

2011 Paper 4 Question 4

Computer Graphics and Image Processing

A new computer display is being designed to project large images onto the walls of buildings. It works by reflecting a laser beam off a mirror mounted on a pair of loudspeaker coils. Two analogue signals control the horizontal and vertical deflection of the laser beam by driving the coils. A third digital signal turns the laser on and off. The deflection coils can be driven up to a frequency of 20 kHz, and the laser can be turned on and off at a frequency of 10 MHz. Two approaches are being considered: raster scan and calligraphic.

- (a) What resolution two-level (on/off) raster display could the hardware support? [4 marks]
- (b) How might grey levels be provided? What resolution raster display could the hardware support if eight levels of grey were required? [3 marks]
- (c) An alternative approach would be a random scan calligraphic display that drew lines by deflecting the mirrors to the beginning of a line, turning the laser on, deflecting the mirrors to the end of the line (ensuring that the intermediate deflections lay along a straight line), and turning the laser off again. How many lines could be drawn on this calligraphic display before the image flickered? [2 marks]
- (d) The analogue signals controlling the horizontal and vertical deflection coils are produced by fast digital-to-analogue converters with 10-bit inputs. Present an algorithm for generating intermediate coordinates along the line to ensure that lines drawn on the calligraphic display are straight and also evenly illuminated. [7 marks]
- (e) How could the algorithm be adapted to draw arcs of circles? [2 marks]
- (f) What additional hardware might be useful to assist with generating the intermediate coordinates from the end points of lines? [2 marks]