Application of Fuzzy inference system to evaluate elapsed time for Generation, Insertion and Retrieval of QR code from Database

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Abstract—QR codes have come a long way since their creation, having first been used to help track parts in the manufacturing process of vehicles .This paper provides idea about system capable of generating QR code, inserting and retrieving it from the database. This paper is divided into two phases.In first phase (encoding phase) alpha numeric string is encrypted and then the obtained string is converted to its equivalent QR code image. In the second phase this Generated QR code is later encrypted using AES encryption technique and stored in database. Fuzzy Inference System is used to evaluate the time elapsed in the process from generation to storing in database as well as retrieval of QR Code from Database. Mamdani model of fuzzy inference system is used to evaluate the total time for insertion and retrieval of QR code from the database.

Index Terms —QR (Quick Response) code , FIS (Fuzzy inference system), AES (Advanced encryption standard), Alphanumeric string, Time evaluation, membership function.

1 INTRODUCTION

The recent interest in the use of visual tags in everyday life is a natural consequence of the technological advances found in modern mobile Phones. The QR code is a matrix consisting of an array of nominally square modules arranged in an overall square pattern, including a unique pattern located at three corners of the symbol and intended to assist in easy location of its position, size and inclination. A wide range of sizes of symbols is provided together with four levels of error correction. Module dimensions are user specified to enable symbol production by a wide variety of techniques[1][2].

Today there are multiple purposes for QR code, including transport ticketing, entertainment, commercial tracking, and product labelling/marketing, just to name a few. We can find QR codes being used to send audiences to a website for browsing, to bookmark a webpage, to initiate phone calls, send short messages, send emails, produce links to web URL's, connect to WI-FI networks, access information etc[1][6].

Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as binary , "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans.

There are two phases in this system namely generation of random alpha numeric string of 16 characters, encrypting it and generation of QR code using this encrypted string.

In the second phase the generated QR code is stored in database. QR code being only machine readable protects data stored within against human intrusion.

2 QR CODE

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Figure 1: QR code

2.1 Features of a QR code

- High data encoding capacity: The maximum QR code symbol has the ability to encode about 7089 characters.
- High-speed scanning and reading: a QR code reader has the ability to recognize many QR code symbols and therefore is read fast.

- Capable of reading Japanese and Chinese encoding: QR codes can also read Japanese and Chinese characters just as fast as English characters.
- Can be read from any direction: Since it is a 2D matrix code, it can be scanned and read from any direction[3][4].

3 Random Alphanumeric String Generation

A 16 character long random string is generated including numbers and special characters using package java.util.random. This string generated is then encrypted using AES encryption algorithm. QR image of this encrypted string is generated and stored in the database.

4 QR code generationalgorithm

The Encrypted string is converted to a QR image using an algorithm. QR code algorithm is made up of two different stages. The first one is similarity transformation where the novel matrix gets transformed in limited steps to real tridiagonal or Hessenberg form. The first stage of the QR algorithm prepares for the next stage which is the actual iterations of tri-diagonal or Hessenberg matrix form[4].
One of the major limitations faced by the QR code algorithm is the fact that the first stage creates a complete 'fill-in' in common sparse matrices (a matrix that is primarily populated with zeros). This, therefore, hinders it from being used in huge sparse matrices because they require excessive memory.

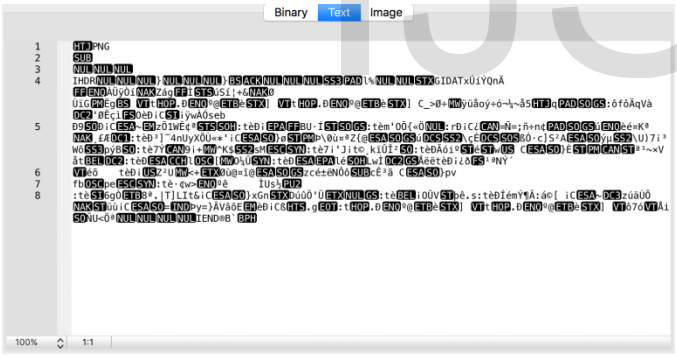


Figure 2: QR code in text form

5Insertion Of QR in Database

The QR generated from the Encrypted string is then Inserted in to the database. The database is created in MYSQL Db. MyISAM engine is used. The reason MyISAM allows for fast reads is the structure of its indexes, each entry points to a record in the data file, and the pointer is offset from the beginning of the file. This way records can be quickly read, especially when the format is FIXED. Thus, the rows are of constant length. Inserts are easy too, because new rows are appended to the end of the data file[6].

