition, rescue parties tried to pass under debris by using the tool of jacks and blocks to support the heavy load. However, this operation itself was too dangerous for them to carry out, when aftershocks were continued. Then, the robot which can help the task by passing under the heavy debris instead of rescue parties was desired.



Fig.1 Overall view of the developed “Bari-bari-II”

In this paper, a novel type of rescue robot is proposed which is aimed to open narrow spaces, move under heavy debris, and search and save out survivors at disastrous site. Unlike most of the conventional mobile robots to move through opened spaces, the proposed robot has the ability of

Hideyuki Tsukagoshi is with Tokyo Institute of Technology, Ohokayama 2-12-1-S5-19, Tokyo, 152-8552, JAPAN (corresponding e-mail: htsuka@cm.ctrl.titech.ac.jp).

cultivating spaces by its own so as to be able to pass through. This paper presents the design concept comparing to the conventional mobile robot, the structure and the behavior to realize the debris opening function under heavy load, and the performance under the debris filled condition by the developed model Bari-bari-II.

II. DESIGN CONCEPT

A. Comparison of the conventional mobile robots

When the conventional mobile methods^{[1]-[2]} are adopted to pass under heavy load condition, you will face to some problems. For example, if the general crawler is used in the above condition, it can not go forward under the heavy load, since the driving directions are opposite between the top and the bottom as shown in Fig.2(a). Instead, when the double crawlers are piled up to solve the above problem, it will be stuck after sandwiched between heavy debris due to the wedge effect, shown in Fig.2(b). Although the alternate support behavior between the front part and the rear one synchronizing with the shrinking and the extending motion seems to work well when one part of the robot can be supported under the object, it can not go forward when it faces to the condition with no obstacles to be supported by, shown in Fig.2(c).

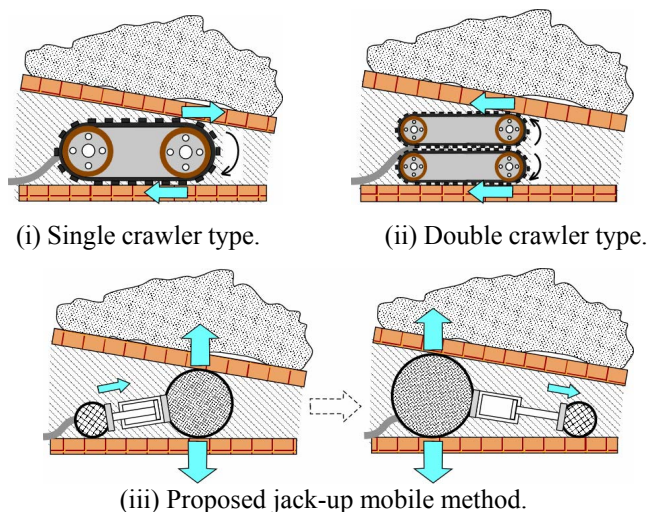


Fig.2 Comparison of the conventional mobile method

B. Proposal of the jack-up mobile method

To solve this problem, we propose the new mobile method consisting of two modes switched alternately, such as the

plates support mode and body support mode. In the plates support mode, an oil hydraulic cylinder on the X-shaped link can spread the middle plates to more than double height of its own, and it is possible to lift up 600kg load, so even 8 persons can be easily raised. In the body support mode, the side frame body supports the load, while the middle plates are moved horizontally by the electric motor. The key point of this robot is the step structure on its head. After the first step is inserted in the small space, the forward motion lets the robot lift up the debris gradually by switching two modes alternately, shown in Fig.3.

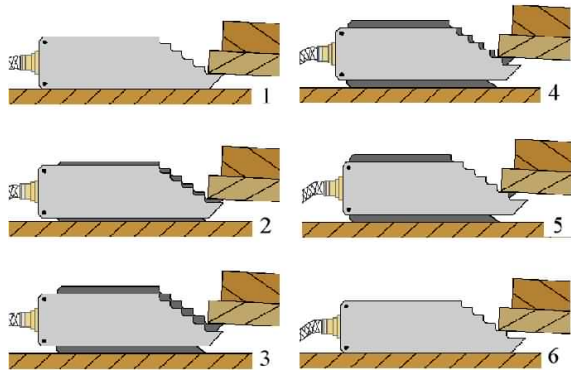


Fig.3 Jack-up mobile method with step structure.

III. DEVELOPED MODEL BARI-BARI-II

The developed Bari-bari-II can open the 10 mm space, and after passing through under debris, it can jack up till 250mm height, to support rescue operation to save out survivors. On the head part of the robot, the remote controlled camera, microphone and the speaker are installed, so the operator outside can obtain the information inside the debris. Adjusting the height of the middle plates is also helpful to allow the robot to cross over obstacles. Furthermore, even when the survivors lies down on the soft cushion, the robot can go forward with by adjusting the height. Even under unstable debris, two robots combination enables them to jack up and go forward stably. Bari-bari-II with the function of debris opening, moving, and searching is expected to help the operation to save out the survivors safely in various type of disaster, such as the traffic accident, the big earthquake, the hurricane, and so on.

Table.1 Spec of “Bari-bari-II”

item	Bari-bari-II
Size	480 x 276 x 140mm
Weight	25 kg
Maximum payload	500 kg
Maximum height	250 mm
Minimum height to be able to be inserted	10 mm
Step height to be able to cross over	60 mm
Maximum velocity	700 mm/min

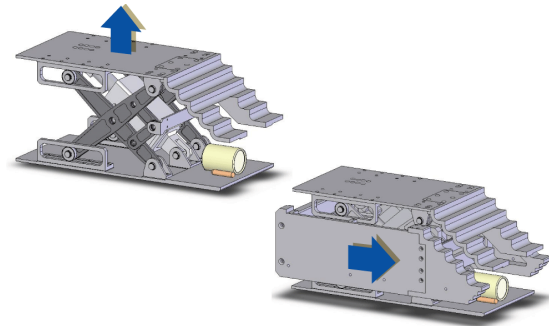


Fig.4 Mechanism to jack up heavy objects and go forward.



Fig.5 Stepping over the obstacle



Fig.6 Image of camera



Fig.7 Rescue operation with “Bari-bari-II”



Fig.8 Cooperation of Bari-bari-I and II

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