RoboCup Rescue 2017 Team Description Paper Quad Force

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Info

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***Abstract*—"Quad Force" is a joint team of studnts from Tohoku University. we use a tracked vehicle "Quince" as a mobile base and develop a new manipulator, control system and user interfaces to meet the specification of robocup rescue.**

***Index Terms*—Tracked vehicle, Manipulator, SLAM, recognition.**

I. INTRODUCTION

"Quad Force" is a joint team of studnts from Tohoku University. Members are from Tadokoro Lab, Kosuge Lab, Hirata Lab and Kitajima Lab. By combining each speciality, we are developping a robot which performs well in locomotion, information gathering, and manipulation tasks.

Our goal of the in the RoboCupRescue 2017 is to evaluate the manuevaring ability of our robot system. Our main development target is 7 DOF manipulator which can complete the manuvaring tasks in the RoboCupRescue.

II. SYSTEM DESCRIPTION

As a mobile base, we use tracked vehicle named "Quince", shown in Fig.1. Now we are developping manipulator, control system, SLAM system, recognition software and user interfaces. Main development targets are described on Fig.2. Details are desclibed below.

A. Hardware

We use "Quice", shown in Fig.1, as a mobile base. the robot has tracked body and 4 active flippers so that the robot can traverse on very rough terrein including stares, random steps or a high single step up to 40 cm. The robot weight is 33kg and payload is about 10kg. Thus, additional devices such as sensors, manipulators or extra batteries can be equipped on the robot. Litium-ion batteris are attached inside the tracks and it runs at least 90 minutes though the robot continuously travers on the rough terrain. The robot has cameras on the front and back, so the human operator can control the robot using those camera information. Detaild information of the robot is shown on Tab.I.

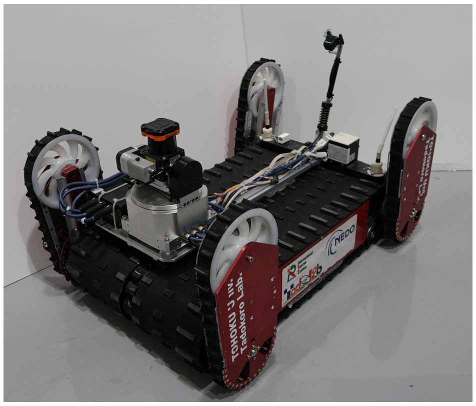

Fig. 1. Tracked vehicle "Quince". We use this robot as a mobile base.

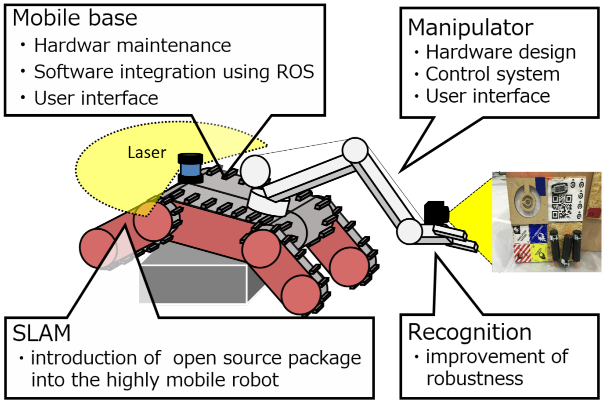

Fig. 2. Development targets of the project.

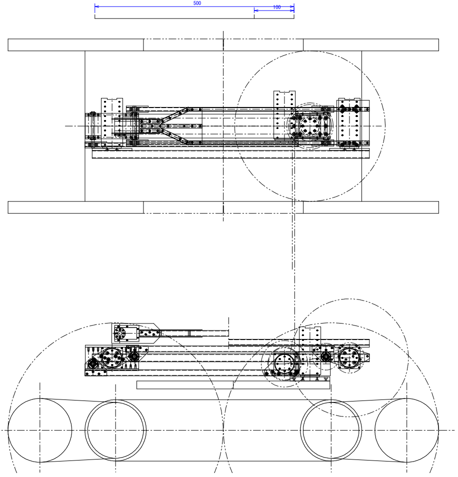

Fig. 3. CAD design of 7 DOF manipulator equipped on the robot.

Now we are developping new manipulator system. CAD design is shown on Fig.3. The Charactaristic of this manipulator is that parellel link is used as a first link to inclease the static payload. The manipulater has 7 DOF and can extend itself at most 1.5m above the ground. It consists of 4 Dynamixel Pro motors[1] and 3 Dynamixel motors[2]. The payload is 2kg so that it can deal with square bars in the maneuvering tasks.

For the 2D SLAM, We attach 2D laserscan sensor. The sensor is attached on the pan-tilt mechanism with two servo motors to stabilize the sensor on rough ground.

B. Software

1) Mobile base: The robot has two motors for drivig tracks and four motors for active flippers. Those motors are controlled using EPOS4 motor driver. we use "epos hardware" package [3] to control the motors and get the state of it. Human operator controlles the robot using joystick in the operator room and velocity command is sent to the robot via wireless communication.

Human operator can control the robot based on the camera information. Also, we have developped a graphic user interface of the tracked vehicle, shown in Fig.4. Using the interface, the operator can easily know the state of robot including angles of active flippers, pose of the robot on 2D map, robot trajectory and laser scan sensor datas. After the integration with manipulator, we extend this GUI to visualize the pose of manipulator using the same screen.

