

Mobile Robot for Inspection

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Abstract: *Introduction of Mobile Robotics. Definitions of Industrial and Service Robots is discussed. Market potential of Mobile Robotics is introduced. A developed Mobile Robot for Inspection and its technical specifications are presented. Control system of Mobile Robot for Inspection is described. Importance of Mobile Robots is given as a conclusion.*

Keywords: *Mobile Robots, Mobile Robots for Inspection, Service Robot, Industrial Mobile Robots.*

1. Introduction

Mobile Robots represent one of the most dynamic development fields of Robotics.

In the world- largest „Library“-the **Internet** we have found a lot of information about Mobile Robots. For example in „Altavista.digital.com“ there are about 1,684,752 matches for the key words “Mobile Robot”.

From the very beginning of the review it worth to point that the terminology around Mobile Robots (MR) is not completely standardized yet and they are often used different names for same units, systems and Robots themselves in different sources. Even in the most prestigious study “Word Robotics” [1] made by the United Nation and International Federation of Robotics experts are very careful in the matter of terminology.

The only firm definition in robotics till now covering not all kind but only the Manipulating Industrial Robots is that of the International Standardization Organization (ISO) – ISO 8373 [2]. This ISO definition states:

“Manipulating Industrial Robot is an automatically controlled reprogrammable, multipurpose manipulator programmable in three or more axes, which may be either fixed in place or Mobile for use in Industrial automation applications”.

For the Service Robots in the same study, the International Federation of Robotics (IFR) has adopted a preliminary definition, which after a few years of experience can be subject to change. This IFR definition states [3]:

“Service Robot – A Robot which operates semi or fully autonomously to perform services useful to the well being of humans and equipment excluding manufacturing operations”.

With this definition manipulating Industrial Robots could also be regarded as Service Robots provided they are installed in nonmanufacturing applications. Service Robots may or may not be equipped with an arm structure as the Industrial Robots. Often but not always the Service Robots are Mobile.

So for the terminology we can conclude the following:

The term Mobile Robot is not defined, the same is valid for terms Automated Guided Vehicle (AGV), Mobile Platforms, Robot Platform, Mobile Manipulator, Mobile Robot Platform together with a number of others showing the applications features but not defining the Robots own category. For example a “Cleaning Robot” can be either Industrial or Service, Stationary or Mobile.

In general Mobile Robots (MRs) can be classified and distinguished in accordance with the following features [4]:

- Designation
 - Mobile Robots for Industrial Applications
 - Service Mobile Robots
- Type of the locomotion system
 - Wheel locomotion system
 - Walking (legged) locomotion system
 - * biped locomotion
 - * multilegged MRs with 4 up to 12 legs
 - Chain locomotion systems
 - Crawling or climbing MRs
 - Special locomotion systems for MRs
- Type of the interfacing
 - MRs with a sophisticated both internal and external interfaces
 - MRs with only external interfacing
 - Special MRs
- Degree of intelligence
 - MRs with a low degree of intelligence
 - MRs with medium degree of intelligence
 - MRs with high degree of intelligence

2. Market Potential

The importance of robotics for the development of the world economy was understood by the United Nations quite in time and this field is monitored yearly. A study made by the experts of the United Nations together with the International Federation of Robotics (IFR) is covering the statistics, market analysis, case studies and profitability of Robot investment.

According to these studies, in terms of units, it is estimated that the worldwide stock of operational Industrial Robots will increase from about 922.900 units at the end of 2005 to 1112500 at the end of 2009, representing an average annual growth rate of 4.9%.

Total word stock of Service Robots for professional use installed up to the end of 2005 are 31600 units.

Total word stock of Service Robots for personal and private use installed up to the end of 2005 are 1.9 million units for domestic use (vacuum cleaning, lawn mowing Robots etc.).

Projections for the period: 2006-2009 – 34000 new Service Robot for professional use will be installed (Underwater, Defence, Laboratory, Medical, Mobile Robot Platforms etc.)

Projections for the period 2006-2009 – about 3.9 million units of Service Robots for personal use will be sold (application areas – all types of Domestic Robots).

These data are showing the large number of Robots for Industrial and Service purposes in use today and their big market potential in near future [1].

3. Mobile Robot for Inspection

From the designers' point of view Our Mobile Robot for Inspection (Fig. 1) is an Intelligent semi autonomous vehicle with all necessary basic systems having as a peripherals wireless system including color camera, infrared black and white camera and a microphone.

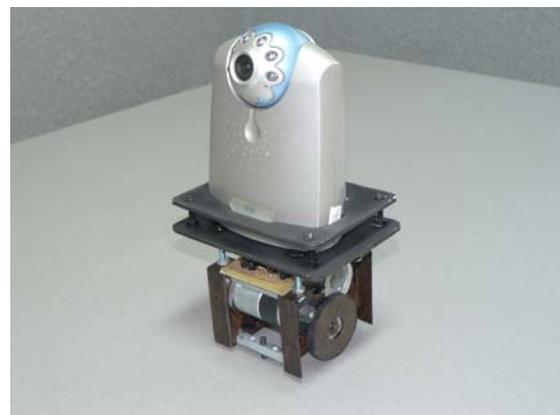


Fig.1 Mobile Robot for Inspection

Necessary systems for our Mobile Robot for Inspection are [5]:

- The locomotion system (wheel locomotion system)
- Driving system (electrically powered by onboard battery)
- Control system (microprocessor based)
- Navigation system (CCTV system with cameras and microphone)
- Communication system (wireless RF modules)

For controlling, navigating and communicating with our Mobile Robot for Inspection, we developed a Host control system including USB hub controller and wireless CCTV system including color images, infrared black and white images and sound.

