RoboCup Rescue German Open 2025 Team Description Paper FUSE

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Info

Team Name:	FUSE
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Team URL:	https://www.instagram.com/fuse_tub/

RoboCup Rescue TDP collection: 2019+: https://https://tdp.robocup.org/tdp/ Pre 2019: https://robocup-rescue.github.io/team_description_papers/

***Abstract*—This paper describes the concepts of the robot PHRYNE, which was designed to participate in the RoboCup 2025 German Open competition. Our team consists of students studying at the Technical University of Berlin, with some members working at the Learning and Intelligent Systems Laboratory (LIS).**

***Index Terms*—RoboCup Rescue, Team Description Paper, PHRYNE**

I. Introduction

THE FUSE Team consists of students from the Technical University of Berlin with some working at the Learning and Intelligent systems Laboratory (LIS). As this is our first year in this competition, we plan to focus more on the robot's mobility in order to navigate rough terrains. Two cameras and one Lidar are mounted on the robot to provide high quality 3D Mapping. Additionally heat camera, RGBD camera and CO_2 sensors are mounted on the robot arm to provide victim and hazardous signs detection. PHRYNE will be remotely operated by and operation at his station.

II. System Description

A. Hardware

To achieve high mobility, dexterity, and strong autonomous capabilities, we developed PHRYNE—a system featuring a chassis with main tracks and flippers to support the manipulator arm and sensor head. Below, we briefly outline the key hardware components and sensors integrated into PHRYNE.

- Locomotion
  The locomotion system is made of 2 main crawler belts and 4 flippers to achieve high mobility. The main drive consists of 2 motors operating at maximum 48V with roughly 258 rpm max. The Belts are made from Polyurethane Foam.
- Power (Batteries)
  The robot uses 2 LiPo batteries. The 48V Battery is use for supplying power to the drive systems while the 24V Battery provides power for the control systems.
- Electronics, including micro-controllers, etc.
  We plan to use the TEENSY 4.1 microcontroller to interface and control the speed and rotation of the motors.
- Manipulation/ directed perception
  The semi-autonomous robot can extend its arm up to 1.5 meters. The manipulator arm consists of a heat camera, RGBD camera and CO_2 sensors.
- Sensors
  2 RGBD Cameras are mounted in the front and backside of the robot to create a high quality 3D Map with the help of a 3D Lidar mounted at the back.
- Computation (high performance for autonomy, etc.)
  For High Level computations we plan to use the NVIDIA JETSON ORIN NX with ROS2 as framework.
- Communication
  We will attach a wifi attena at the back of the robot and broadcast the wifi signal to be picked up by the router at the operator station.
- Operator station
  The operator station mainly consists of 1 Laptop and a simple internet router.

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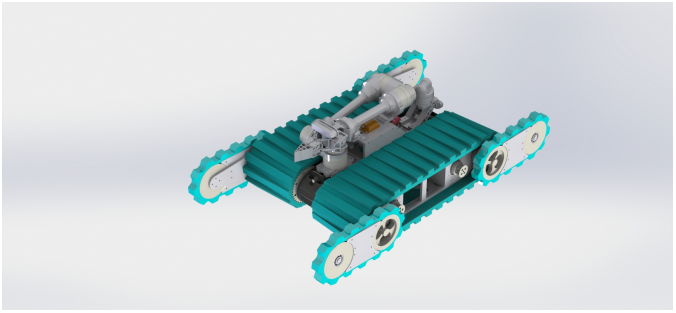

Fig. 1. PHRYNE

B. Software

We plan to split the software into 2 sections:

- Low level control
  The TEENSY 4.1 microcontroller will be used as a main

MCU for the low level control. Its job is to control the speed of the main drive, the rotation of the flipper actuators and the inverse kinematics calculation of the arm.

- High level control
  The NVIDIA JETSON ORIN NX is used here to interface remotely with the operator station, creating a 3D Map, detecting victims and harzardous signs and also communicate with the low level side.

III. Application

A. Set-up and Break-Down

The robot can be easily set up by putting the 2 Batteries inside the main chassis and turning on the 3 switches (POWER, CONTROL, ARM). As for the operation, it can be set up by connecting the laptop with the WiFi broadcast from the robot. When connected, the operator can run a simple script to open up the control screen and start.

B. Mission Strategy

In this first year of the competition, we plan to focus more on the mobility tasks, which mostly involved in navigating in rough terrains. We will also be doing some tasks that include the use of the arm (Dexterity) but the purpose is to just collect data to design a better arm for the next year.

C. Experiments

We will test our robot in multiple terrains which can be found around our university campus, such as ramps, staircase and sand areas.

D. Application in the Field

Our primary objective of this project is to, one day, be able to deploy the robot in real life rescue situations. Our robot should be able to create a 3D map of the scene accurately and report the location victims or any hazardous activity to the human rescue team. As in this prototype the robot still lacks dexterity and cannot be operated in high temperature environments. We plan to develop our robot and find better materials to solve these problems in the future.

IV. Conclusion

We have developed PHRYNE with high mobility performance and moderate arm performance. We will evaluate these performances within the RoboCup Rescue competition and use its performance as a reference for future development.

Appendix A
Team Members and Their Contributions

- Woraphon Choaywong Mechanical design, Electronics, Low Level Control and SLAM
- Patthicha Mahakijdechachai Project Management
- Harry Bason Mechanical design
- Phumin Lertpredanan Electrical design
- Eckart Cobo Briesewitz Programming
- Denis Shcherba Programming

TABLE I
Hardware Components List

Part	Brand & Model	Unit Price in EUR	Num.
Drive motors	Maxon RE 50 200 W	614.4	2
Drive gears	Planetary Gearhead GP 52	426.09	2
Drive encoder	Encoder HEDS 5540	147.79	2
Motor drivers	ESCON Module 50/5	189.78	2
DC/DC	I7A4W033A033V-001-R 500W	64.2	4
Battery Management		?	1
Batteries	LiPo Batteriy 24V 10Ah	154.9	2
Micro controller	Teensy® 4.1 Development Board	31.5	1
Computing Unit		?	1
WiFi Adapter	TPLINK ARCHERT3+	19.95	1
Cameras	Intel® RealSense™ D435i	369	2
Infrared Camera	Arducam B0063 MT9M001	23.9	1
CO_2 Sensor	DEBO GAS MQ6 3	5.52	1
Battery Chargers		?	4
6-axis Robot Arm		?	1
Aerial Vehicle		?	1
Rugged Operator Laptop	ThinkPad P16s Gen 3	EUR 2,500	1

Appendix B
CAD Drawings