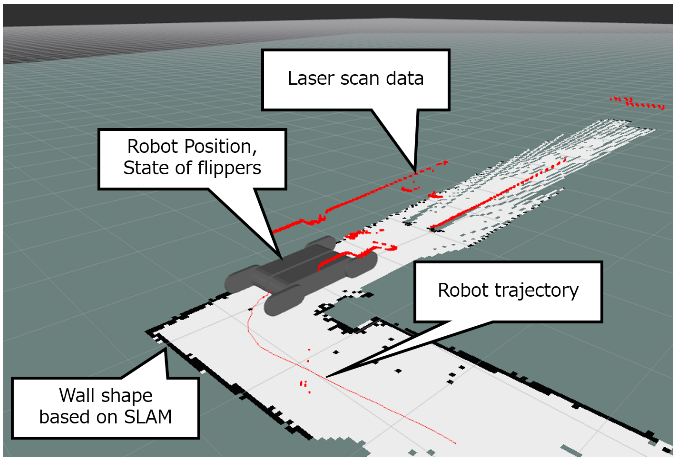

Fig. 4. Graphic user interface of the robot. It visualizes the angle of active flippers, robot posse on 2D map, trajectory and sensor datas. Human operator can easily know the state of the robot from a single screen.

2) Manipulator: In manuevering tasks, human operator would like to command the linear and angular motion separately to the end-effector while the tasks, such as pulling doorknob, pulling rod out from a pipe, and building scaffold using wood bars.

To meet the requirement, we will use "Moveit" package[4] as a manipulator controller. It provides inverse kinematiks solver and path planner. By using the package, operation gets much easier because operator shoud just command the goal position of the end-effector while manuvaling tasks. Also, It provides useful control interface, shown in Fig.5.

Currentry, we have finished a machanical designing of manipulator. after this, we will implement the software part descrived above.

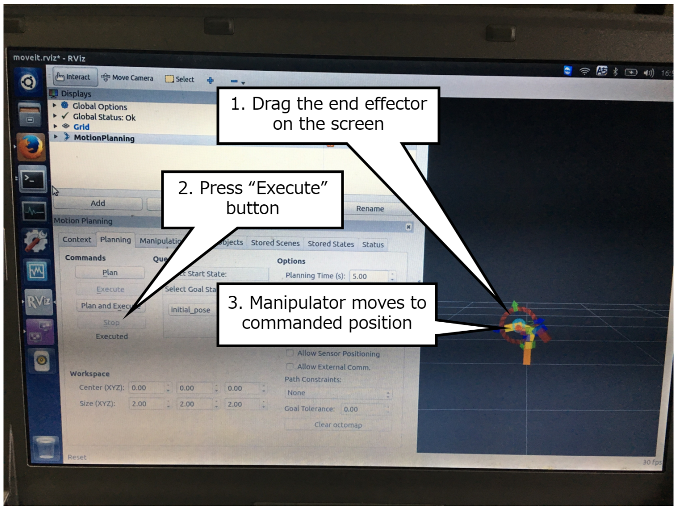

Fig. 5. Graphic user interface of "Moveit", manipulator controller. Operator can easily command the end-effector position by dragging the end-effector on the screen.

C. Communication

5GHz Wi-fi is used for the communication between robot and operator's laptop. communication channel can be changed by resetting wireless router between the games.

D. Human-Robot Interface

We have developped a GUI of tracked vehicle shown in Fig.4. The operator can know the state of robot using camera visions and the GUI information. Operator command the motion of the mobile base using joystick. Manipulator is controlled using GUI based interface, shown in Fig.5, by dragging the end-effector on the screen using a mouse. To increase the speed of manipulation task, we may compare the GUI-based control interface and Joistick-based one and choose the better way.

III. CONCLUSION

In this paper, we described our development target, direction, and progresses. In May 2017, we will completely integrate the system and test it in Robocup Japan Open. After this, we will improve the system and update TDP again.

APPENDIX A
TEAM MEMBERS AND THEIR CONTRIBUTIONS

- Shotaro Kojima Hardware setup of mobile base, GUI development
- Takumi Fujinami Control system of mobile base
- Eri Takane Mechanical design of end-effector
- Kazuya Konada Control system of manipulator
- Keisuke Okabe Control system of manipulator
- Masahiro Fujita System integration
- Takahiko Kobayashi Mechanical design of manipulator

TABLE I
SPECIFICATION OF THE ROBOT

Attribute	Value
Name	Quince
Locomotion	tracked
System Weight	33kg
Weight including manipulator	38kg(expected)
Transportation size	0.5 x 0.7 x 0.5 m
Typical operation size	0.5 x 1.0 x 0.5 m
Battery endurance (idle/ normal/ heavy load)	240 / 120 / 90 min
Maximum speed (flat/ outdoor/ rubble pile)	0.5 / 0.3 / 0.15 m/s
Payload (typical, maximum)	5/ 10 kg
Arm: maximum operation height	150 cm
Arm: payload at full extend	0.5kg

APPENDIX B
LISTS

A. *Systems List*

ACKNOWLEDGMENT

The authors would like to thank to the proffessors of our belonging laboratoris, who understands our motivations and supports this project.

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[4] "moveit," http://wiki.ros.org/moveit.