БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ • BULGARIAN ACADEMY OF SCIENCES

ПРОБЛЕМИ НА ТЕХНИЧЕСКАТА КИБЕРНЕТИКА И РОБОТИКАТА, **67**
PROBLEMS OF ENGINEERING CYBERNETICS AND ROBOTICS, **67**

София • 2016 • Sofia

Design and functionality of Web User interface for control of service mobile robots through the Internet

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Abstract: *service mobile robots are not enough autonomous or need additional management and instructions to do their job. So there is a need to control the robots distantly from any place in any time. In this paper we describe the development and the properties of web based user interface for control service mobile robots. In this interface we added different menus, properties, joypads, audio and video streaming, information for robot's battery, sensors and other. The main function of the user interface is to provide user control on the robot and all the necessary information about robot's systems. The application is working on the internet so the user may connect to the robot through the internet from anywhere and by any device with a web browser.*

Keywords: *service robot, mobile robot, user interface, web application, internet, robot control, telecommunication*

1. Introduction

In a joint effort started in 1995 the United Nations Economic Commission for Europe (UNECE) and IFR engaged in working out a preliminary service robot definition and classification scheme, which has been absorbed by the current ISO Technical Committee 184/Subcommittee 2 resulting in a novel ISO-Standard 8373 which had become effective in 20121. A preliminary extract of the relevant definitions is given here:

- A robot is an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention.
- A service robot is a robot that performs useful tasks for humans or equipment excluding industrial automation application. Note: The classification of a robot into industrial robot or service robot is done according to its intended application.
- A personal service robot or a service robot for personal use is a service robot used for a non-commercial task, usually by lay persons. Examples are domestic servant robot, automated wheelchair, personal mobility assist robot, and pet exercising robot.
- A professional service robot or a service robot for professional use is a service robot used for a commercial task, usually operated by a properly trained operator. Examples are cleaning robot for public places, delivery robot in offices or hospitals, fire-fighting robot, rehabilitation robot and surgery robot in hospitals. In this context an operator is a person designated to start, monitor and stop the intended operation of a robot or a robot system.

A robot system is a system comprising robot(s), end-effector(s) and any machinery, equipment, devices, or sensors supporting the robot performing its task [1].

Control of mobile robots is a complex process that requires coordination and cooperation between many subsystems. When the robot is oriented and designed for helping people in their homes, its control becomes even more difficult and responsible task. It is important that the movement is executed with higher precision. Also, the control logic must be very tolerant to mistakes made by the operator [2].

When we have a service robot at our home or office and we want to control it easy and safety than is necessary to be developed a program or application that will provide this to the user. Internet based applications and interfaces are very suitable for this purpose, because we can connect to the robot from everywhere.

Visual part of computer application or operating system through which a user interacts with a computer or a software. It determines how commands are given to the computer or the program and how information is displayed on the screen. Three main types of user interfaces are Command language: the user must know the machine and program-specific instructions or codes. Menus: user chooses the commands from lists displayed on the screen. Graphical user interface (GUI): user gives commands by selecting and clicking on icons displayed on the screen. In our case the user is going to interacts with the robot's computer.

The user interface has to provide all function of the robot. These functions must be structured clear and comfortable, to be easy for use. Also there must have a description for each function: how it is working, how to operate with it and what can be done [3].

User interface requirements [4]:

Keep the interface simple. The best interfaces are almost invisible to the user. They avoid unnecessary elements and are clear in the language they use on labels and in messaging.

Create consistency and use common UI elements. By using common elements in your UI, users feel more comfortable and are able to get things done more quickly. It is also important to create patterns in language, layout and design throughout the site to help facilitate efficiency. Once a user learns how to do something, they should be able to transfer that skill to other parts of the site.

Be purposeful in page layout. Consider the spatial relationships between items on the page and structure the page based on importance.

Strategically use color and texture. You can direct attention toward or redirect attention away from items using color, light, contrast, and texture to your advantage.