Our Mobile Robot for Inspection which have an onboard controller and which is RF interfaced with a powerful central Host controller (H) can replace human workers performing tasks such as Inspection of different places – flats, offices, production plants etc. As they can be guided via a video system, the operator does not have to enter the area of operations and can inspect many different places at once.

- Technical specifications

Mobile Robot for Inspection consist of two passive plastic pins for keeping Robot horizontal, two active wheels driven by gear-motors and driving belt mechanisms, Robot body, microprocessor controller, RF module, wireless system including color camera, infrared black and white camera, microphone and batteries.

Technical specifications of our Mobile Robot for Inspection are presented in Table 1.

Parameters	Mobile Robot for Inspection
Size without camera	7.5x7.5x8 [cm]
Cameras size	8.5x5x10.5[cm]
Camera signal	2.4 GHz signal, which penetrates walls and ceilings
Camera range	App. 100 metres
Motor type	6V, DC Gear motor
Gear ration	10:1
Rotation Speed	Up to 215 rpm
Current at max torque	85mA
Maximum torque	1.5 Ncm
Weight without camera	App. 325 g

Table.1 Technical specifications of our Mobile Robot for Inspection

4. Control System of Our Mobile Robot for Inspection

The general structure schematics of the system for control of our Robot is realized by use two hierarchical levels (see Fig. 2).

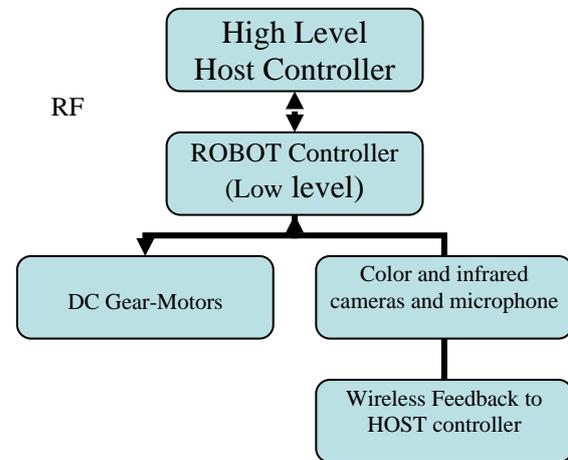


Fig. 2 Control System of Our Mobile Robot for Inspection

The Host controller is used at the High-level while the low level use Atmel’s ATtiny2313 MCU microcontroller. The Interface between Host controller (High-level) and controlling modules (low level) are made by using a standard RF interface.

The system allows precise positioning and monitoring of the Robot coordinates. The user interface allows for convenient human interfacing. Most of the components are standard and RF communication is very common in the field of remote control.

- Functional description

The control system consists of a Host Controller, CCTV system, a RF Transmitter and an Input Device (in our case USB Joystick).

Host Controller is powerful microcontroller, which performs main functions in accepting user commands and passing them to the Robot through the RF interface.

CCTV system includes color images, infrared black and white images and sound, all received by a wireless feedback from the Robot (Picture and Sound).

RF Transceiver may be internal or external to the controller.

The Input Device is an appropriate Human Interface Device (HID) - USB Joystick.

The Robot has an embedded controller which accepts user commands through RF module and controls the DC motors and wireless camera for performing of the requested operations.

- Embedded controller's description

The embedded controller module is designed with Atmel's ATtiny2313 MCU. This microcontroller, being cheap and small in resources, is very fast for its class (up to 24 MIPS at 24 MHz clock), and has several special features that make it ideal for given application. It's fast speed helps to implement simple firmware-only RF communication stack that minimizes the number of external parts, reduces the EMF (Electro Magnetic Field) noise and improves stability. The built-in PWM (Pulse Width Modulation) block makes it easier to control the speed of DC motors [6].

5. Conclusion

As it was described, in the beginning of robotics development, most of the Robot applications were related to industries and manufacturing and these Robots were called Industrial Robots. With development of the new technologies, sensors and microprocessors, today Robots are working in many fields of Service. Starting from Service Robots for professional use to Service Robot for personal use including also educational, entertainment and leisure Robots.

Having our Robot as a basic platform and adding some additional modules (as for example a gripper and different sensor systems etc.) we will develop a family of Mobile Robots for a variety of applications.

We can expect that the field of robotics will be changed dramatically in the 21st century. The number of Service Robot applications will grow much faster than those of the Industrial Robots. All this is expected because of the penetration of Service Robots in all spheres of human life and activities.

References:

- [1] co-authored by: United Nations and International Federation of Robotics; Statistics, Market Analysis, Forecasts,

Case Studies and Profitability of Robot Investment; WORLD ROBOTICS 2005.

- [2] <http://www.iso.org/iso/home.htm>;
International Standardization Organization (ISO).
- [3] <http://www.ifr.org/>;
International Federation of Robotics (IFR).
- [4] N Chivarov, A Tool Kit for Modular, Intelligent, Mobile Robots; Dissertation; Austrian National Library; April 2001.
- [5] N Chivarov, N Shivarov and P. Kopacek; A Tool Kit for Intelligent, Mobile Robots 6th IFAC Symposium on Robot Control, SYROCO'2000, September 21-23, Vienna, Austria, VOL. I.
- [6] N Chivarov and N Shivarov; DEVELOPMENT OF A SOCCER ROBOT; PRACTRO'2007.