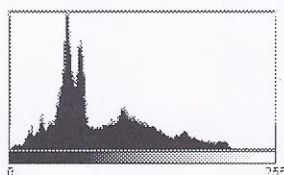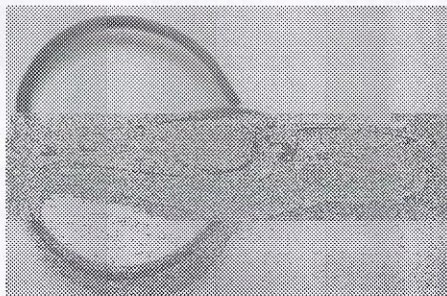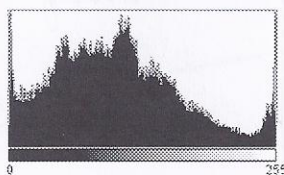# Exam Intelligent Sensors  Theme 10 (4-12-2011, 10.30-12.00)

1.  Consider a picture of a Chinese scissor.
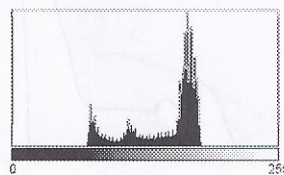
-  Which of the three histograms corresponds to the shown picture? Motivate your choice. (5p)



(a)          (b)          (c)

Image contains three main intensities:
-  Background (relatively light)
-  Scissor
-  Shadow of scissor (a bit ligther than the scissor itself)

Histogram should contain three peaks, with the largest peak caused by the background intensity.  Because the background is lighter than the scissor and shadow of the scissor, the largest peak should be on the right of the peaks caused by the scissor and the shadow of the scissor.

-  Histogram (b) has a rather continuous spread => incorrect
-  Histogram (a) has a large peak, but no peaks for the scissor and scissor' shadow. Furthermore if the largest peak would correspond to the background then the background would be darker than most of the rest of the image => incorrect.
-  Histogram (c) has 3 peaks and the largest peak is on the right of the other two peaks = > correct

- Draw an example of a linear grayscale transformation that could enhance the contrast of the picture. (5p)

More contrast if we apply a transfrom that has the same effect as the histogram equalization transform:
  1. lowest intensities are mapped to 0 (black)
  2. highest intensities are mapped to 255 (white)
  3. the higher the peak in the histogram the steeper the transform
  4. monotonic increasing

A simplified transform fulfilling 1 and 2 is correct.

~~4. monotonic increasing~~

image (c)