Use typography to create hierarchy and clarity. Carefully consider how you use typeface. Different sizes, fonts, and arrangement of the text to help increase scanability, legibility and readability.

Make sure that the system communicates what's happening. Always inform your users of location, actions, changes in state, or errors.

Think about the defaults. By carefully thinking about and anticipating the goals people bring to your site, you can create defaults that reduce the burden on the user.

Commonly used languages and tools for developing web user interfaces are html, CSS, JavaScript etc. HyperText Markup Language (HTML) is the standard markup

language for creating web pages and web applications. With Cascading Style Sheets (CSS), and JavaScript, it forms a triad of cornerstone technologies for the World Wide Web. Web browsers receive HTML documents from a webserver or from local storage and render them into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document [5].

The most common use of JavaScript is to add client-side behavior to HTML pages, also known as Dynamic HTML (DHTML). Scripts are embedded in or included from HTML pages and interact with the Document Object Model (DOM) of the page. Some simple examples of this usage are:

- Loading new page content or submitting data to the server via Ajax without reloading the page (for example, a social network might allow the user to post status updates without leaving the page).
- Animation of page elements, fading them in and out, resizing them, moving them, etc.
- Interactive content, for example games, and playing audio and video.
- Validating input values of a Web form to make sure that they are acceptable before being submitted to the server.
- Transmitting information about the user's reading habits and browsing activities to various websites. Web pages frequently do this for Web analytics, ad tracking, personalization or other purposes.

Because JavaScript code can run locally in a user's browser (rather than on a remote server), the browser can respond to user actions quickly, making an application more responsive. Furthermore, JavaScript code can detect user actions that HTML alone cannot, such as individual keystrokes. Applications such as Gmail take advantage of this: much of the user-interface logic is written in JavaScript, and JavaScript dispatches requests for information (such as the content of an e-mail message) to the server. The wider trend of Ajax programming similarly exploits this strength [6].

Cascading Style Sheets (CSS) are a stylesheet language used to describe the presentation of a document written in HTML or XML (including XML dialects like SVG or XHTML). CSS describes how elements should be rendered on screen, on paper, in speech, or on other media [7].

2. Methods

The communication between the robot assistant and the users is a really important issue. It determines how fast he will adapt to the system and starts using its full potential. That’s why we created user interface for controlling the robot. With this interface the control, setup and communication with the robot could be done via any decent device with a web browser – smartphone, tablet, laptop or a personal

computer. This type of interface allowed us to reduce costs for hardware to their minimum, because this interface was hosted on the already existent computer in the robot.

For the interface we used the Python based web framework – Django [8]. We implemented two sided video and audio communication in real time via the WebRTC library which is already supported in most of the modern web browsers. The interface also provides access to all parameters of our robot assistant system and saves any modification of them, which makes personalization and tuning of the robot a very pleasant and user friendly task. There is also a virtual joystick for controlling the position of the robot and live video stream from its camera. Also, the current status of the platform is shown on the interface. We made special buttons for voice synthetizing of important to our person information, like the weather or the current time.

In manual mode the user sees four windows. Camera of the robot, user's device camera, virtual joystick and robot info. In this mode the user controls every movement of the robot by itself (Fig. 1).

