Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Mobile Systems

Date: Tuesday 27th May 2008
Time: 09:45 – 11:45

Please answer Question ONE and TWO other Questions from the remaining THREE questions provided

This is a CLOSED book examination

The use of electronic calculators is permitted provided they are not programmable and do not store text
1. **Compulsory**

   Answer all of the following (2 marks each)

   a) An analogue signal can be converted into a form suitable for handling in a computer by (i) passing it through an anti-alias filter, then (ii) sampling and finally (iii) quantizing the signal. Explain why each of these three processes is required.

   b) What is meant by the terms ‘time domain’ representation and ‘frequency domain’ representation of an audio signal, and how may one representation be converted into the other?

   c) Sketch the organisation in memory of a double-buffered DMA real-time data output process.

   d) Describe the characteristic features of an event-driven system. Why does designing a real-time system to be ‘event-driven’ help minimise power consumption?

   e) What is the advantage of the cellular spatial organisation used by mobile telephone systems?

   f) Typical mobile telephone handsets employ two programmable processors. What are the characteristics of each of these processors and what are their primary functions?

   g) What are the key psychoacoustic techniques used in mp3 music compression?

   h) Where, in JPEG image compression, is the primary trade-off between compression ratio and image quality made?

   i) What is the minimum Hamming distance between any two valid codewords in a digital system that is intended to correct any single bit error?

   j) How does effective error correction help save power in a mobile system that transmits data using radio communications?
2. You are involved in the design of a mobile system to support voicemail in an office environment. Discuss the approach you would take to specifying the operation of one of the following:

a) the speech sampling system
b) the speech compression/decompression system
c) the error correction system used to recover from radio transmission errors
d) system power analysis and optimisation

Whichever task you choose, be sure to write down the technical issues that arise, the trade-offs you need to consider, and the way your task interacts with other members of the design team who are performing the other three tasks above. (20 marks)

3. This question is concerned with designing a low-power System-on-Chip for a mobile system.

a) The total power, P, of a CMOS chip can be expressed as:

\[ P = \frac{1}{2} C_{\text{total}} \times f_{\text{clock}} \times V_{\text{DD}}^2 \times \alpha \quad \text{(EQ 1)} \]

Describe each of the terms on the right-hand side of this equation. (5 marks)

b) Explain why reducing the clock frequency does not, of itself, improve the power-efficiency of a CMOS chip. (3 marks)

c) For each of the four terms on the right-hand side of EQ 1 describe a design approach or feature that can improve power-efficiency by reducing the contribution of that term to the total power. (2 marks each)

d) Describe the trade-offs that must be considered when designing compression and error-correction schemes for a mobile system that uses radio communication. (4 marks)
4. This question is concerned with still and moving image compression and transmission, together with high-level mobile system design issues.

a) Calculate the capacity required to store a 1 hour, uncompressed TV programme. Explicitly state the figures for image size, frame rate, etc. used in the calculation. (2 marks)

b) Why are RGB signals converted into luminance and chrominance signals for video compression? (2 marks)

c) What is meant by run-length encoding and how is the technique used in JPEG compression? (2 marks)

d) Why is there potentially a problem in keeping audio and video in sync in MPEG? How is the problem overcome? (2 marks)

e) Why is interlacing used in Video analogue systems? (2 marks)

A town council has decided that, in order to reduce general car crime rates, it will equip all of its traffic wardens with mobile systems that can capture an image of a car registration number plate and send that image back over a radio communications link to a central server. The central server will then identify the registration number and check it against the national database to identify unregistered, uninsured or stolen vehicles.

f) Describe the various trade-offs that should be considered in deciding how best to transmit the image of the registration number plate over the radio communications link in order to maximise the battery life of the mobile system and suggest an optimal scheme. (7 marks)

g) The primary role of the traffic wardens is to identify parking offences and to issue parking tickets to offending vehicles that have exceeded the maximum allowed parking time in a particular location. What additional features should be incorporated into the mobile system in order to automate this process as far as possible? (3 marks)

END OF EXAMINATION