Final Year Project I (EELE 5301)
Fuzzy Logic Washing Machine
Proposal

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To
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Introduction:

The primary goal of control engineering is to distill and apply knowledge about how to control a process so that the resulting control system will reliably and safely achieve high-performance operation. In this project we show how fuzzy logic provides a methodology for representing and implementing our knowledge about how best to control a process.

Fuzzy Logic was initiated in 1965, by Lotfi A. Zadeh, professor for computer science at the University of California in Berkeley. Basically, Fuzzy Logic (FL) is a multivalued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, etc. Notions like rather tall or very fast can be formulated mathematically and processed by computers, in order to apply a more human-like way of thinking in the programming of computers.

Fuzzy logic deals with uncertainty in engineering by attaching degrees of uncertainty to the answer to a logic question. Why should this be useful? The answer is commercial and practical. Commercially fuzzy logic has been used with great success to control machines and consumer products. In the right applications fuzzy logic systems are simple to design, and can be understood and implemented by non-specialists in control theory.

In most case someone with a intermediate technical background can design a fuzzy logic controller. It is not the answer to all technical problems, but for control problems where simplicity and speed of implementation is important then it is strong candidate. It is provides a method of reducing as well as explaining the system complexity.

Fuzzy Logic provides a different way to approach a control or classification problem. This method focuses on what the system should do rather than trying to model how it works. One can concentrate on solving the problem rather than trying to model the system mathematically, if that is even possible.

On the other hand the fuzzy approach requires a sufficient expert knowledge for the formulation of the rule base, the combination of the sets and the defuzzification. In General, the employment of fuzzy logic might be helpful, for very complex processes, when there is no simple mathematical model, or if the processing of (linguistically formulated) expert knowledge is to be performed.

In our project we select a washing machine as an application on a fuzzy logic technology. Washing machines are a common feature today in the houses. The most important utility a customer can derive from a washing machine is that it saves the effort he/she need to put in brushing, agitating and washing the cloth.

Fuzzy logic washing machines are gaining popularity. These machines offer the advantages of performance, productivity, simplicity, and less cost. Sensors continually monitor varying conditions inside the machine and accordingly adjust operations for the best wash results. As there is no standard for fuzzy logic, different machines perform in different manners.
This project aims at presenting the idea of controlling the washing time using fuzzy logic control and describes the procedure that can be used to get a suitable washing time for different cloths.

The process is based entirely on the principle of taking non-precise inputs from the sensors, subjecting them to fuzzy arithmetic and obtaining a crisp value of the washing time. It is quite clear from the work itself that this method can be used in practice to further automate the washing machines.

Fuzzy Logic detects the type and amount of laundry in the drum and allows only as much water to enter the machine as is really needed for the loaded amount. And less water will heat up quicker - which means less energy consumption.

Washing machines are mainly of three types, namely, semi-automatic, automatic, and washer. In semi-automatic machines the controls are not fully automatic and manual intervention is required. In fully automatic machines, no manual intervention is required during the washing process. Washers are single-tub machines that only wash. Since washers don’t have the facility for drying the clothes, these cost less than semi-automatic and fully automatic washing machines.

For automatic machines, programs have to be selected and set by the user prior to the start of wash cycle. Sensors sense the wash load and decide the program ideal for washing the clothes, water level, time required to wash, number of rinses and spins, type of fabric, etc. Fuzzy logic washing machines with special sensors are the most easy to use.

Fuzzy logic washing machines are gaining popularity. These machines offer the advantages of performance, productivity, simplicity, productivity, and less cost. Sensors continually monitor varying conditions inside the machine and accordingly adjust operations for the best wash results. As there is no standard for fuzzy logic, different machines perform in different manners. Typically, fuzzy logic controls the washing process, water intake, water temperature, wash time, rinse performance, and spin speed. This optimizes the life span of the washing machine. More sophisticated machines weigh the load (so you can’t overload the washing machine), advise on the required amount of detergent, assess cloth material type and water hardness, and check whether the detergent is in powder or liquid form. Some machines even learn from past experience, memorizing programs and adjusting them to minimize running costs.
Most fuzzy logic machines feature ‘one touch control’. Equipped with energy saving features, these consume less power and are worth paying extra for if you wash full loads more than three times a week. Inbuilt sensors monitor the washing process and make corrections to produce the best washing results. In some machines a tangle sensor senses whether the clothes are tangled and takes corrective action by adjusting the water current, so the clothes don’t tangle further and are cleaned better.

The fuzzy logic checks for the extent of dirt and grease, the amount of soap and water to add, direction of spin, and so on. The machine rebalances washing load to ensure correct spinning. Else, it reduces spinning speed if an imbalance is detected. Even distribution of washing load reduces spinning noise.

Wash programs to suit different types of clothes. The programs include ‘regular’ for normal wash, ‘gentle’ for delicate clothes, ‘tough/hard’ for rugged clothes, and so on. In addition, you are able to select the temperature of wash and number of runs for better cleaning. But beware! If these washing machines don’t have fuzzy logic technology to automatically control the temperature when the clothes start to get overheated, you might be stuck with ruined clothes.

**Automation:**

On fully automated washing machines, you don’t need to wet your hands just put in your clothes, turn the machine on, and wait for it to finish washing and drying. On semiautomatic machines, you have to manually transfer the clothes from the washer to the dryer.

**Statement of the Problem:**

Fuzzy logic is the most common method to solve non linear and dynamic problems. Unlike boolean logic which the transition from set to set is instantaneous, the transition in fuzzy logic may be gradual. This make fuzzy controller has smooth response.

Implementing algorithms in software limits the performance of real-time systems, since the data is processed serially. A fuzzy inference system has been implemented on an FPGA.

