


**Technical Aspects of Multimodal System**  
 Dept. Informatics, Faculty of Mathematics, Informatics and Natural Sciences  
 University of Hamburg

## Praktikum: 2

### Lego Mindstorms experience

**Lecturers**

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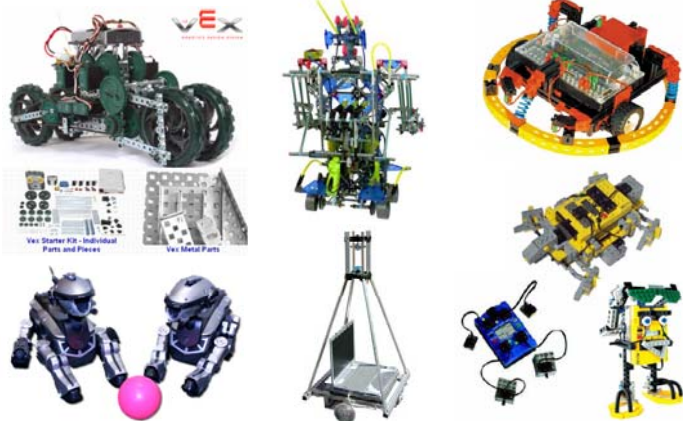
@LEGO

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## Content of today's lecture

- Introduction to Lego mindstorms
- Telebot system: first experiments
  - Introduction
  - Components
  - Hardware realization
  - Integration
  - Possible tasks
  - Implementation: mechanical system, programming, testing
- Final evaluation

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## Lego mindstorms

- Lego Mindstorms**  
 The latest product in the Mindstorms series is Mindstorms NXT, released in August 2006. The kit includes three servo motors, a touch sensor, a light sensor (now with the ability to differentiate between colors based on grayscale readings), a new sound sensor, an ultrasonic sensor and a new NXT 'Intelligent Brick'. The kit is sold for \$249 USD.



Available in GUC Library: Mario Ferrari, Giulio Ferrari, Ralph Hempel, *Building Robots With Lego Mindstorms - The Ultimate Tool for Mindstorms Maniacs*. Syngress Publishing, 1 edition, 2001.






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## Reading material

- Building Robots with LEGO Mindstorms NXT;** by, Mario Ferrari, Giulio Ferrari, and David Astolfo
- The LEGO MINDSTORMS NXT Zoo! - A Kid-Friendly Guide to Building Animals with the NXT Robotics System;** by Fay Rhodes
- LEGO Mindstorms NXT Power Programming: Robotics in C;** by, John C. Hansen

<http://mindstorms.lego.com/Books/>

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## Web links for today

- Lego mindstorms**  
 - <http://mindstorms.lego.com/default.aspx?domainredir=www.legomindstorms.com>
- Telebot project**  
 - <http://tams-www.informatik.uni-hamburg.de/people/hzhang/projects/index.php?content=Telerobot>

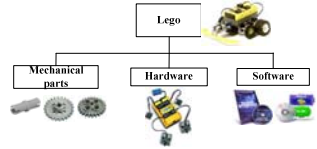
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## Edutainment robots –Lego

- Lego mindstorms**
  - Developed in cooperation with MIT Media Lab researchers in 1998.
  - RCX
    - 3 sensory inputs and 3 motor outputs.
    - includes a display and buttons for selecting programs and viewing status of in/outputs
    - includes an IR serial port, through which it is programmed
  - Robotics Invention System (RIS) and easy-to-use GUI



<http://mindstorms.lego.com/>

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## Edutainment robots –Lego

Design & build

Program

Download software

Test & evaluate

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## Lego mindstorms

NXT Technology Overview

Overview

NXT Software

NXT's new Open Source Firmware

Meet the Robots

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## Components of Lego mindstorms

TOUCH SENSOR

The Touch Sensor gives your robot a sense of touch. The Touch Sensor detects when it is being pressed by something and when it is released again.

PRESSED RELEASED BUMPED

Suggestions for use

Try Me

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## Components of Lego mindstorms

SOUND SENSOR

The Sound Sensor makes your robot hear!

The Sound Sensor can detect both decibels [dB] and adjusted decibel [dBA]. A decibel is a measurement of sound pressure.

dBA: in detecting adjusted decibels, the sensitivity of the sensor is adapted to the sensitivity of the human ear. In other words, these are the sounds that your ears are able to hear.

dB: in detecting standard [unadjusted] decibels, all sounds are measured with equal sensitivity. Thus, these sounds may include some that are too high or too low for the human ear to hear.

Test It!

Test the Sound Sensor's ability to read sound volume:

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## Components of Lego mindstorms



**LIGHT SENSOR**

The Light Sensor is one of the two sensors that give your robot vision [The Ultrasonic Sensor is the other]. The Light Sensor enables your robot to distinguish between light and dark. It can read the light intensity in a room and measure the light intensity of colored surfaces.