6 Fuzzy Inference System

Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as binary, "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans[5].

Basically a fuzzy inference system is composed of five functional blocks:

- Rule base containing a number of fuzzy if-then rules.
- Database which defines the membership functions of fuzzy sets used in the fuzzy rules.
- Decision-making unit which performs the inference operation on the rules.
- Fuzzification interface which transforms the crisp inputs into degree of match with linguistic values.
- Defuzzification interface which transform the fuzzy results of interference into a crisp output.
- Usually, the rule base and the database are jointly referred to as the knowledge base[5].

This Fuzzy Inference system is used to evaluate the total time elapsed for the whole process of QR generation from generation of alpha numeric string to retrieval of image from the data base.

7 Fuzzy model for Calculating the Time Elapsed

The input parameters used to evaluate the time elapsed are:

- No. of QR images
- Size of a Image in bytes.

The fuzzy controller takes two inputs, processes the information and gives output as time elapsed. The basic structure of fuzzy logic controller is shown in figure. 3.

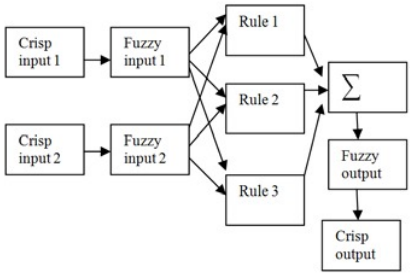


Figure 3: Basic Structure of fuzzy logic controller

7.1 Membership Functions

The two crisp inputs, no. of images and size varies from 0 to 300 and 0 to 1600 bytes respectively are presented as fuzzy sets defined by their respective membership functions.
Let the output; Time elapsed be allowed to have five linguistic values very low, low, medium, high and very high. Similarly, let the input variable; no of images be expressed as less, medium and large.Size of the image be described as being small ,medium and large. The fuzzy inference system is shown in following figure.

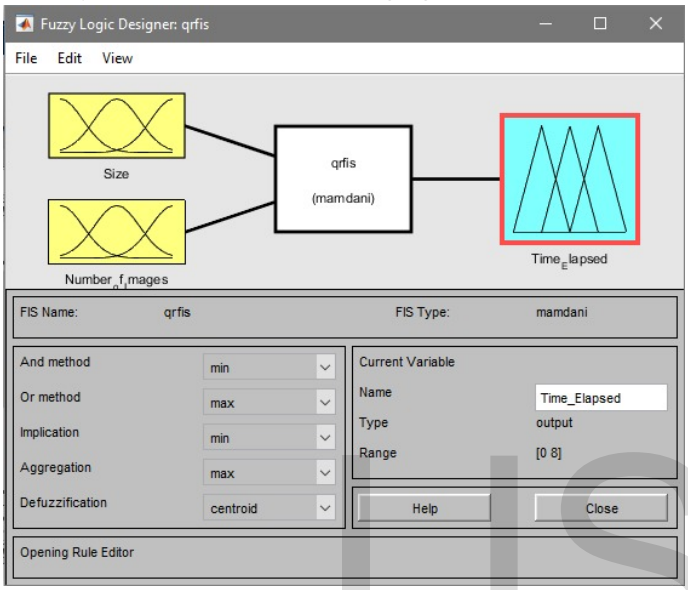
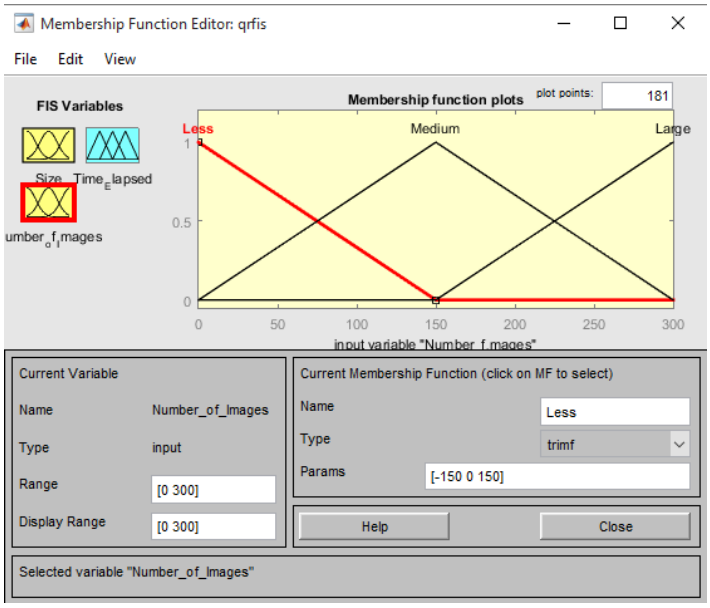


Figure 4: Fuzzy inference system

The parameter used to define membership function of number of images are [0 0 50],[0 150 300] and [150 300 300]. Similarly
Membership function for size of image [0 0 800],[0 800 1600], and [800 1600 1600]. MF for time Elapsed are [0 0 2],[0 2 4], [2 4 6], [4 6 8] and [6 8 8].



