

Embedded Systems Hands-On 1: Design and Implementation of Hardware/Software Systems

Task 7: Project Application



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Goal



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- ▶ Apply knowledge and skills learned in Task 1 to 6
- ▶ Focus on Hardware- or Software development



- ▶ 10 weeks for
 - ▶ planning,
 - ▶ implementation,
 - ▶ debugging,
 - ▶ *and documentation*
- ▶ No strict implementation requirements, besides
 - ▶ Exploit Raspberry Pi and/or the extension board
 - ▶ Limited Budget (30€) for additional hardware
 - ▶ Schematics and board layouts for **generated hardware** (KiCad)
- ▶ Every group is assigned a dedicated project (no duplicates, no first come first serve)
 - ▶ Generate an issue in *your* Gitlab project
 - ▶ Specify up to three desired topics with priorities
 - ▶ Discuss feasibility of own project with me in advance



- ▶ 9.8.2020: Deadline to select topic / discuss own project
- ▶ 23.8.2020: Decide about required hardware (BOM)
- ▶ 18.10.2020: Video submission deadline (seafire)
- ▶ 30.10.2020: Last day for colloquium



- ▶ *Virtual* Demo Day
- ▶ 2-minute video of project
 - ▶ Present goal of project
 - ▶ Insights into your implementation
 - ▶ Live Demo of the project
- ▶ Videos will be shared among participants



- ▶ E104 is available for e.g. measurements
 - ▶ One group at a time
 - ▶ Keep distance
 - ▶ Open the windows
 - ▶ Desinfect your hands
- ▶ B013 is available for soldering
 - ▶ One group at a time
 - ▶ Face mask required
 - ▶ Open the windows
 - ▶ Desinfect your hands
- ▶ Contact me at least one day in advance

Selected projects from last year



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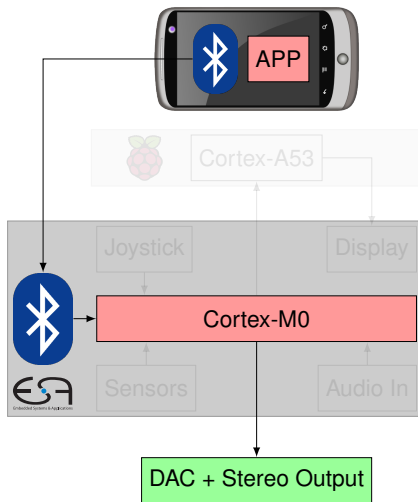
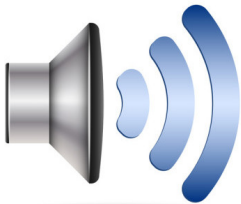
- ▶ Pi-Plantbot
 - ▶ Control water pump
 - ▶ Measure humidity in pot
 - ▶ Telegram bot
- ▶ E-ccordion
 - ▶ New music instrument with many Buttons
 - ▶ Microcontroller generates MIDI signals
- ▶ LoRa communication
 - ▶ Long range communication between two extension boards
 - ▶ Example: Tic-Tac-Toe
- ▶ Acoustic communication
 - ▶ Generate sound signals
 - ▶ Detect sound signals via microphone

T7.2: Audio Player



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- ▶ Choose appropriate codec
- ▶ Encode on source device
- ▶ Bluetooth streaming to Cortex-M0
- ▶ Decode on Cortex-M0
- ▶ Analog output via **speaker board**

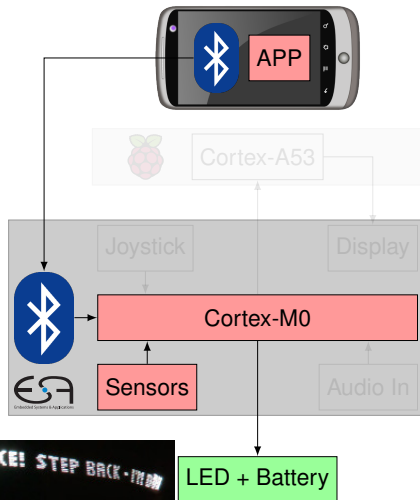
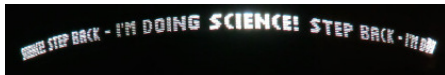
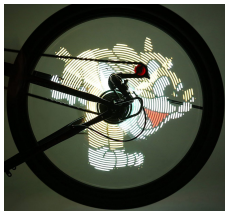