O                    255

output 255

O          255   input

output 255

O          255   input
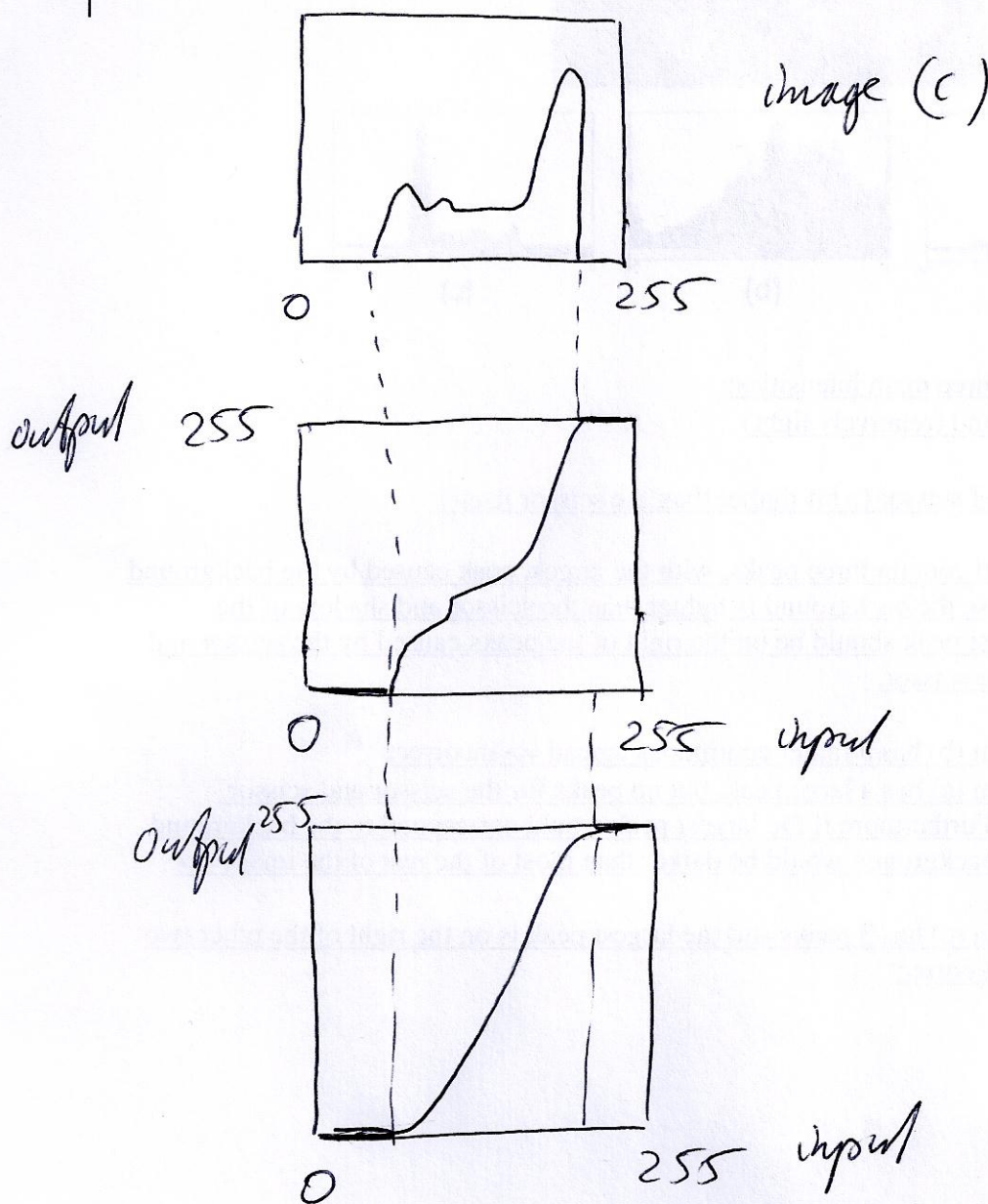
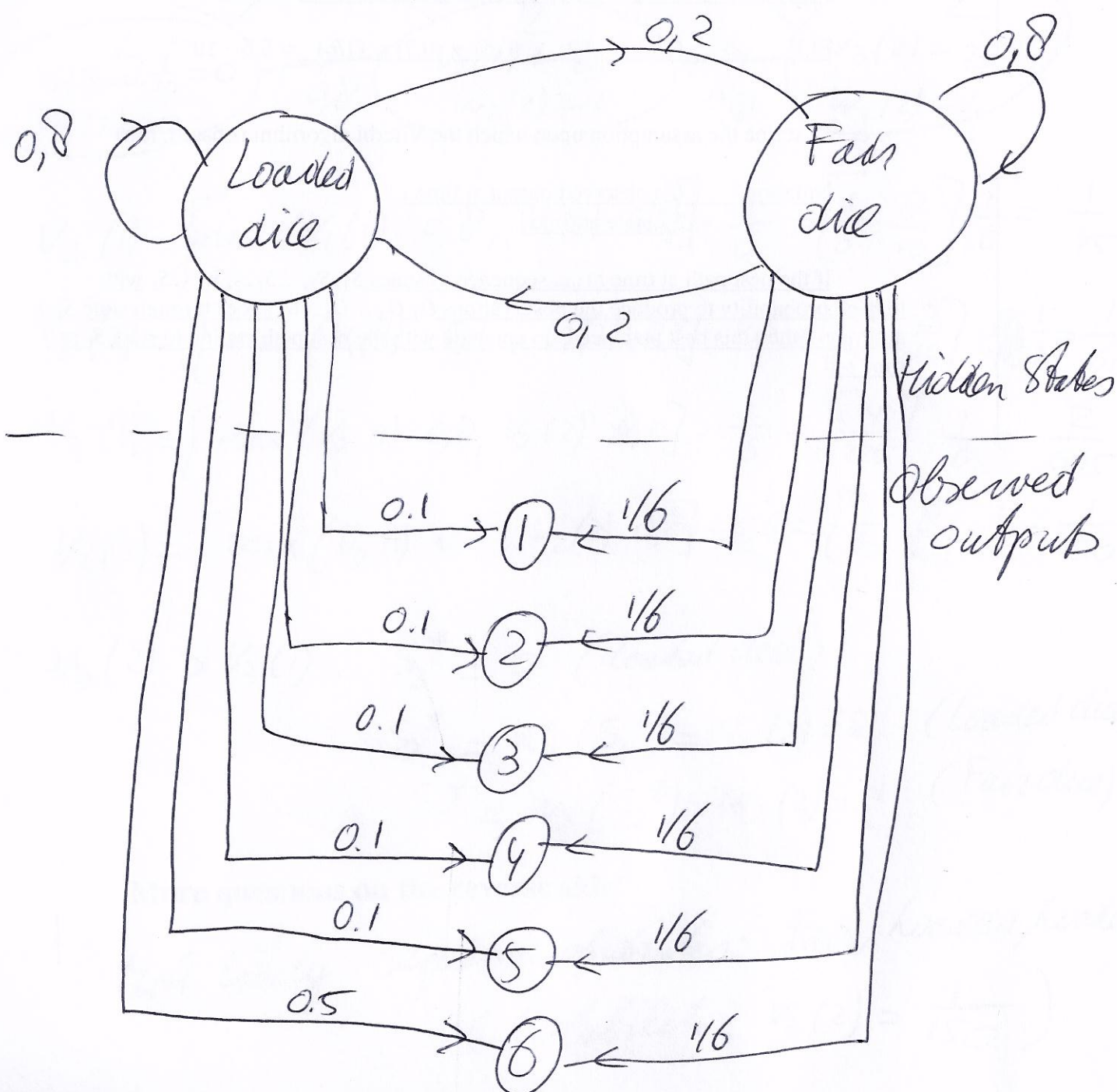① ② and ③ ④
incorporated in
transform.

