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Mobility of SCADA System in Enrolment with Fuzzy Logic Technology

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Abstract:

Supervisory control and data acquisition (SCADA) system are used in industries to monitor the machines' performances. The machine produced many data that fed into the computer for processing. From the data given, the controller or operator will know the performance of the machines. In this research, the use of SCADA is proposed to monitor the enrolment process in an institution. The proposed SCADA system is a mobile SCADA where an app is designed to monitor the number of candidates enrolled, dropped the programmes enrolled and reasons of dropping the programmes enrolled. All the detail of enrolment data is fed from the front-line operators and the data is interface to the management's mobile terminal via the Internet connection. The paper provides the design of the system using Fuzzy Logic (FL) technology and the app design. The results will show how the Fuzzy Logic (FL) plays an important role to manage and control the data of the enrolment.

Keywords: Mobility of SCADA, Fuzzy Logic, Enrolment data, app, Internet Connection.

1-Introduction

Many SCADA systems nowadays is stationary and not in mobile state. Most of them provide data acquisition interface from the hardware to the computers. There is a computer room or controller room that installed with many computers and servers. All these computers provide the function of displaying the data, monitoring the hardware performance in the fields and perform an action to alert the operator when fault happen or some computer automatic control the hardware to recover the fault in the system. Although, stationary SCADA can provides many information related to the hardware performances, but some information could be not significant. In this case, the SCADA computer systems can be reduced in terms of their functionality and make it as simple as it so that the whole SCADA system can be shows in a small app function. Using app is very convenient and allows user to have have quick checks the system

and quick obtained the important information from the network. Due to the SCADA is presented in the smart phone, so it promotes mobility. Hence, the term "Mobile SCADA" exists [1].

The SCADA fetching the data from the hardware and send the data for processing via the data acquisition. The fetching and processing data are the two important functions in the SCADA system. The designers can choose to use differences techniques to process and fetch data. The most commonly used technique is the digital processing technique via the controllers in the networks[10]. A communication networks is the basic circuits build up to fetch the data and process the data in the SCADA system. A more advance technique perhaps is using the FL that installed upfront of the SCADA to process the data or in the controller to process the data. FL basically performs the logic function that enable the data to be collected more precise by eliminating the unwanted data presents in the network. This is needed because many digital network process the data without care on the type of data fetching and ending up with errors presented in the data. In some systems, filter is installed to automatically filter the data before enter into the controller for further processing. The filter usually is a hardware and only suitable to filter out electronic signals where it contents the noises [2].

For the enrolment data, it is not generated by the hardware of a machine or not produced by the sensor. Therefore, it cannot be filter out using the electronic filter. The enrolment data is collected manually from the human who keyed in the data into the upfront computers for record. The enrolment data is the students' information related to whether they confirmed to study the programme or they do not want to study the programme. To justify the students who confirm enroll the programme, special marking should be given for the confirmed data. For students who under keep in view (not confirm to enroll), special marking also must be given to the data so that it enables the system to identify. Also, the marking of the data should be given for those students who make half consideration to enroll. With all these data already marked, the FL can be implemented to identify the data accurately whether the students want to enroll or not to enroll the course or programme. The FL suggested to be implemented in the computer before they the information send over an internet network and display in the management mobile terminal [3].

2-Related works

Benmessaoud, Tahar, et al. "Fuzzy logic applied to SCADA systems." Publishing, 2018. mentioned in This article Mobility of SCADA System in Enrolment with Fuzzy Logic TechnologyThis article delves into the real-time monitoring of a wind farm utilizing big data gathered through the Supervisory Control and Data Acquisition (SCADA) system. The SCADA system plays a pivotal role in facilitating informed decision-making regarding the type of maintenance required. By analyzing the collected data, the system generates alarms, which, if inaccurately triggered, may lead to unwarranted interventions by the maintenance team, resulting in production losses and increased costs.To enhance the efficacy of wind farm maintenance management, we present a novel approach employing Fuzzy Logic for alarm identification based on SCADA system data. The alarms identified through this method fall into two distinct categories: orange alarms, indicative of faults necessitating preventive maintenance, and red alarms, signaling critical states that pose a potential risk of system failures. This innovative approach aims to reduce false alarms, thereby contributing to a more effective and cost-efficient wind farm maintenance strategy [8].

Harbi, Jasim A. "Application of SCADA System by Using (Fuzzy Logic Controller) on the Cathodic Protection System for Oil Pipelines." Publishing, 2021. mentioned inThis article is devoted to designing and implementing a Supervisory Control and Data Acquisition system (SCADA) for monitoring and

managing the corrosion of an underground pipeline. A microcontroller, equipped with various sensors and a communication system, is employed to oversee and control the impressed current cathodic protection (ICCP) process for the pipeline. The hardware combination is developed using LabVIEW and a personal computer (PC) interface, resulting in a comprehensive "SCADA" system that incorporates two control methods: a Fuzzy Logic Controller (FLC) for closed-loop operation and a conventional approach for an open-loop system. In evaluating these methods under a temperature of 30°C, a comparative analysis is conducted in both low soil moisture (50%) and high soil moisture (80%) conditions. Parameters such as potential between the pipeline and anode, current, and power are measured. A notable finding is a 39.7% decrease in power consumption when transitioning from low to high soil moisture levels. The study concludes that the closed-loop approach using FLC demonstrates superior performance and efficiency in power consumption [9].

2-Methodology

- General Idea of the System design

The proposed mobile SCADA system to monitor the enrolment process can be seen as shown in Fig. 1. Note that the FL is an algorithm that written in programming form. The proposed programming language to design FL is the C# (C Sharp). The C# is chosen because it can show the graphics and presents the GUI so that user can see how the FL accurately interpret the correct enrolment data from the big data pool given at the upfront of the computer [4].