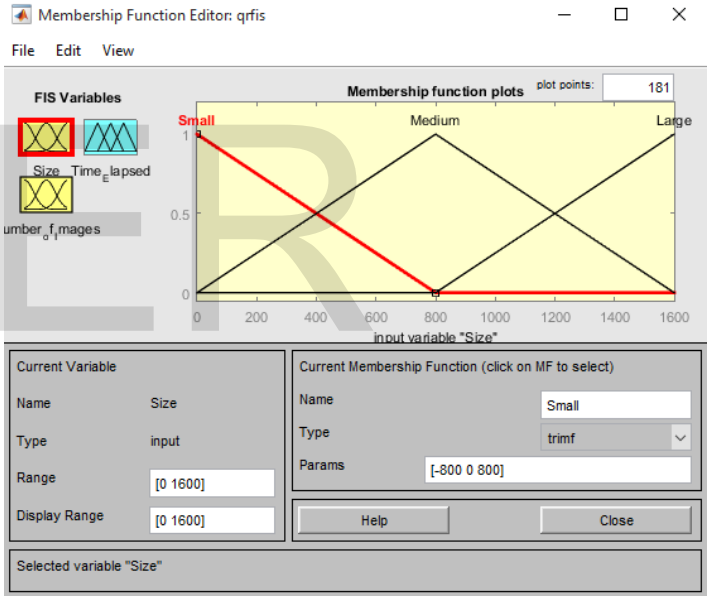


Figure 6: Membership function for Size of image

7.2 Details About the Rules Applied

The decision which the fuzzy controller makes is derived from the rules which are stored in the database. These are stored in the set of rules. Basically the rules are if-then statements that are intuitive and easy to understand, since they are nothing but common English statements[9]. The set of rules/statements used here to derive the output are Shown in following table.

Total nine rules are generated according to the two inputs.

Figure 5: Membership function for number of images

No of image/Size of Image	Small	Medium	Large
Less	very small	small	medium
Medium	small	medium	large
Large	meduim	large	very large

Table 1: Rules of FIS

The rules have been defined in imprecise sense and hence they are not crisp but fuzzy values. The two input parameters after being read from the sensors are fuzzified as per the membership function of the respective variables. At last the crisp value of time elapsed is obtain as an answer.