T7.3: Animated LED



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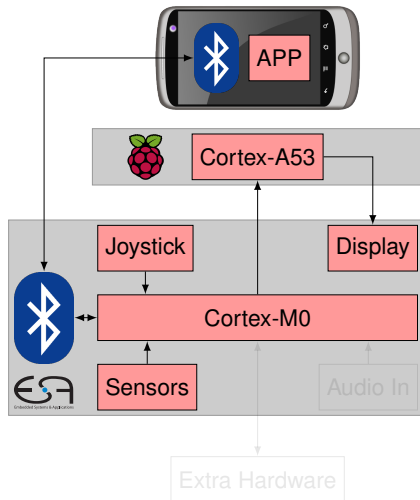
- ▶ Transmit text/picture from source device to Cortex-M0 via Bluetooth
- ▶ Capture position / acceleration of Cortex-M0
- ▶ Build **LED board**
- ▶ Position-dependent LED control to display content due to persistence of vision



T7.4: Game Controller

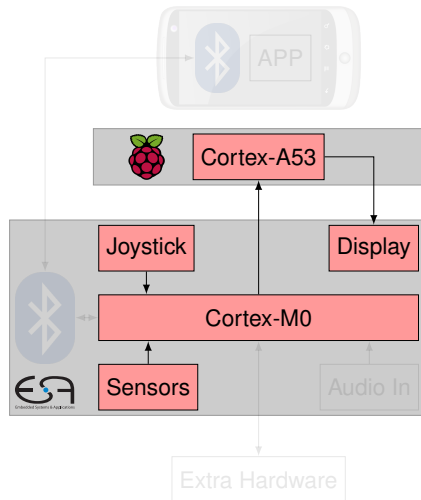


- ▶ Bidirectional Bluetooth link to end device
- ▶ Cortex-M0 provides sensor data (light, position, acceleration, magnetic field, ...) and joystick status on request or periodic
- ▶ Cortex-M0 receives content to be displayed on TFT
- ▶ Example app on end device



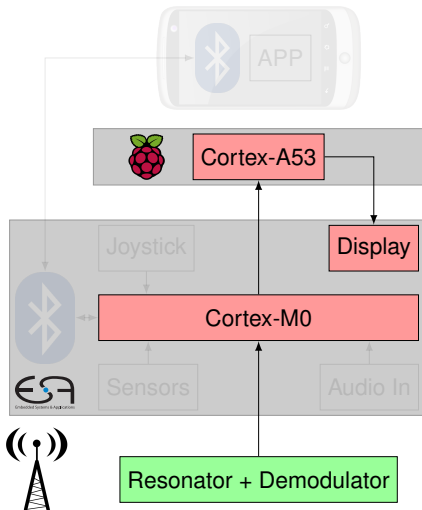
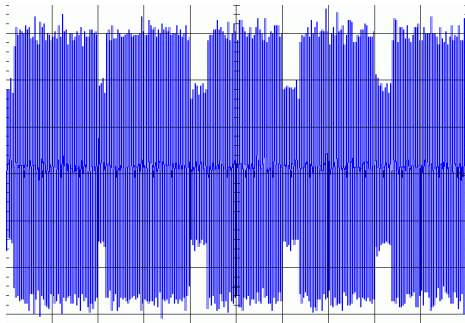
T7.5: Game Boy Emulator

- ▶ Emulator on Cortex-A53
- ▶ Video output on TFT (*not HDMI*)
- ▶ Jump-And-Run controller by Cortex-M0 sensors (position, acceleration) and joystick



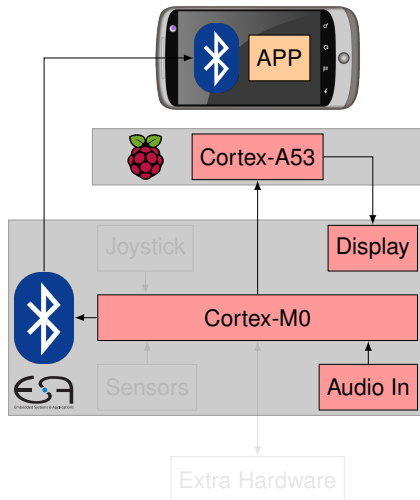
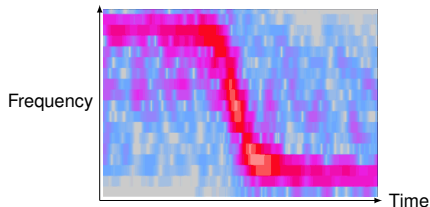
T7.6: Radio Controlled Clock