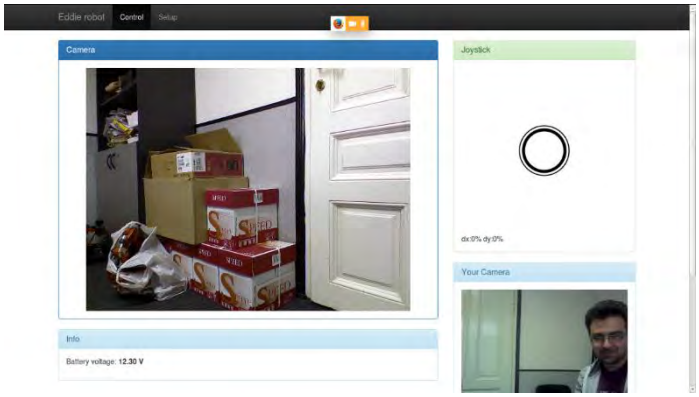

Figure 1. Manual Mode

Virtual joystick: It works like a single analog stick on a physical joypad. It is integrated into the web user interface and allows easy remote control of the system via any web browser. But again, tests show that older and hand disabled persons cannot use it well. So, here we can change the analog virtual stick with analog virtual pushbuttons. Pressing any of the buttons will result in rotation or movement in the desired direction.

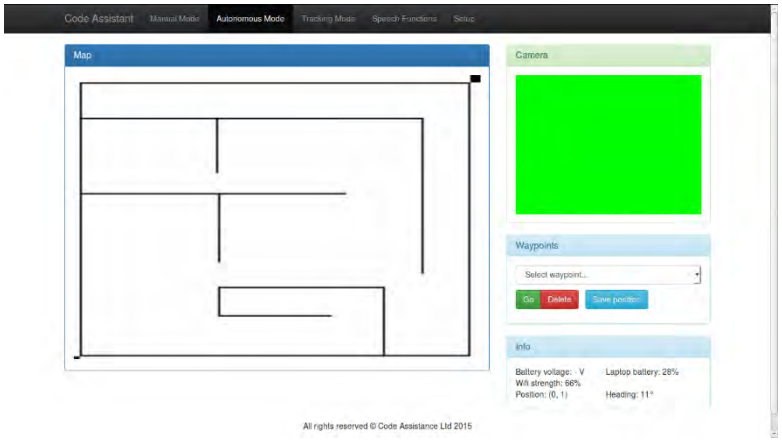

Figure 2. Autonomous Mode

Autonomous mode: in this menu we added the navigation of the robot [9]. In this menu the user sees the map of the building and can control the robot by selecting the desired destination. The robot will go there autonomously, thanks to the ROS Navigation stack. User can see where is the robot on the map and what the robot's camera is capturing (Fig. 2).

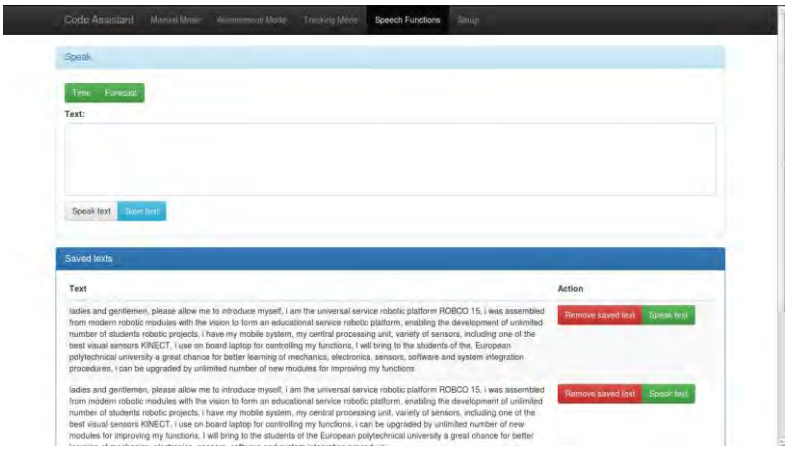

Figure 3. Speech Functions

Text speech, time and forecast: this menu is under construction. Its functions are to give to the user current time and date and the forecast (Fig. 3). Here the user can add some texts that the robot will speak in different cases.

Robot setup menu is very important (Fig. 4). Here the user can change most of the robot's properties. This menu may be dangerous for the people if something is not correct so we made it only for developers only.

