‘Smart Sleeve: an Experimental Hardware Extension Platform for Mobile Devices in Smart Spaces’

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Motivation and Goals

• Motivation:
  • Create an extensible hardware platform to facilitate Pervasive Computing research using mobile phones with new interfaces/sensors

• Goals:
  • Create an extensible platform to expand the capabilities of a mobile device: ‘Smart Sleeve’ + ‘Add-on Modules’
  • Implement example add-on modules (e.g. NFC, Location, Robotic)
  • Manufacture & distribute a small number of prototypes for research

<table>
<thead>
<tr>
<th>Add-on Module</th>
<th>User Interaction which is Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near Field Communication</td>
<td>Touch-based services</td>
</tr>
<tr>
<td>Location</td>
<td>Location-based services</td>
</tr>
<tr>
<td>Robotic</td>
<td>Motion-based services</td>
</tr>
</tbody>
</table>
System Overview (cont.)

Mobile Device

- Add-on Module 1 Application
- Module 1 API
- Add-on Module 1 Server
- USB Drivers
- USB / Pop-Port™

Smart Sleeve

- Power Management
- μC
- USB Host Controller
- 8-Bit BUS
- Mini USB

Add-on Module 1

- e.g. i) Sensor/NIF
- ii) Memory
- iii) Interface

Add-on Module 2

- e.g. i) Sensor/NIF
- ii) Memory
- iii) Interface
Core System Hardware Implementation

- Low Battery Detector
- Battery Charger
- Power Management
- 3.7V Battery
- Sleeve to Module Interface
- Microcontroller Atmega128L
  - 7.37 MHz
  - RS 232 Driver
- JTAG Programming & Debugging
- USB Host Controller AT43USB380
  - 6 MHz

Nokia Research Center Cambridge, PCG, M. Michalakis and D.N. Kalofonos – May 8, 2006
Sleeve to Module Interface

- 21-pin proprietary connector used to interface Add-on Modules with the Smart Sleeve
- Features an SPI + I²C + 8-bit BUS + UART + Several I/Os & Interrupts

<table>
<thead>
<tr>
<th>PIN</th>
<th>NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vin</td>
<td>Power coming from the 3.7V Li+ Battery</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground pin of the entire circuit, connected to the ground plane</td>
</tr>
<tr>
<td>3</td>
<td>PE3</td>
<td>May be used as Enable Pin used to power up the Add-On Module</td>
</tr>
<tr>
<td>4</td>
<td>MOSI</td>
<td>SPI interface pin – Master Output Slave Input</td>
</tr>
<tr>
<td>5</td>
<td>MISO</td>
<td>SPI interface pin – Master Input Slave Output</td>
</tr>
<tr>
<td>6</td>
<td>SCK</td>
<td>SPI interface pin – Serial Clock</td>
</tr>
<tr>
<td>7</td>
<td>nSS</td>
<td>SPI interface pin – Slave Device Selector [Active Low]</td>
</tr>
<tr>
<td>8</td>
<td>SDA</td>
<td>I²C interface pin - Pin PD1 on Atmega128L – Interrupt</td>
</tr>
<tr>
<td>9</td>
<td>PB5</td>
<td>May be used as a Reset pin - General I/O</td>
</tr>
<tr>
<td>10</td>
<td>UART_RX</td>
<td>PE0 - Also used as MOSI for SPI Programming from the Add-On Module</td>
</tr>
<tr>
<td>11</td>
<td>PC0</td>
<td>Used as ChipSelect for SPI Flash Memory - General I/O</td>
</tr>
<tr>
<td>12</td>
<td>PC1</td>
<td>Pin # 36 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>13</td>
<td>PC2</td>
<td>Pin # 37 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>14</td>
<td>PC3</td>
<td>Pin # 38 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>15</td>
<td>PC4</td>
<td>Pin # 39 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>16</td>
<td>PC5</td>
<td>Pin # 40 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>17</td>
<td>PC6</td>
<td>Pin # 41 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>18</td>
<td>PC7</td>
<td>Pin # 42 on Atmega128L – General I/O</td>
</tr>
<tr>
<td>19</td>
<td>PE4</td>
<td>Pin # 6 on Atmega128L – Interrupt</td>
</tr>
<tr>
<td>20</td>
<td>SCL</td>
<td>I²C interface pin - Pin PD0 on Atmega128L – Interrupt</td>
</tr>
<tr>
<td>21</td>
<td>UART_TX</td>
<td>PE1 - Also used as MISO for SPI Programming from the Add-On Module</td>
</tr>
</tbody>
</table>
Near Field Communication Module

- **Hardware**
  - *PN511 Transmission Module* - Highly integrated transmission module for contactless communication at 13.56 MHz
  - Supports *ISO 14443A / Mifare* and *Felica* scheme
  - Supports communication speeds up to 424 Kbit/s (Card -> PN511)
  - SPI interface up to 5 Mbit/s (PN511 -> MCU)
  - Typical operating distance of up to 10 cm

- **Interface**
  - Basic Function Library implemented that captures all the functionality of the PN511
  - APIs hide the complexity of the overall system when developing firmware
NFC Module PCB Layout

68.8345 (mm)

27.8133 (mm)
Location Module

Mobile Device

Smart Sleeve

Location Module

Cricket

GPS chipset
Location Module PCB Layout
Robotic Module

• Remote Control Points
• Internet
• Mobile Device
• Quad Crawler Robot

Cellular Data

ENHANCED ROBOT LOCATION

802.11 or Bluetooth

Smart Sleeve
Mechanical Design

- Front Face where Mobile Device fits
- Inside Layer where main board attaches
- Main PCB Board
- Add-on Module
- Back Cover

Smart Sleeve Cover
Assembled PCB
NFC Demo

Connecting (both callbacks)...OK
Subscribed to ALL records.
Sending read NTI PHandleNewNTipRecordL: Size = 10
Record type = typeR
Record Content = Michalakis
Function Success...OK
Sending read NTI PHandleNewNTipRecordL: Size = 18
Record type = myCard
Record Content = Dimitris Kalofonos