mbed Research Projects

Dr Rob Toulson
Anglia Ruskin University

rob.toulson@anglia.ac.uk
Twitter: @DrRobt
Summary

• USB capabilities
  – Mouse
  – Keyboard
  – Audio

• Closed loop control

• DSP and audio processing

• Arts and culture based research projects
  – Technology for music therapy
  – Sonic art

• The Internet of Things and Websockets

• From mbed to manufacture
USB capabilities

Using the mbed to emulate a USB mouse

/* Program Example: Emulating a USB mouse */

#include "mbed.h"                  // include mbed library
#include "USBMouse.h"              // include USB Mouse library
USBMouse mouse;                    // define USBMouse interface

int dx[]={40,0,-40,0};            // relative x position co-ordinates
int dy[]={0,40,0,-40};            // relative y position co-ordinates

int main() {
  while (1) {
    for (int i=0; i<4; i++) {
      mouse.move(dx[i],dy[i]);     // move mouse to co-ordinate
      wait(0.2);                  // scroll through position co-ordinates
    }
  }
}
# USB capabilities

/* Program Example: MIDI messaging with variable scroll speed */

#include "mbed.h"
#include "USBMIDI.h"

USBMIDI midi; // initialise MIDI interface
AnalogIn Ain(p19); // create analog input (potentiometer)

int main() {
    while (1) {
        for(int i=48; i<72; i++) { // step through notes
            midi.write(MIDIMessage::NoteOn(i)); // note on
            wait(Ain); // pause
            midi.write(MIDIMessage::NoteOff(i)); // note off
            wait(2*Ain); // pause
        }
    }
}

The output of the program example is shown here in the MIDI control window of Apple Logic software.
Closed loop cruise control example – proportional control

Driver chooses cruise speed setpoint in kph

- Setpoint speed

Electronic system (microcontroller)

- Subtract actual speed from setpoint speed
  - Speed error
  - Control value

- Multiply by a calibrated value K

- Convert to PWM output (lookup table)

Mechanical system (plant)

- Engine creates torque (power)

- Torque converted through gearbox

Torque propels vehicle

- Sensor measures wheel speed in rps

- ADC

- Convert wheel rps to actual speed in kph

http://mbed.org | Rapid Prototyping for Microcontrollers
Closed loop control

Closed loop cruise control example – proportional control

A – high gain

B – low gain
Closed loop control

PID control

[Diagram of PID control system]

http://mbed.org | Rapid Prototyping for Microcontrollers
Closed loop control

Closed loop compass example

www.youtube.com/watch?v=yz6vZYxyc
DSP and audio processing

Digital delay guitar effect
DSP and audio processing

Digital delay guitar effect
The Lagoglyph Sound System

By artist Eduardo Kac

http://www.youtube.com/watch?v=cCYn7oQILiA
Technology for music therapy

Opportunities:

- A new musical instrument
- Greater participation
- Analysis and evaluation
- Remote therapy
- Invisible vs visible technology
The Internet of Things

Wi-fi networked table lamp

http://www.youtube.com/watch?v=Lsg2T5xX5a8
The Internet of Things: Websockets

Architecture

WebSocket communication:
- Send sensor data in JSON format

WebSocket communication:
- receive all sensor data
- receive commands from phones
- display data of "added" boards

WebSocket communication:
- receive all sensor data
- display data related to the scanned QR code
- can "add" a graph to the dashboard

Desktop browser: Dashboard (Javascript)

Mobile browser (Javascript)

Scan

http://mbed.org | Rapid Prototyping for Microcontrollers
From mbed to manufacture

Freescale freedom development platform for mbed design for medium scale production

Bespoke PCB based on the mbed, showing the LPC1768 in place
Summary

• USB capabilities
  – Mouse
  – Keyboard
  – Audio

• Closed loop control

• DSP and audio processing

• Network communications

Arts and culture based research projects
  – Technology for music therapy
  – Sonic art

• The Internet of Things and Websockets

• From mbed to manufacture