A short introduction to LEGO Mindstorms

LEGO Mindstorms @ Chair Brauer

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Introduction
Everyone knows this one ...
LEGO Technic

... but how about these?
Lego Mindstorms - Hardware Architecture
RCX I

- Hitachi H8 series microcontroller
- 8 bit CPU at 16 MHz
- 32 KByte RAM
- 16 KByte ROM for the BIOS
- serial I/O (input/output)
- ADC (analog digital converter)
- built-in timers
RCX II

- One Liquid crystal display (LCD)
- Four push buttons
- One small internal speaker
- Three sensor inputs
- Three actuator outputs
- One infrared (IR) interface with a proprietary protocol (not IrDA!)
Actuators

- (Geared) MiniMotor (9 Volts)
- Light Brick
- Servo Motor
Sensors I

Two categories:

- Active sensors (powered sensors), e.g. rotation sensor
- Passive sensors (unpowered sensors), e.g. touch sensor
Sensors II - Standard Sensors

- Light Sensor
- Touch Sensor
- Rotation Sensor
Sensors III - Custom Sensors

- Sensor interface is well documented
- Many building instructions exist, see Michael Gasperi’s page
- Some commercial shops (e.g. http://www.mindsensors.com, http://hightechnicstuff.com)
Sensors IV - Nonstandard Sensors

- Magnetic Compass Sensor
- Ultrasonic Range Sensor
- Active Sensor Multiplexor
LEGO Mindstorms - Software Architecture
Software Architecture I

- System ROM Layer
  - Low level control software (like PC BIOS)
  - Convenient interface to the hardware
  - Allows second piece of software - the firmware
  - Located in the RCX ROM
Firmware (1)

- Can bypass system ROM software for complete control of the RCX
- Erased when power is permanently removed
- Located in the RCX RAM
Firmware (1)

- LEGO firmware as standard firmware (shipped with LEGO Mindstorms Developers Kit, see http://mindstorms.lego.com)
- Replacements (e.g. brickOS kernel, lejos VM) are available
- Firmware replacements push further the limits of the hardware
Software Architecture Example

brickOS program

$c / c++$ compiler

PC

IR

native binary code

user programs

RCX

brickOS kernel

system ROM

hardware
Bibliography
References


End