2. In a dishonest casino employees are ordered to secretly switch back-and-forth between a fair die and a loaded die. The loaded die has a 50 % chance of rolling a '6', whereas the chance of rolling a '1', '2', '3', '4' or '5' is 10%. On average casino employees switch between dices every 5 turns.

   a. Draw a Hidden Markov Model for the rolling of dices in this casino. Indicate the hidden states and the observed output of the model.(6p)

Two states: F (fair dice) and L (loaded dice)
On average casino employees switch between dices every 5 turns. Hence there is a 80% probability that dice is not changed and a 20% probability that the casino employee changes the dice.

Hidden States

Observed output

| Loaded dice | | Fair dice |
|---|---|---|
| 0,8 | 0,2 → | 0,8 |
| | ← 0,2 | |

| | Loaded | | Fair |
|---|---|---|---|
| 0.1 → | ① | ← 1/6 | |
| 0.1 → | ② | ← 1/6 | |
| 0.1 → | ③ | ← 1/6 | |
| 0.1 → | ④ | ← 1/6 | |
| 0.1 → | ⑤ | ← 1/6 | |
| 0.5 → | ⑥ | ← 1/6 | |

3. On the image indicated with "Original" the
following nine operations have been applied:

    A. Maximum filter
    B. Minimum filter
    C. Mean filter
    D. Threshold filter
    E. Ideal LowPass filter
    F. Ideal HighPass filter
    G. Laplace operator
    H. Sobel operator (both directions)
    I. Histogram equalization
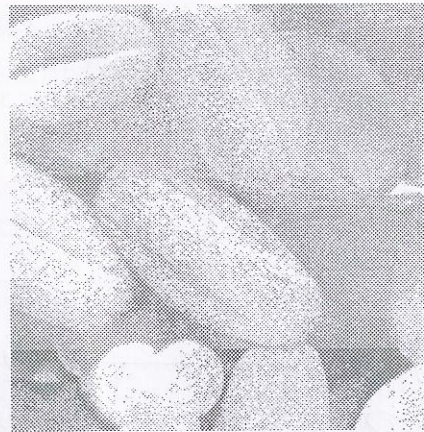


Original

The results of the nine operations are depicted below.

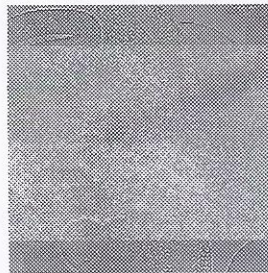a. Denote for each of the images the corresponding operation. Motivate your choices.
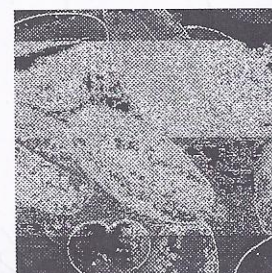(12p).
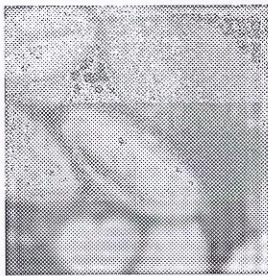


(1)

(2)

(3)

(4)

(5)

(6)

(7)

(8)

(9)

**More questions on the next page!**

- Image (3) is the only pure black and white image. Hence this must be the result of a Threshold filter:     3-D

- Image (5) is image with the most contrast. Hence it must be the result of the histogram equlaization transform:     5-I

- Images (1) and (8) are the only two images with "ringing" effect (grid in background). Hence these two images are the result of the ideal lowPass and HighPass filters. Image (8) contains fine detail (e.g the small black dots on the larger objects) => high pass filter:     8 – F
  Image (1) is a smoothed version of the original, hence a lowPass filter:     1-E

- Images (4) and (6) are results of edge detection filters: Laplace and Sobel. A property of the Laplace transform is the very gray appaerance of the resulting image. Thus: image (4) corresponds to the Laplace transform:     4-G and 6-H

- The remaining images (2), (7) and (9) are the result of the min, max and mean filters.
  Image (2) is the darkest of the three images, thus result of min filter:     2-B.
  Image (9) is the lightest of the three images, thus result of max filter:     9-A.
  Image (7) is original image with some blurring, thus result of mean filter:  7-B.