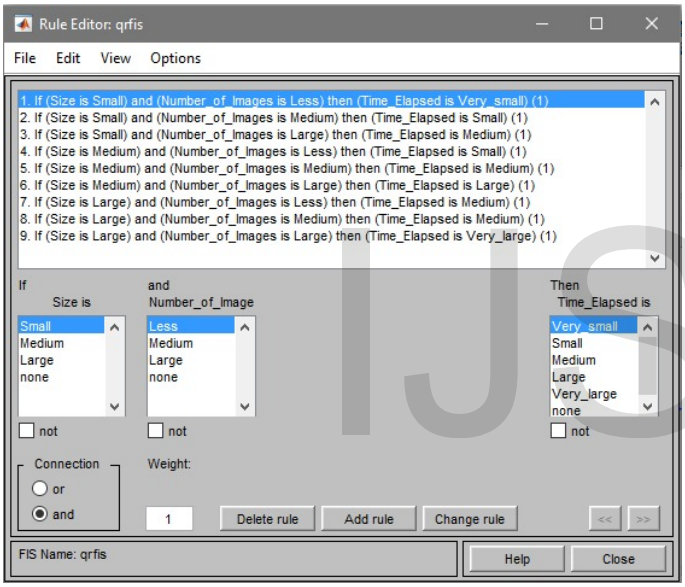


Figure 7: Rule base Diagram

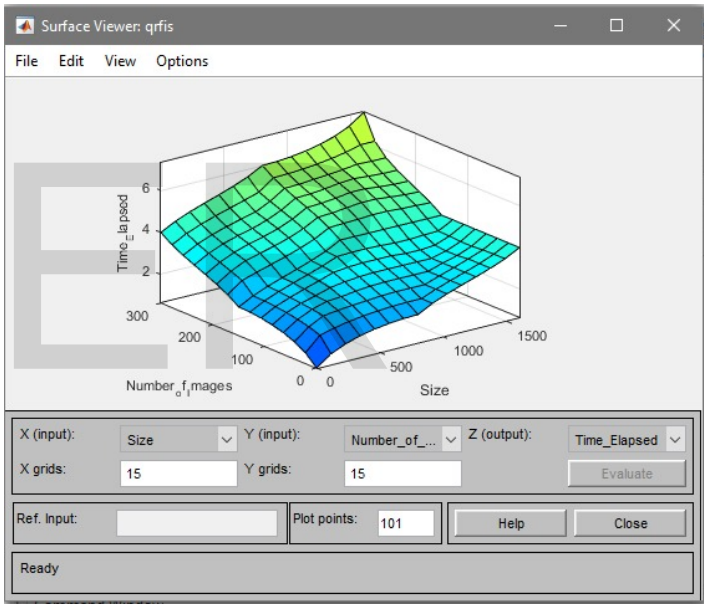


Figure 8: Membership function for time elapsed.

Figure 9: The Surface view Diagram

7.3 Results

The execution of rules is done by using MATLAB. The sensors sense the input values and using the above model the inputs are fuzzified and then by using simple if-then rules the output fuzzy function is obtained. The membership function of output time elapsed is shown in figure 8.

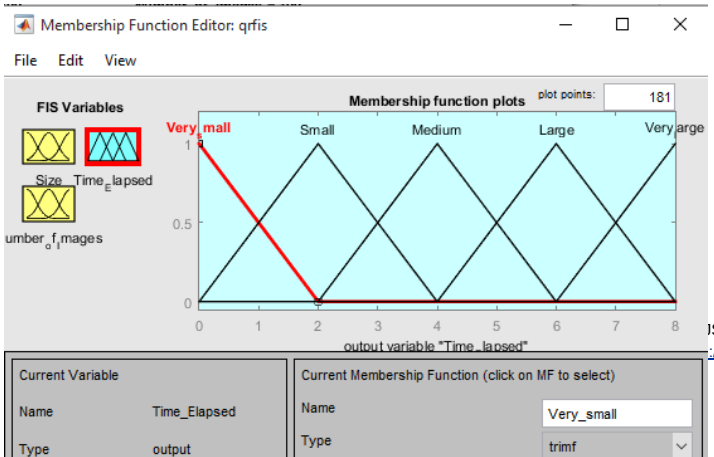


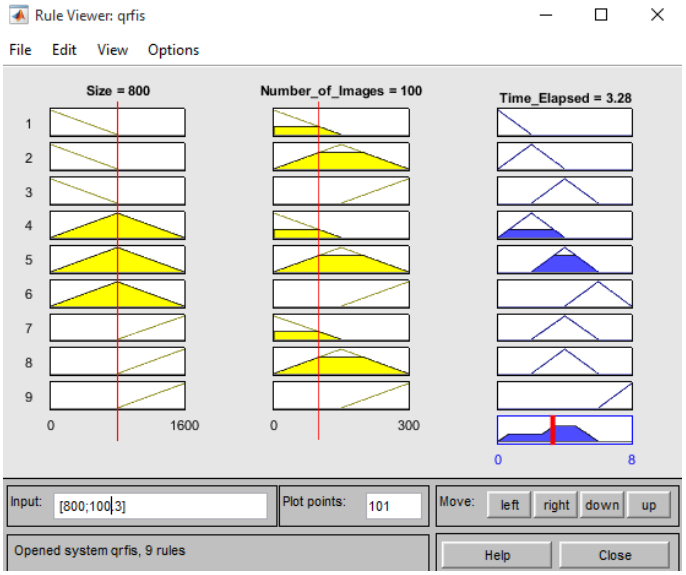
Figure 10: Rule view diagram

Size of image: 800 bytes.
Number of images: 100
Total time taken for insertion and retrieval of QR Code images: 3.28 seconds

8. Conclusion

The QR Code Image is generated from an encrypted alpha-numeric string is inserted in to database by using the

FIS(Fuzzy Inference System).We have been able to obtain the time elapsed based on the inputs.The output obtained can be used as benchmark for designing an efficient system which



can generate maximum no of images in affordable time.

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