Controlling Machines with Smalltalk on Raspberry Pi

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Motivation
Mundartenstation
(Station of German Dialects)

• Button to start / stop playback
• LED to indicate playback
• MP3 support
• configuration via CSV-Files
Raspberry Pi
900Mhz Quad-Core ARMv7 @ 1GB RAM

26 GPIOs + Power + Ground
Matrix Circuit

- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols

- \( \text{X} \) = on
- \( \text{X} \) = off
- \( \text{X} \) = in
- \( \text{X} \) = out
Matrix Circuit

- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols
- ![Diagram of matrix circuit]
  - X = on
  - X = off
  - X = in
  - X = out
Matrix Circuit

• How to connect 84 Buttons and LEDs to 27 GPIOs?
• 84 Buttons = 7 rows x 12 cols
• \( \text{□} = \text{on} \)
• \( \text{□} = \text{off} \)
• \( \text{□} = \text{in} \)
• \( \text{□} = \text{out} \)
Matrix Circuit

- How to connect 84 Buttons and LEDs to 27 GPIOs?

- 84 Buttons = 7 rows x 12 cols

- $\text{on}$
- $\text{off}$
- $\text{in}$
- $\text{out}$
Matrix Circuit

• How to connect 84 Buttons and LEDs to 27 GPIOs?

• 84 Buttons = 7 rows x 12 cols

• On
• Off
• In
• Out

r1
r2
r3
r4

c1  c2  c3  c4
Matrix Circuit

- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols
- $\times$ = on
- $\Box$ = off
- $\Box$ = in
- $\Box$ = out
Matrix Circuit

- How to connect 84 Buttons and LEDs to 27 GPIOs?
- 84 Buttons = 7 rows x 12 cols

- \( \text{X} \) = on
- \( \text{X} \) = off
- \( \text{X} \) = in
- \( \text{X} \) = out
Matrix Circuit

• How to connect 84 Buttons and LEDs to 27 GPIOs?
• 84 Buttons = 7 rows x 12 cols
  • \( \boxdot \) = on
  • \( \square \) = off
  • \( \dashbox \) = in
  • \( \square \) = out
LED Matrix Circuit

• How to connect 84 Buttons and LEDs to 27 GPIOs?

• 84 Buttons = 7 rows x 12 cols

• \( x \) = on

• \( x \) = off

• \( x \) = in

• \( x \) = out
Hardware Assembly
Hardware Assembly
GPIO Access

- sysfs in Kernel via /sys/class/gpio
How to program the Raspberry Pi?

- Cincom® is Cosponsor of Erlebniswelt Deutsche Sprache
- Initial Port of VisualWorks® VM within 5 Days
VisualWorks

Sound System

Matrix Button System

4@2

on

off

GPIO

GPIO

GPIO
VisualWorks

Sound System

LED Sound System

Matrix Button System

Matrix LED System

4@2

on

off

GPIO

GPIO

GPIO

GPIO
Sound System

1. Wait for Any Button-Press
2. Play Track
3. Wait for Button-Release
4. Wait for End of Track or Same Button-Press
5. Wait for Button-Release
6. Repeat
Testing on Windows

Sound System

Matrix Button System

GPIO

GPIO

GPIO

Dummy Objects
Developer Tools
## Developer Tools

<table>
<thead>
<tr>
<th>Pin</th>
<th>GPIO</th>
<th>Description</th>
<th>I/O Type</th>
<th>Pin</th>
<th>GPIO</th>
<th>Description</th>
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<td></td>
<td>in</td>
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<td>GPO11</td>
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<td>20</td>
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<td></td>
<td>in</td>
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<td>GPO14</td>
<td>(TXD0)</td>
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<td>out</td>
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<td>GPO25</td>
<td>(GPIO_GEN6)</td>
</tr>
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</table>
Home Automation

the Heeg way
Kitchen Lift
The Lift

Motor with Windlass
Top Contact
Door Contact 1
Controls
Door Contact 2
Bottom Contact

🍵🍺
Connecting 220V

- Relays to switch via GPIO
- Contactor to switch Motor
- Relay switches Contactor
Hardware Assembly
Hardware Assembly
Hardware Assembly
Hardware Assembly
Software Model

Motor Control

Lift

GPIO

Relay Array

Conductor Array

Single-Phase AC Motor

GPIO

Trigger Button

Sensor Button

up/down

stop
5 Software Rules

- Door open $\iff$ Stop
- Driving Up $\land$ Top Contact $\iff$ Stop
- Driving Down $\land$ Bottom Contact $\iff$ Stop
- $\neg$ Driving $\land$ $\neg$ Bottom Contact $\land$ Control Down $\implies$ Drive Down
- $\neg$ Driving $\land$ $\neg$ Top Contact $\land$ Control Up $\implies$ Drive Up
Demo

- Controlling the Lift from a Workspace
- Using Model Objects for Buttons
LiftApplication is used to control the lift.

Usage

```plaintext
self openForSimulation
```

Instance Variables:

```plaintext
lift <Lift>
```
Maintenance

- X11 via SSH
- basically unnecessary
- runs since October
- daily use
Beaglebone Black
Virtualization Layer

Matrix Button System

vGPIO1
vGPIO2
vGPIO3

GPIO1
GPIO2
GPIO3
Availability

- 32bit Linux ARM VM
  - available since August 19th, 2016
  - through Cincom Smalltalk Developer Program
- Smalltalk GPIO Access
  - to be determined
Summary

Connecting Hardware to Smalltalk was never more fun