The RescueBot - A new variant of the VolksBot

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Abstract. This paper presents the RescueBot — a new variant of the platform VolksBot. It is primarily build for search and rescue operation. The robot is assembled from standard VolksBot components and underlines the platform's rapid prototyping concept.

Keywords: Rescue Robotics, Search and Rescue, VolksBot

1 Introduction

In this paper, we present our approach for a modern rescue robot based on the VolksBot[1] platform. As we and some international partners are currently working together in an EU project called NIFTi[2], we created a new robot for this project, which is based on a VolksBot and capable to perform search and rescue operations. The project NIFTi is trying to minimize the gap between humans and robots in order to achieve a common goal, which is demonstrated by the support of search and rescue personnel in dangerous situations. Our approach enables our partners to develop a dedicated rescue robot rapidly based on the experience with the VolksBot platform. In particular, they do not have to cope with problems related to mechanical engineering. Since VolksBot was designed as a rapid prototyping platform, the primary focus of this platform relies on the reusability of different system components.
In chapter 2, we give a short overview of different VolksBot projects, as well as other state of the art rescue robots. After that, we briefly review the concept of the VolksBot platform, which has been introduced in [1]. In section 4, we will introduce our newest modification, the RescueBot.

2 Related work

Using the VolksBot high value construction kit, various variants of powerful mobile robots can quickly be built and adapted for different applications such as

[1] http://www.volksbot.de/index-en.php
[2] http://www.nifti.eu/

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Fig. 1. The new RescueBot robotic platform with a small and robust 3D Laser range finder.

autonomous transportation, exploration, surveillance, education, research and industrial rapid-prototyping. VolksBot offers three families of robots:

- VolksBot RT (Rough Terrain)
- VolksBot XT (eXtreme Terrain)
- VolksBot Indoor

Several projects use these robots as basic platforms and extend them with application-specific features, e.g., the TrashBot, the DataBot, the AtHomeBot, the PresentationBot, or the MarBot. The last mentioned robot for example is used for sea bed analysis in shallow water. Further variants like the ProfiBot utilize the platform for education in the field of mechatronics.
In the field of rescue robotics, there are lot of different competing platforms. They can be classified into four categories according to their application area:

- unmanned ground vehicles (UGV),
- unmanned aerial vehicles (UAV),
- unmanned underwater vehicles (UUV), and
- unmanned surface vehicles (USV).

The RescueBot belongs to the category of UGV platforms and especially to the tracked robots in contrast to wheeled or legged ones, which are also common types of locomotion for such devices. The tracked approach has mainly the advantage that it can traverse steps, stairs and uneven surfaces without the need of a complex kinematic.
The telemax by telerob [3] and the PackBot by IRobot [4] as commercial platforms are examples for such UGVs, which are being used for EOD (Explosive

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Ordnance Disposal) tasks. AMOEBA-I is an example for a shape-shifting UGV [5], which can change the alignment of its components depending on which surface it is operating on. Another recent example is the Track Walker, which utilizes three chains for leg-track hybrid locomotion [6]. This allows the robot either to drive on its chains or to walk with its legs depending on the surface. The Rugbot [7] and the Robbie [8] are two of the various robotic platforms which are developed by universities in the context of the RoboCup rescue league. The goal of this competition is the development of robots that are able to operate in search and rescue scenarios.

3 Brief review of the concept

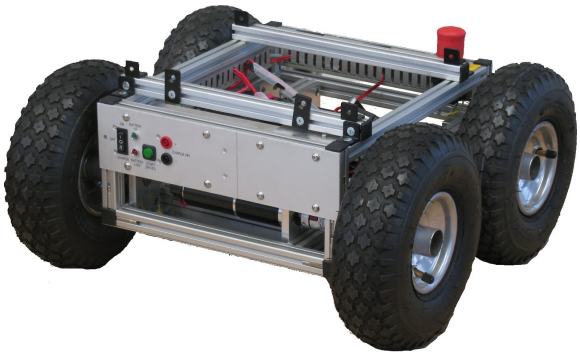

Fig. 2. VolksBot RT4 standard platform.

The following part briefly reviews the VolksBot concept, which has been previously presented in [2].

The VolksBot is a flexible and modular mobile robot construction kit. The rationale of the VolksBot system is the physical rapid prototyping of mobile service robots. This means that the VolksBot system can be extended by a wide variety of sensors, actuators and software modules, allowing cost- and resource-efficient development of mobile service robots. All robots of the VolksBot system are based on the same high value components and interfaces, which make it easy to adapt existing robots to changing requirements. If you start with a simple VolksBot platform (e.g. see Fig. 2) you can easily add components over time, which always match with your actual needs and your future demands. This guarantees a high security of the investment since once purchased components and obtained experiences can be used for a wide variety of applications.

