

# RoboCup Rescue 2024 TDP Agent Simulation Ri-one (Japan)

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**Abstract.** This paper describes the strategies devised in 2024 for expeditious life-saving operations. We developed a police force's rule-based action to remove the debris rapidly. The rule is demonstrated expeditious life-saving efforts in scenarios which importance of rapidly clearance the blocks.

## 1 Introduction

Last year's Ri-one developed extensive exploration by agents. However, these methods were based on the assumption that agents could move to their destination, leading to insufficient results depending on the debris clearance situation. Moreover, Last year's Ri-one conducted clearance operations even on passable roads, which resulted in inefficient clearance efforts. We addressed this issue by establishing rules for clearing the rubble on a road. Therefore, we can reduce unnecessary clearing the debris. Section 2 explains the rule of cleaning a road. Section 3 describes strategy of some agents.

## 2 Rule of Cleaning a Road

This section is explained a rule of clearing the debris. In addition, this section describes the actions in the event of getting stuck in debris.

### 2.1 The Details of the Rule

The rules for a clearing road is decided based on the midpoints of the edge shared by the road and its adjacent road, as well as the centroid of the road. If the line segment between centroid and one of middle points intersects with an edge of the debris, clearance operations are carried out along the line from the closest intersection point to the agent's removal range. The agent's can detect passable road if the line segments don't intersect edges of any blocks. Figure 1 shows the line segments which drawn on the road by the rule.

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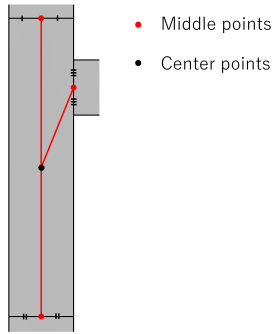


Fig. 1: Image of line segments

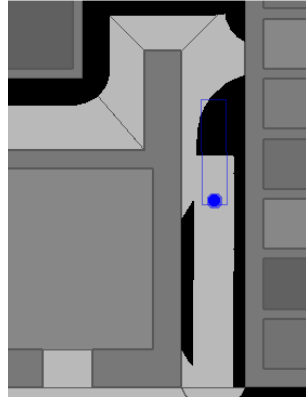


Fig. 2: Picture of simulation

## 2.2 Action of a Stuck Agent

According to the rule, passable road don't put on the middle points and the centroid of the road. Therefore, a stacked agent move nearest points in the points. If an agent gets stuck on the clearing road by the rule, we can establish a standardized protocol for actions to take. This consistency helps reduce instances where agents become stuck and rescuing civilians is late.

## 3 Strategy

### 3.1 Police Force (PF)

PF has the task of rubble removal. The task affects other agent's movement. We change PF's target detector and action in 2024. First, this subsection describes the problem of the target detector and the way of solving the problem. In 2023, There is the problem that PFs remove rubble on only one road when there is some rubble on more than 2 straight roads. A PF can't make a new movement route due to the problem. Not to make a new movement route occur issue that AT and FB can't leach the civilians who need rescue. PFs detect a neighbor road preferentially to resolve the problem. Therefore, PFs can make a new movement route surely. Second, this subsection explains PF's action. PF's action installed the rule described in section 2. Therefore, AT and FB can decide that a road is passable.

### 3.2 PathPlanning : Ambulance Team (AT)

AT has the task of transporting injured civilians to a refuge. In 2023, AT could not transport the civilians certainly because PathPlanning uses impassable roads to make a route. According to the rule, AT determined the advisability of passable roads. Consequently, impassable roads are removed for the rule before route searches. Therefore, AT can transport a civilian to a refuge steadily.

### 3.3 PathPlanning : Fire Brigade (FB)

FB has the task of rescuing buried civilians. In 2023, FB could not leach the civilian certainly due to FB try to through the blocked road. According to the rule, FB become to determine the advisability of passable in this year. Consequently, impassable roads are removed for the rule before route searches.

## 4 Preliminary Results

In this section, we describe the results of the experiments. These experiments aimed to confirm the effectiveness of implemented functions.

### 4.1 Experiment Conditions

In the experiments, Ri-one 2024 and Ri-one 2023 were compared. Ri-one2024 is an modified implementation of 2023 [1]. Ri-one 2024 refers to the modified version of Ri-one 2023. The simulations were carried out 10 times for each scenarios. The specifications of the used computer followed the table 1. The experiment results followed table 2. The map area of the scenarios used experiment is shown by the figure 3.

Table 1: specs of a computer

OS	Ubuntu 18.04
CPU	Intel Core-i9 10850K
Memory	DDR4-2666 32GB

Table 2: Average score for each map

Scenario	Team	
	Ri-one 2023	Ri-one 2024
berlin	72.2006127	71.5991522
kobe	176.029718	177.637451
vc	248.5726029	257.6820569

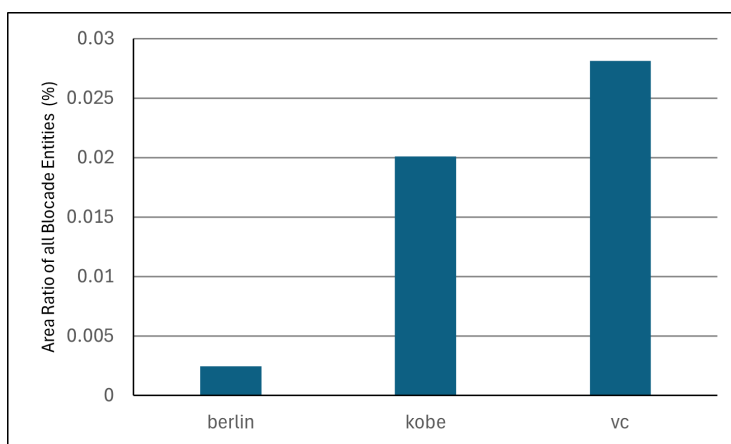


Fig. 3: Area ratios of all blockade entities in each map. The graph illustrate area ratio which total size of all blockade entities occupy each map size at first. The size of a blockade entity is calculated by the bounding-box of the blockade.

The experiment results show that there is a proportional relationship between the total area of debris in proportion to the map area and the increase in score. This development proves to be effectiveness in scenarios where efficient debris removal is important.

## 5 limitation

Ri-one 2024 have a problem lies in the lack of coordination between Fire Brigades and Ambulance Teams. The developments reduce the problem of agents being unable to rescue citizens due to the inability to reach the rescue target. However, there remains an issue where AT fails to transport the civilian to a refuge after FB rescues citizens. We need to improve the communication and coordination between FB and AT.

## References

1. Ikegami, T., Nomoto, H., Yano, K., Sawai, Y.: Robocuprescue 2023-rescue simulation league. team description ri-one (japan) (2023)