Department of Computer Science and Engineering
University of California at San Diego

CSE 255
Winter 1998

Project 5

DUE AT THE FINAL EXAMINATION, FRIDAY MARCH 20.

The assignment here is to develop a fuzzy controller in software. The target application is the shower demo available at `http://ai.iit.nrc.ca/fuzzy/shower/title.html`.

(1) First, you should implement an inference engine for fuzzy control in C. This program should allow for two input variables and two output variables. The controller should be able to run on a small eight-bit single-chip microcontroller. Make your program as small as possible, and make assumptions as necessary for this hardware environment. In particular, assume that all inputs and outputs are eight-bit unsigned integers.

Trapezoidal fuzzy sets and rules for the controller should be supplied as C arrays, made readable by using macros to give names to the fuzzy sets. For example:

```
#define NUMZSETS 3

#define ANY 0
#define SLOW 1
#define FAST 2

short zset[NUMZSETS][4] = {{0,0,255,255},
                           {0,40,60,100},
                           {5,10,15,20}};
#define NUMRULES 2

short rule[NUMRULES][3] = {{ANY, SMALL, SLOW},
                            {DARK, ANY, SLOW}};
```

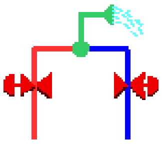
The macros above say that there are three different fuzzy sets on the z axis. The fuzzy set `SLOW` has $\mu(z)$ linearly increasing from 0 to 1 for z ranging from 0 to 40, $\mu(z) = 1$ for $40 \leq z \leq 60$, a linear decrease from 60 to 100, and $\mu(z) = 0$ for $60 \leq z \leq 255$. The first fuzzy rule given says that if x is `ANY` and y is `SMALL` then z should be `SLOW`.

(2) Second, you should design fuzzy control rules for the shower demo mentioned above. These rules should be implemented using the C program described above. (For extra credit, implement software that lets your controller interface directly with the web demo.)

(3) Third, reflect on the general problem of shower control and design and implement a simple alternative controller for the shower. This alternative controller should also be a small C program capable of running on an eight-bit microcontroller. Decide what the major criteria are for evaluating the performance of a controller for this application, and optimize both controllers. Which controller ends up being superior?

As usual, document your work in a well-written report of up to ten pages. Among other issues, discuss how easy or hard it is to write good fuzzy rules. Compare carefully the advantages and disadvantages of your fuzzy controller and your alternative controller for the shower application. Also discuss how realistic the shower demo is an illustration of real-world control problems in manufacturing.

From `http://ai.iit.nrc.ca/fuzzy/shower/title.html`:

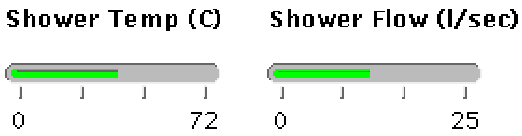


Take the Fuzzy Shower Challenge

This challenge is faced every morning by everyone. It is trying to survive controlling the shower. This task will be used to demonstrate the speed of the FuzzyCLIPS program.

The initial settings for the shower will be randomly selected for you and you can choose to control the shower yourself or have the FuzzyCLIPS program take over. This example will show the advantages of the FuzzyCLIPS expert system.

You will be asked to adjust the shower so that it is under control. The goal is to try and get the shower running in target zone for both temperature and flow. This is accomplished when both of the slider graphical images are displaying green.



The target temperature is between 34 and 38 degrees Celsius and the target flow rate is between 11 and 13 litres/sec.

The time taken is measured in the number of adjustments to the hot and cold water taps. One call to adjust the shower counts as one pass. The FuzzyCLIPS program is timed in the same way. One iteration through the inference engine counts as one adjustment or pass. Your goal is to try and beat the FuzzyCLIPS control system.