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The component-based approach offers a plug-in architecture in electronic hardware, software and mechanics. It provides open interfaces to hardware and software modules. Combined with an effective and robust design, a wide range of domain-specific robots can be created with little effort. Furthermore, the modular concept facilitates reusability of already developed components. The VolksBot concept was successfully applied in national and international R&D projects. The construction kit is the result of long-time experiences of Fraunhofer IAIS and the answer to the problems and difficulties with the construction of autonomous mobile robots hardware and software. The robot construction kit is continuously enhanced with new and special components based on our experience in current national and international R&D projects. During the last years the kit has also become very popular in the education of master and PhD students due to the professional selection of industrial components for the kit.

4 RescueBot

4.1 Introduction

Recent catastrophes have shown that there is a need of technical support for rescue operations, may it be collapses of buildings [9] or trapped people in a collapsed mine [10]. These events raise the question whether robot assistance would be helpful to allow the rescue team to operate in terrain that is not discoverable by themselves. Canines are a great choice to spot the buried people. But with the aid of a rescue robot it is also possible to help those people as the robot (tele-operated or autonomous) can move small rocks by itself and can provide aid in many other ways as well. Inspired by the RoboCup Rescue community and bomb defusing robots, e.g., the telemax [3], we developed our own rescue robot based on a VolksBot RT4 (see Fig. 2). Primarily built for educational purposes it can also be adapted to the application in search and rescue operations. The RescueBot as it is called also serves as a preliminary experimental platform for the NIFTi project.

4.2 Requirements

Several difficulties arise from the usage of a robotic platform in the field of urban search and rescue. Because operations in this area are mainly being performed in dangerous and hazardous environments the robot needs to be resistant against fire, water, and other influences that could harm its correct operation. It has to be able to operate in rough terrain, climb small hills and overcome obstacles. It should be robust and capable to compensate shocks that could occur due to smaller drops. Also it is important that the robot can operate autonomously and is not necessarily required to have a cable attached to it.
As rescue operations are very exhaustive and usually taking long time, a long run-time of the battery is also needed. Operation in rough terrain puts all components under deep stress, therefore the durability of the components should be

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maximized.
The design of the robot shall also allow the robot to be man-packable, therefore a flat chassis and a compact assembly of the robot is required. Another feature that would be nice to have is that the robot can be easily extended with standard components.

4.3 Design decisions

The design of the RescueBot is based on the VolksBot RT4 platform and therefore has a height of 80 mm (see lower right picture in Fig. 3). It is mainly inspired by robots that have already been successfully used in the context of rescue operations.

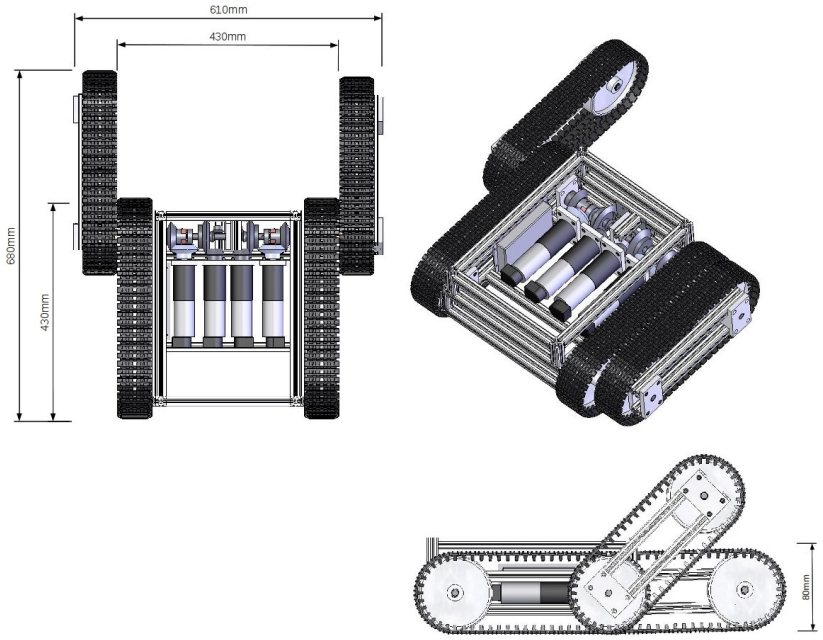

Fig. 3. CAD-drawings of the robotic platform design.

The main idea was to utilize a pair of flippers to allow stable vehicle handling and the ability to overcome obstacles. As the operation environment might be very limited in its dimensions a flat chassis comes in handy. This compact design also allows the robot to be very portable. All required components have been assembled in such a way that they fit best into the limited space of the robot chassis and leave minimal open space in the interior.

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The rubber tires on the VolksBot RT4 have been exchanged to plastic chains that allow us to have better grip on different grounds. These include climbing stairs or moving on uneven ground.
Since the VolksBot platform is mainly constructed out of standard components and designed in a very modular way the integration of sensors and actuators (e.g. manipulators, arms) onto the robot is very simple and can be done in short time. Last but not least the usage of standard components greatly lowers the cost and allows an easier integration of those components onto the robot.
The RescueBot is an evaluation platform that can be extended to meet the requirements stated in section 4.2.