- ▶ Analog DCF77 receiver including resonator and demodulator
- ▶ Decode time signal on Cortex-M0
- ▶ Display date and time on TFT



T7.7: Doppler Speed Gauge

- ▶ Sample analog audio jack
- ▶ Transformation into frequency domain
- ▶ Detect significant frequency changes of dominant noise source
- ▶ Calculate speed of noise source
- ▶ Display results on TFT
- ▶ Optional: Results via Bluetooth

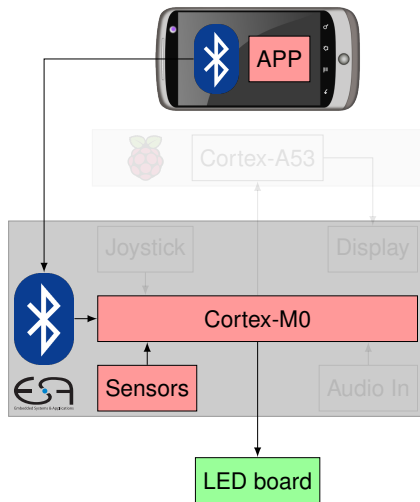
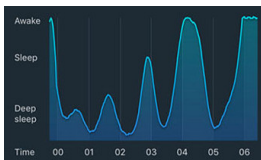


T7.8: Wake-Up Light



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- ▶ Build **dimmable LED board**
- ▶ Capture movement of sleeping person by acceleration sensor (mounted on mattress)
- ▶ Analyze sleeping pattern
- ▶ Wait for shallow sleep in wake-up time slot configurable via Bluetooth
- ▶ Slowly increase LED intensity to trigger wake-up



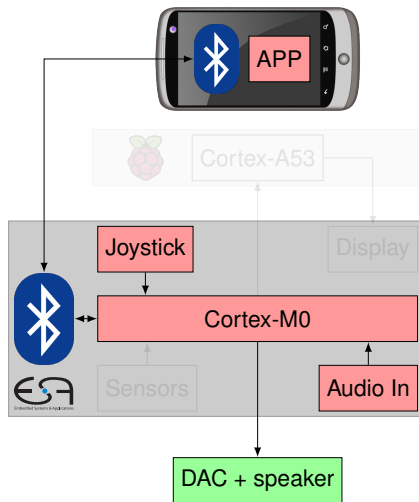
T7.9: Morse En/Decoder



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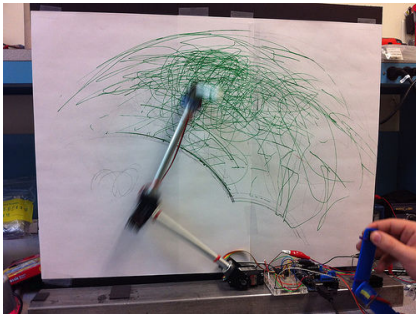
- ▶ Bidirectional Bluetooth link to end device
- ▶ Generate **speaker board**
- ▶ Encode received characters and playback morse code
- ▶ Sample audio input and joystick
- ▶ Decode received morse symbols
- ▶ Transmit decoded characters to end device

A B C D E F G
H I J K L M N
O P Q R S T U
V W X Y Z












T7.10: Robot Arm

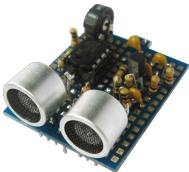
- ▶ Assemble the robot arm
- ▶ Implement I²C slave on ATMEGA64 controller
- ▶ Connect Cortex-M0 as master to robot arm via I²C
- ▶ Implement whiteboard writer controlled by Cortex-M0



Define your own project

► Try to exploit available peripherals:

-  Speakers
-  CCD cameras
-  Solar modules
-  Peltier elements
-   Sensor Kit
-  Ultrasonic transceivers
-  6-DOF robotic arm
-  NFC-Controller
- RC Car
- LoRa



Announcements



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- ▶ Task 5.2 cancelled
- ▶ Task 1-6 deadline extended: 9.8.2020

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