

HSL-Throw: The Hand-Launchable Two-Wheeled Rescue Robot

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Abstract—The requirements of robotic systems for search and rescue operations vary depending on the situation. While several systems have been developed to address these needs, there remains a demand for a general-purpose rescue robot. In this paper, we introduce the electronic and hardware design of a mobile robot platform that is small, low-cost, and equipped with diverse sensors, making it easily portable. The goal of this project is to develop a platform for rescue, research, or educational purposes that can semi-autonomously assist rescue teams or even students by utilizing object detection capabilities. We propose a real-time object detection model based on the Tiny-YOLO deep learning framework to achieve this. This platform balances capabilities, accessibility, cost, and open design, offering an open-source software development kit (SDK). The electronic structures, including sensors, motor drivers, and device communication management (DCM), are designed based on a 32-bit ARM microcontroller running under the FreeRTOS with task scheduling. Additionally, an RPI Zero 2W board is used for wireless communication, image processing, and ambient sound detection. Manual deployment of robots in rescue situations can be challenging due to human visual errors. This paper discusses the integration of this robot with artificial intelligence, which is currently being developed by the MRL Robotics Research Lab.

Index Terms—Rescue Robots, Mobile Robot Platform, Human-Robot Interaction, Tiny-YOLO, FreeRTOS, ARM Microcontroller.

I. INTRODUCTION

Rescue robots are highly attractive for search and rescue operations due to their ability to navigate through rubble or hazardous areas. Compared to dogs or human workers, these robots are more expendable, making them ideal for initial reconnaissance in dangerous areas. Experiences from rescue operations, as well as those involving robots, have highlighted several challenges and limitations of the current systems. The main challenge in urban search and rescue operations lies in the unpredictable and highly variable nature of disaster environments. Although numerous solutions have been proposed and developed in the past, none have proven to be both affordable and reliable enough to be widely adopted in all areas of rescue operations. In recent years, significant progress has been made in object detection, especially with the promotion of deep convolutional neural networks (CNN). One of the most important frameworks in this regard is Tiny-YOLO, a lightweight version of the YOLO (You Only Look

Once) object detection model. Tiny-YOLO, due to its simpler structure and efficient use of resources, is particularly suitable for robots with limited computational power, such as rescue robots. Tiny-YOLO works by dividing the input image into a grid of cells, predicting both the location and category of objects simultaneously in real-time. This allows robots to detect humans or other objects under rubble or in complex environments, even in low-light conditions or when parts of the body are obscured. In this paper, we review past incidents where rescue robots were deployed and examine the challenges encountered in identifying trapped individuals or objects in such complex environments. We also discuss the benefits of leveraging deep learning models like Tiny-YOLO to enhance the detection capabilities of rescue robots. This paper introduces the rescue robot platform HSL and also reviews similar systems such as Recon Scout and IRobot FirstLook. In the following sections, we will further explore the performance and capabilities of existing rescue robot platforms “Fig. 2”. Finally, we will provide an overview of the HSL robot system and explain how Tiny-YOLO is integrated for object detection.



Fig. 1. Example of a figure caption.

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Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections II-A to II-H below for more information on proofreading, spelling and grammar.

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$$a + b = \gamma \quad (1)$$

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- The subscript for the permeability of vacuum μ_0 , and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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- In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
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- There is no period after the “et” in the Latin abbreviation “et al.”.
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An excellent style manual for science writers is [7].

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TABLE I
TABLE TYPE STYLES

Table Head	Table Column Head		
	<i>Table column subhead</i>	<i>Subhead</i>	<i>Subhead</i>
copy	More table copy ^a		

^aSample of a Table footnote.



Fig. 2. Example of a figure caption.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an

example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

ACKNOWLEDGMENT

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REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

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