Vrije Universiteit, Department of Computer Science

Examination paper for **Pervasive Computing**

17th of December 2014, 12:00-14:45

This is a closed book written exam.

No printed material or electronic devices are admitted for use during the exam.

The answers may be given in English or Dutch.

Both practical work and exam are compulsory and graded on an 1 to 10 scale.

The exam grade is calculated as (Q1+Q2+...+Q6+10)/10.

The final grade is calculated as 0.5*PRAC + 0.5*EXAM.

A pass is given only if both practical work and exam components are >= 5.5.

|	Q1	Q2	Q3	Q4	Q5	Q6	ΣQi	Maximum credits= (ΣQi+10)/10
a)	4	4	3	4	6	6		
b)	6	3	2	4	6	4		
c)		2	5	4	6			
d)		3		4	6			
e)				4				
f)				4				
Total	10	12	10	24	24	10	90	10

Good luck!

Q1. Systems [10p]

A self-driving car is an example of a pervasive computing system.
   a) Enumerate the three properties of pervasive computing systems and show how these properties are manifested in this system. [4p]
   b) Now we focus on its functionality of recognizing traffic lights. Draw a diagram where you show the main building blocks of this system, and explain their role. [6p]

Q2. Signals [12p]

Given the sinusoidal signal plotted below in time domain:
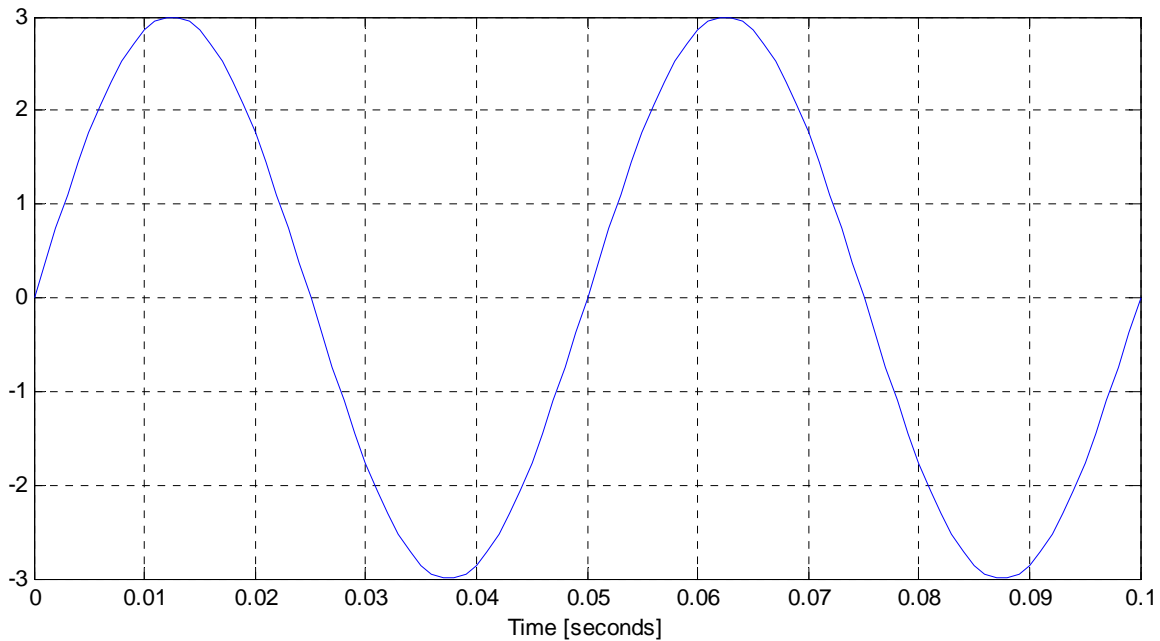
   a) What is its amplitude? Its phase? Its period? Its frequency ? [4p]
   b) What would be a reasonable sampling frequency? Justify your answer. [3p]
   c) How many samples do we obtain?   [2p]
   d) What happens if we use a much higher / much lower frequency than in Q2b)? [3p]

Q3. Control [10p]

a) What is a LIDAR? What does it measure and how? [3p]
b) Take as example an automatic insulin pump. What is the controlled variable? [2p]
c) Draw a block diagram where you illustrate the feedback control principle of this pump. [5p]

Q4. Image & sound processing [24p]