In control engineer the most common approaches to implement fuzzy controller are fuzzy controller chip or microcontroller. Our project describes an approach to implement fuzzy controller using Field Programmable Gate Array (FPGA). The advantages of the FPGA approach to fuzzy controller implementation include higher sampling rate than traditional fuzzy chips and more flexible than fuzzy chip or microcontroller also attracting the interest of the real-time
applications. With enhanced capabilities most of the processing tasks can be loaded from the software program stack to embedded processors on the FPGA to improve performance and reduce the cost of the whole system. A fuzzy inference system has been implemented on an FPGA, and used to control a motor in a washing machine, and all parts. The given results demonstrate the capability of such embedded controller in washing machine applications where simplicity, reliability and stability are more important issues. We can build or change facilities in controller that fuzzy chips and microcontrollers don’t have.

Washer is a significant application in Gaza strip, because we want to help civil society. The control board is one of the important problems in Gaza, which suffering from siege, so we want to do this project to solve some of this problem.

the government and the companies which deal with this product (washing machine ) should be care on this task, because it will solve big problem in our life and it will encourage the youth in our country to do some project which can help people in there life

**Methodology:**

A design methodology for fuzzy logic- based control systems. The methodology employs hardware/ software codesign techniques according to an ‘a priori’ partition of the tasks assigned to the selected components. This feature makes it possible to tackle the control system prototyping as one of the design stages. In our case, the platform considered for prototyping has been a development board containing a standard microcontroller and an FPGA. Experimental results from an actual control application validate the efficiency of this methodology.

The capability of fuzzy controllers to describe with simple rules the linguistically expressed experience and knowledge of a human expert and to achieve that without the need of a mathematical model of the plant under control, have motivated a great increase in the number of control applications using fuzzy logic-based inference techniques. The input of a common controller is a specific numeric value, but the knowledge base for fuzzy control is expressed with language. The system must turn numeric values into language and corresponding domains to allow the fuzzy inference engine to inference. This transformation is called fuzzification. The reverse of fuzzification, defuzzification transforms the fuzzy inference engine’s output values into equivalent assured values, making the assured value comply with the input signals of the controlled system. This process gives output control signals to the controlled system.

So we decide use fuzzy logic technology in our project which washing machine, and as we saw above by this technology the washing machine will think significantly as human, it will not work as the machine which program
digitally without using fuzzy logic which work in a certain thing and can't take
decision but when we use fuzzy logic it can take decision and think
significantly as human. To make that really we will use FPGA hardware
component. If there is any problem in using FPGA component in our future
work, especially when we begun to write the program part we will use PIC to
program it to control the machine instead of FPGA

Our project is one of the important on fuzzy applications, so we want to do this
which considered the first project that work with fuzzy logic in our university
at the level of graduate degree.

**Objective:**

Design a small washing machine, with a controller that is programmed using
fuzzy technique which gives the correct wash time even though a precise model
of the input/output relationship is not available. Also in the second semester we
will produce on the same model a software program loaded on FPGA kit using
VHDL language as a link between the source code and the kit.

**Outcomes:**

We will program on micro c software as the first step, then we will transfer
Micro c program to another language deal with FPGA kit that will be
compatible to fuzzy logic.

And finally at the end of this project we hope to accomplish the following on a
form mini washing machine:
1- Low power consumption.
2- Easier to deal with user.
3-No wasting time also no wasting efforts.
Plan of Activities with Deadlines:

### Time Table and Deadlines

<table>
<thead>
<tr>
<th>Steps</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtaining sources</td>
<td>1/3</td>
</tr>
<tr>
<td>having research equipments</td>
<td>20/3</td>
</tr>
<tr>
<td>Research Start</td>
<td>1/5</td>
</tr>
<tr>
<td>End the first Project</td>
<td>15/6</td>
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<tr>
<td>start work</td>
<td>20/9</td>
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<tr>
<td>get the component</td>
<td>20/10</td>
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<tr>
<td>the project under test</td>
<td>20/11</td>
</tr>
<tr>
<td>Finishing the hardware</td>
<td>10/12</td>
</tr>
<tr>
<td>Fishing the Final Report</td>
<td>25/12</td>
</tr>
<tr>
<td>Revising the Final Report</td>
<td>31/12</td>
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</table>

### Cost:

<table>
<thead>
<tr>
<th>s</th>
<th>Component</th>
<th># of units</th>
<th>Unit Price (NIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FPGA Kit</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>Body (structure)</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>Control Panel</td>
<td>1</td>
<td>200</td>
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<tr>
<td>4</td>
<td>Motor</td>
<td>1</td>
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<td>5</td>
<td>Lashes</td>
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<td>70</td>
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<tr>
<td>6</td>
<td>Timer Board</td>
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<td>500</td>
</tr>
<tr>
<td>7</td>
<td>Wheel for barrel</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>8</td>
<td>Vacuum</td>
<td>1</td>
<td>70</td>
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<tr>
<td>9</td>
<td>Door Lock</td>
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<td>10</td>
<td>Water Valve</td>
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<tr>
<td>11</td>
<td>Discharge Pump</td>
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<td>12</td>
<td>Hose Pull</td>
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<tr>
<td>13</td>
<td>Discharge Hose</td>
<td>1</td>
<td>10</td>
</tr>
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</table>

| Total Price                  | 3080 (NIS) |
References:

[8] Industrial Application of Fuzzy Logic Control
   www.fuzzytech.com/binaries/e_p_dv1.ppt, access date; May 24, 2010
   http://www.samsungelectronics.com.my/washing_machine/tech_info/index.html, access date; May 24, 2010
[10] SGI RASC RC100 Datasheet, Silicon Graphics Inc. 2006,
    http://www.sgi.com/pdfs/3920.pdf, access date; May 24, 2010