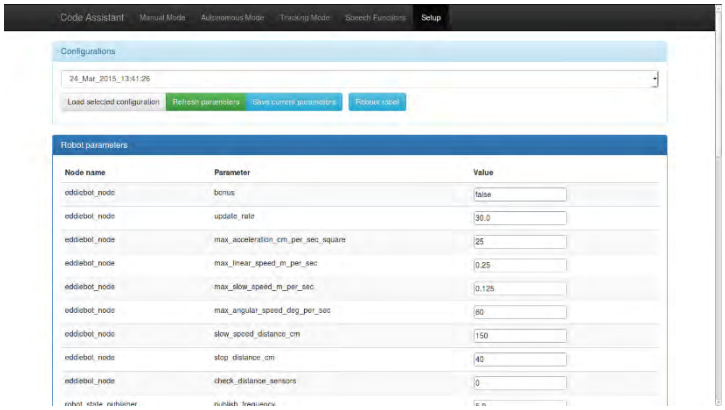

Figure 4. Setup Menu

Since robot system is based on ROS [10]. So, we used the JavaScript library roslibjs and the rosbridge package for establishing the communication between the user interface and the mobile platform.

Figure 6 shows how the interface interacts with the ROS system. Via rosbridge websocket and JavaScript the interface asynchronously gets the current state of the mobile assistant system and sends movement requests to it. Also, the UI gets the camera stream through a HTTP connection thanks to the ROS web video package. The audio stream from the robot microphone and the video/audio stream from the device to the robot screen and speaker are transferred through the WebRTC protocol. As of today, WebRTC is supported in most of the browser for Windows, Linux and Android.

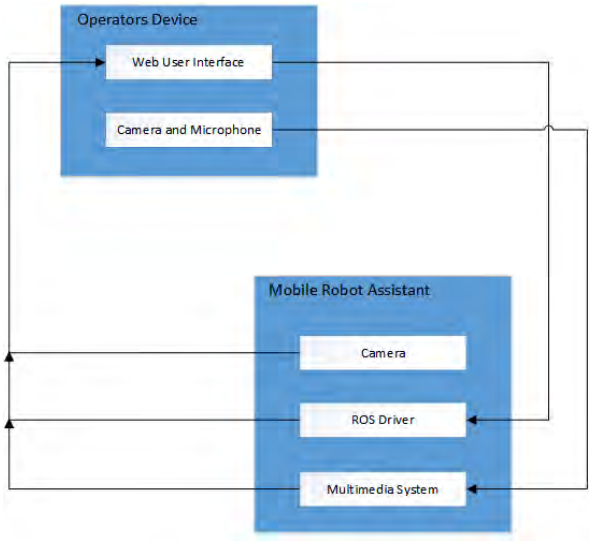

Figure 5. Communication between GUI and Robot

We developed additional application that will be a part of the GUI of the robot. This application is for children (Fig. 6). We believe that the robot must be good friend of the children, so it will play games with them.