Consider this image below with some coins on it.
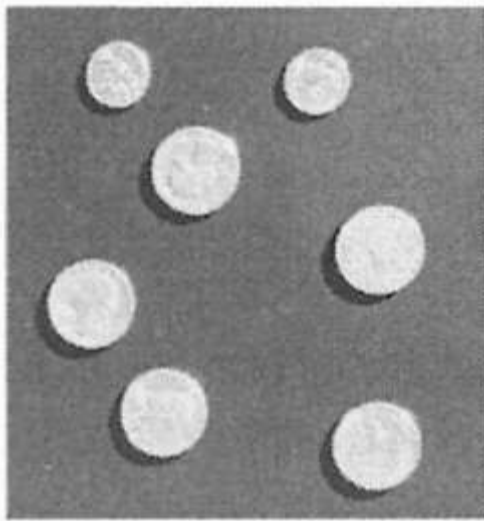
a) Sketch its histogram. [4p]
b) Explain how to apply a thresholding operation in this case. [4p]
c) Define the concept of BLOB in image processing and count the number of black BLOBs using 4-connectivity in the image below. [4p]
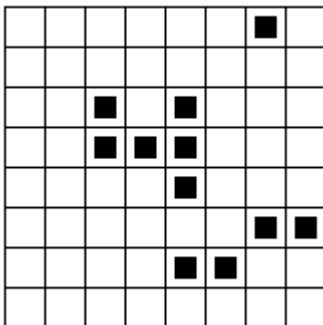
d) We take the signal from Q2 and we add it with a signal with the same amplitude, same duration, but with frequency equal to zero. Sketch the frequency spectrum of this combined signal. [4p]
e) Sketch the spectrogram of the combined signal from Q4d). [4p]
f) Sketch a spectrogram of the sound recorded in a room with a noisy fridge where a cat meows three times. [4p]

5. Classification [24p]

a) Below you can see a chart with the frequencies of the first formants F1 and F2 of some common vowels. Explain how we can classify the vowels a (as in "hard"), i (as in "heed") and u (as in "who'd") by using a rule-based classifier and this chart. [6p]
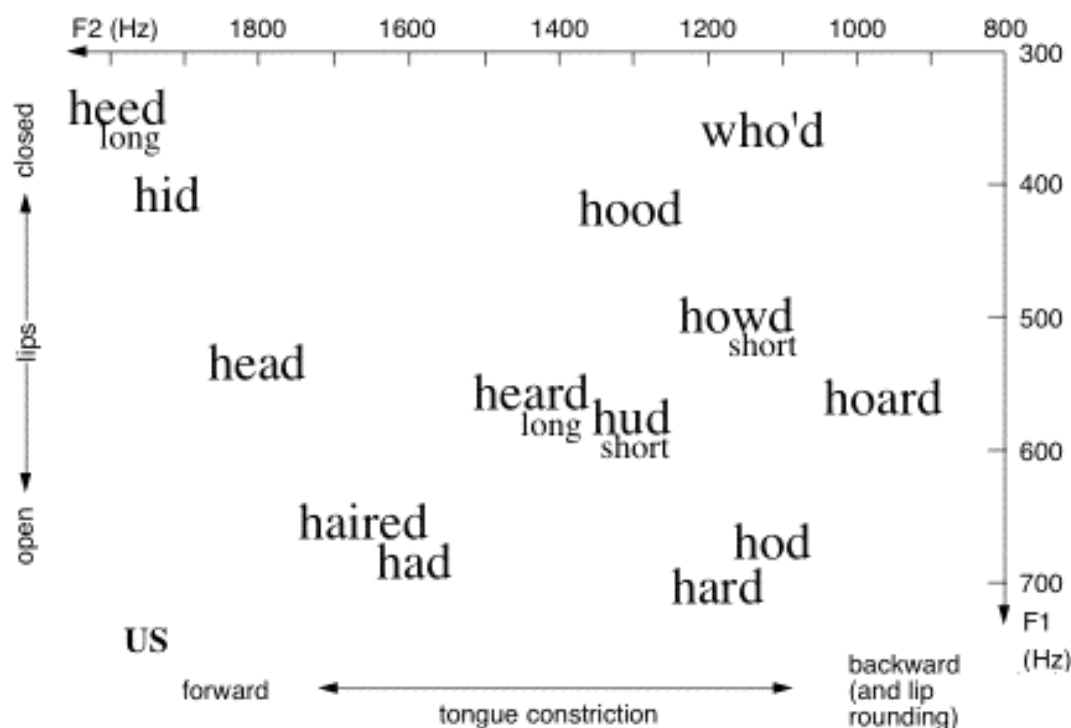
b) Explain how template matching works. Give one advantage and one disadvantage. [6p]
c) What is a neural network? Explain how to use a neural network to recognize 3 handwritten characters. [6p]
d) What is a confusion matrix? Sketch an example of a perfect confusion matrix for a system that recognizes pedestrians on the street. [6p]

6. Quality [10p]

a) We want to test a module for a human resources system, that decides how we should process employment applications based on the person's age. The rules are:
  - 0-16 don't hire
  - 16-18 hire on part time basis only
  - 18-55 hire full time
  - 55-99 don't hire

Generate test cases for testing this module using equivalence partitioning. [6p]

b) Formulate an ethical question related to a robotic nanny that takes care of small children. [4p]