4.4 Implementation

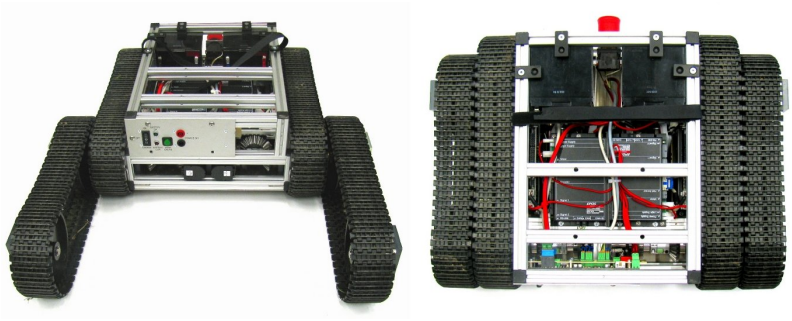

Fig. 4. The basic RescueBot platform without a processing unit and sensors attached to the chassis.

The RescueBot has in its smallest state (see Fig. 4 on the right hand side) a size of 430x610x80 mm (LxWxH) and with extended flippers a size of 680x610x80 mm (see Fig. 4 on the left hand side). It weighs 26.6 kg without any additional sensors and computational units and can carry an approximate extra payload of 50 kg. With the use of two 12 Ah lead accumulators the robot is able to operate at least 1 hour till it has to be recharged. The robot is equipped with four 150 W maxon motors: two motors actuate the flippers and the other two are controlling the chain drives. With these motors and a planetary gearing of 74:1 the robot is able to drive at an approximate speed of 1.2 m/s.
Due to the modular design of the VolksBot it is possible to easily extend and exchange different parts of the robot. Hence, for example, the robot can be equipped with a 3D Laser scanner and a robust laptop to control the RescueBot autonomously (see Fig. 5).
The recommended operating system for all VolksBot models is Linux. On this layer, we provide different interfaces to control the components, for example, via ROS.

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4.5 Discussion

To be able to compare our RescueBot against other common rescue robots, we decided to take a look at the first and second place of the robot league of RoboCup Rescue 2009. The first place, iRAP PRO, features four flippers and the runner-up CASualty features two flippers.
Compared to the iRAP PRO from King Mongkut's University of Technology North Bangkok, Thailand, our robot uses an individual controller for each flipper. The iRAP PRO has two flippers in the front, which are controlled by one motor controller, and it has two flippers in the back, which are also controlled by one motor controller. With our solution the robot has more flexibility handling different surfaces by having the capability of moving the flippers independently. CASualty from the UNSW, Australia, uses two flippers, with less length than ours. Because of longer flippers our robot has a better capability of climbing stairs (or other objects like bricks, stones, or pallets) in contrast to CASualty.

4.6 Conclusion and future work

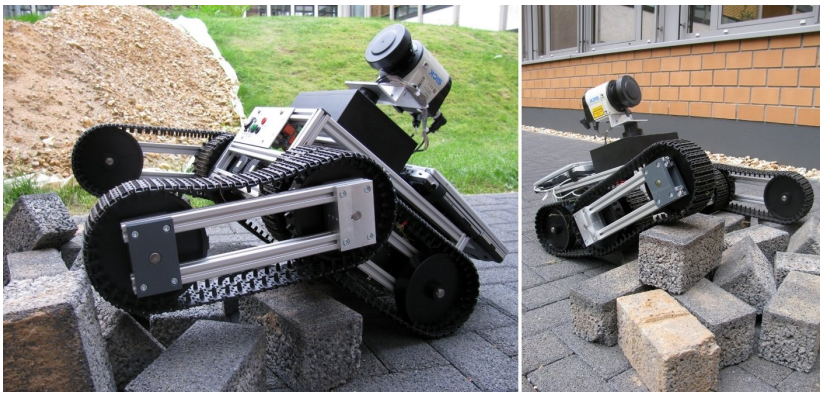

Fig. 5. The RescueBot climbing uneven terrain.

In this paper, we presented the RescueBot as a new variant of the VolksBot robotic platform. It has been designed especially for the usage in search and rescue operations. Like our other models it is extendable with a 3D Laser range finder, camera, and other sensors. The model introduced here is our first prototype iteration, which shows how a VolksBot can be also used in rescue robotics. In the future the plastic chain needs to be replaced with a rubber-coated one to have better grip when climbing or driving on uneven terrain. Furthermore, two additional flippers will be attached to the robotic platform to increase stability,

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enhance the grip, and enable the robot to maintain a horizontal frame independent of surface irregularities.
A video of the robot can be seen at Youtube: http://www.youtube.com/watch?v=Y6Yg0z7Roz0

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