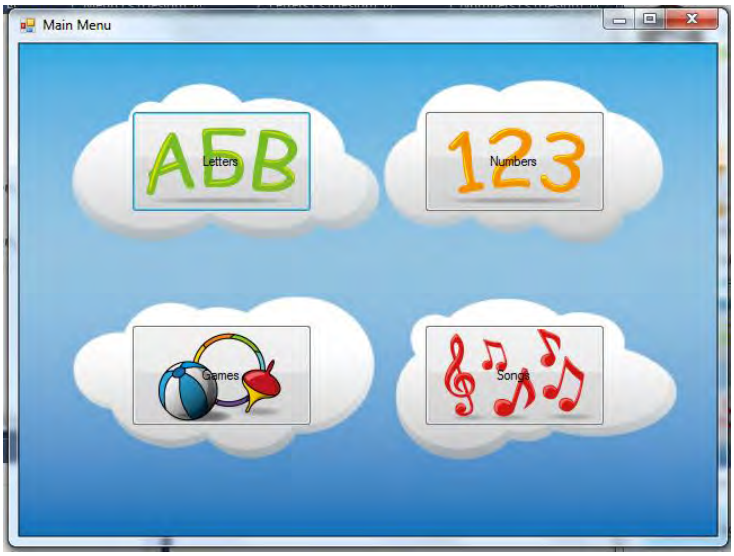

Figure 6. Application for Children

The application for children has four main buttons: letters, numbers, games and songs. Letters button opens new window with the alphabet and every letter is separate button. When a letter button is pressed the robot will pronounce the letter and a word with that letter. Numbers menu presents a window with numbers from 0 to 9 and example equations. In the games we added two games, one for letters and one for numbers.

3. Results

Graphical User Interface of the robot provide different functions to the user. The user can choose between Manual or Autonomous mode for robot control. He can inspect the room and navigate the robot to any destination. May be held conversations between the user and a person that is near the robot. The application for children gives to the robot opportunity to interact with children.

4. Conclusion

Robots are going to be part of our daily routine. Graphical user interfaces will help us to learn how the robots can be integrated in our homes or offices. The more functions the user interface has the more opportunities there will be for the user to interacts with the environment through the robot.

5. References

[1] "Definition of Service Robots," IFR, [Online]. Available: http://www.ifr.org/service-robots/. [Accessed 20 10 2016].

[2] Nayden Chivarov, Denis Chikurtev, Kaloyan Yovchev, Stefan Shivarov, "Cost-Oriented Mobile Robot Assistant for Disabled Care," in *IFAC*, Sozopol, 2015.

[3] Nayden Chivarov, Stefan Shivarov, Kaloyan Yovchev, Denis Chikurtev, Nedko Shivarov, "Intelligent modular service mobile robot ROBCO 12 for elderly and disabled persons care," in *RAAD*, Smolenice, 2014.

[4] "User Interface Design Basics," [Online]. Available: https://www.usability.gov/what-and-why/user-interface-design.html. [Accessed 10 2016].

[5] "HTML," Wikipedia, [Online]. Available: https://en.wikipedia.org/wiki/HTML. [Accessed 2016].

[6] "JavaScript," Wickipedia, [Online]. Available: https://en.wikipedia.org/wiki/JavaScript#Use_in_Web_pages.

[7] "CSS," Mozilla Foundation, [Online]. Available: https://developer.mozilla.org/en-US/docs/Web/CSS.

[8] "Django documentation," Django Software Foundation, [Online]. Available: https://docs.djangoproject.com/en/1.10/.

[9] D. Chikurtev, "Improving and Optimizing the Navigation for Mobile Robot for Inspection by Using Robot Operating System," *Problems of Engineering Cybernetics and Robotics,* pp. 63-74, 2015.

[10] J. M. O'Kane, A Gentle Introduction to ROS, 2013.

Acknowledgments
The research work reported in the paper is partly supported by the projects funded by the Young Scientists Grants, reg. No 102/2016.

Дизайн и функциональность WEB-интерфейса пользователя для контроля сервисных мобильных роботов через Интернет

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Аннотация: *сервис мобильных роботов не достаточно автономными или нуждаются в дополнительном управления и инструкции для выполнения своей работы. Таким образом, существует необходимость контролировать роботов дистанционно из любого места в любое время. В этой статье мы опишем развитие и свойства веб-интерфейс пользователя для управления обслуживания мобильных роботов. В этом интерфейсе мы добавили различные меню, свойства, пультов потоковое аудио и видео, информация для батареи робота, датчики и другие. Основная функция пользовательского интерфейса является обеспечение пользовательского элемента управления на робота и всю необходимую информацию о системах робота. Приложение работает в Интернете, так что пользователь может подключиться к роботу через Интернет из любого места и с помощью любого устройства с веб-браузером.*

Ключевые слова: *служба робот, мобильный робот, пользовательский интерфейс, веб-приложений, интернет, управление роботом, телекоммуникации*