This is what your eyes see



This is what your robot will see, using the light sensor.

This is what your robot will see, using the light sensor.

**Test it!**  
 Test Light Sensor readings. Here's how:



Overview

- The NXT
- Touch Sensor
- Sound Sensor
- Light Sensor
- Ultrasonic Sensor
- Servo Motors
- LEGO MINDSTORMS NXT Software
- Robot

Other Features

- NXT/Tech
- Bluetooth
- Mobile Application

<http://mindstorms.lego.com/Overview/>

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## Components of Lego mindstorms



**ULTRASONIC SENSOR**

The Ultrasonic Sensor is one of the two sensors that give your robot vision [The Light Sensor is the other]. The Ultrasonic Sensor enables your robot to see and detect objects. You can also use it to make your robot avoid obstacles, sense and measure distance, and detect movement.

The Ultrasonic Sensor measures distance in centimeters and in inches. It is able to measure distances from 0 to 255 centimeters with a precision of +/- 3 cm.

The Ultrasonic Sensor uses the same scientific principle as bats: it measures distance by calculating the time it takes for a sound wave to hit an object and return - just like an echo. Large sized objects with hard surfaces return the best readings. Objects made of soft fabric or that are curved (like a ball) or are very thin or small can be difficult for the sensor to detect.

\*Note that two or more Ultrasonic Sensors operating in the same room may interrupt each other's readings.

**Test it!**  
 Test the Ultrasonic Sensor's ability to measure distance:



Overview

- The NXT
- Touch Sensor
- Sound Sensor
- Light Sensor
- Ultrasonic Sensor
- Servo Motors
- LEGO MINDSTORMS NXT Software
- Robot

Meet the Robots

- Alpha Rex
- Spike
- Robolab
- Robot

Other Features

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## Components of Lego mindstorms



**SERVO MOTORS**

The three Servo Motors give your robot the ability to move. If you use the Move block in the LEGO MINDSTORMS NXT software to program your motors, the two motors will automatically synchronize, so that your robot will move in a straight line.

**Built-in Rotation Sensor**  
 Each motor has a built-in Rotation Sensor. This lets you control your robot's movements precisely. The Rotation Sensor measures motor rotations in degrees or full rotations (accuracy of +/- one degree). One rotation is equal to 360 degrees, so if you set a motor to turn 180 degrees, its output shaft will make half a turn.

The built-in Rotation Sensor in each motor also lets you set different speeds for your motors [by setting different power parameters in the software]. Try running the motors at different speeds.

**Test it!**  
 Test the built-in Rotation Sensor's ability to measure distance:



Overview

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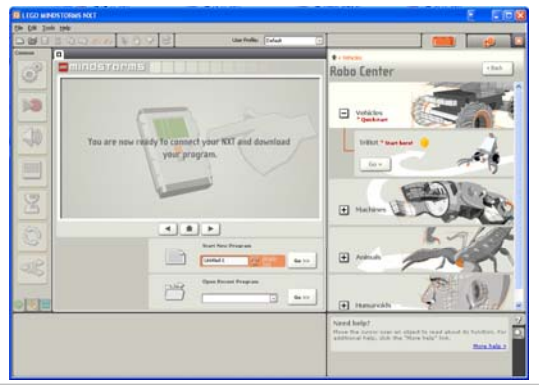
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## Lego mindstorms NXT



The screenshot shows the 'LEGO MINDSTORMS NXT' software interface. The main window displays a message: "You are now ready to connect your NXT and download your program." Below this, there are buttons for "Start New Program", "Open Recent Program", and "Help". On the right side, there is a "Robo Center" panel with various robot models and a "Help" button. The interface is designed for programming and controlling the NXT robot.

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## Other prototypes

<http://mindstorms.lego.com/buildinginstructions/>

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## Lego mindstorms test

- Building a robot
- Programming it
- Testing and improving

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## Content of the next lecture



- Introduction to Lego mindstorms
- Telebot system first try
  - Build the mechanical structure, program and test the robot, improvement
- Final evaluation

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## Telebot system introduction

- Telebot (TAMS group based on cooperation with BUAA, 2006)
  - 9 channels for sensor inputs; 4 outputs for actuators
  - Communication interface
  - Java and C++ programming easy
  - More flexible and extended functions

@Tams/hzhang/project

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## Praktikum: 3

### Telebot: first try

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## Let's get started!

# Telebot + index

**TriBot** + Back



Make a vehicle that listens to your commands.  
Can you build and program a sound-controlled vehicle and make it go where you want it to go and do what you want it to do?

1. Driving Base \* Quickstart
2. Bumper
3. Grabber
4. Sound Control
5. Light Sensor
6. Locate Object

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## Discussion.....

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## *Praktikum: 4*

### *Telebot system environment*

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## *Praktikum: 5 & 6*

### *Telebot sensors and actuators*

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## *Praktikum: 7 & 8 & 9*

### *Telebot system integration*

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