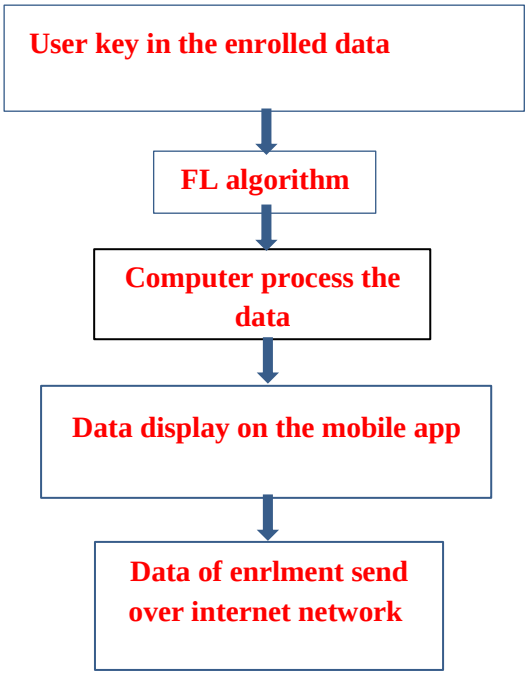

Fig. 1. General idea of the mobile SCADA system

Once the FL algorithm interpret the data, the data is then send over an internet network. At the mobile terminal, the app designed will fetch the data from the network and display it.

- Fuzzy Logic Algorithm Design to Interpret the Enrolment data.

The overall idea behind the FL algorithm to process the enrolment data is shown in Fig. 2 [5]:

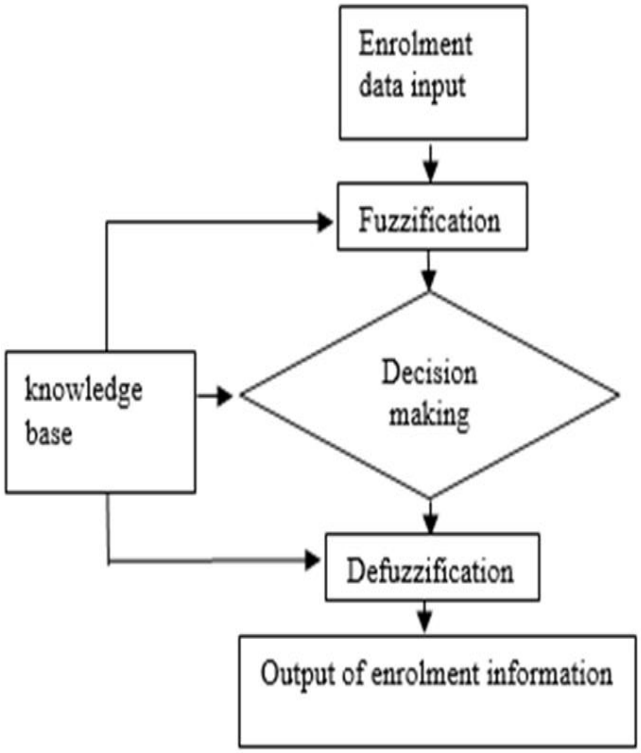

Fig. 2. The algorithm of FL applied to process the enrolment data

The important point is, given the enrolment data that have two three types: (a) confirmed enroll because the candidates have paid the deposit (b) Not confirmed enroll because they don't pay deposit and not giving any information to follow up (c) 50% confirmed enroll because because multiple times of visited, repeated asking the questions and giving detail to follow up. From the information, it is seen that there are three types of data given. The given data set at the input for Fuzzification can be illustrated in Fig. 3.

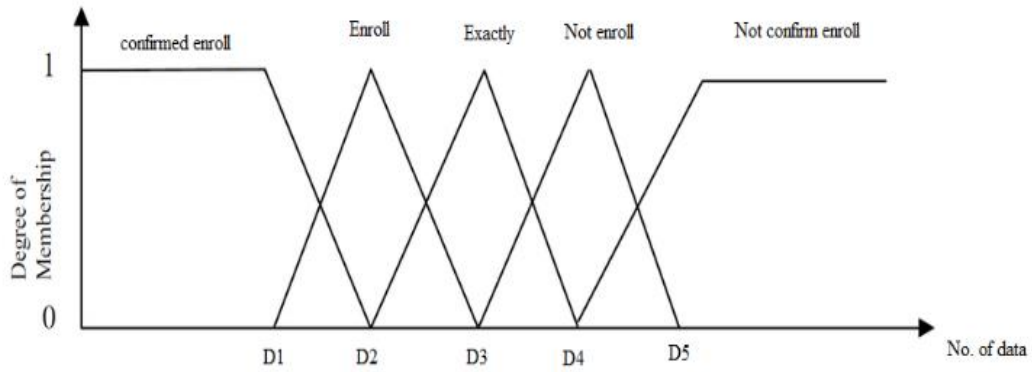

Fig.3 . The enrolment data for Fuzzification

As mentioned before, the operators that keyed in the enrolment data has to mark the data type of Fuzzification. The accuracy of defuzzification will depend on the input data and the decision making process. The rules applied at the decision making process and the defuzzification can be seen as illustrated in Fig. 4 [6].

Let x = 50% data that confirmed enrolled
y = confirmed enrolled
z = not confirm enrolled

Set: IF x = $C_{50\%}$ THEN out = D
IF y = $C_{100\%}$ THEN out = E
IF z = $C_{0\%}$ THEN out = F

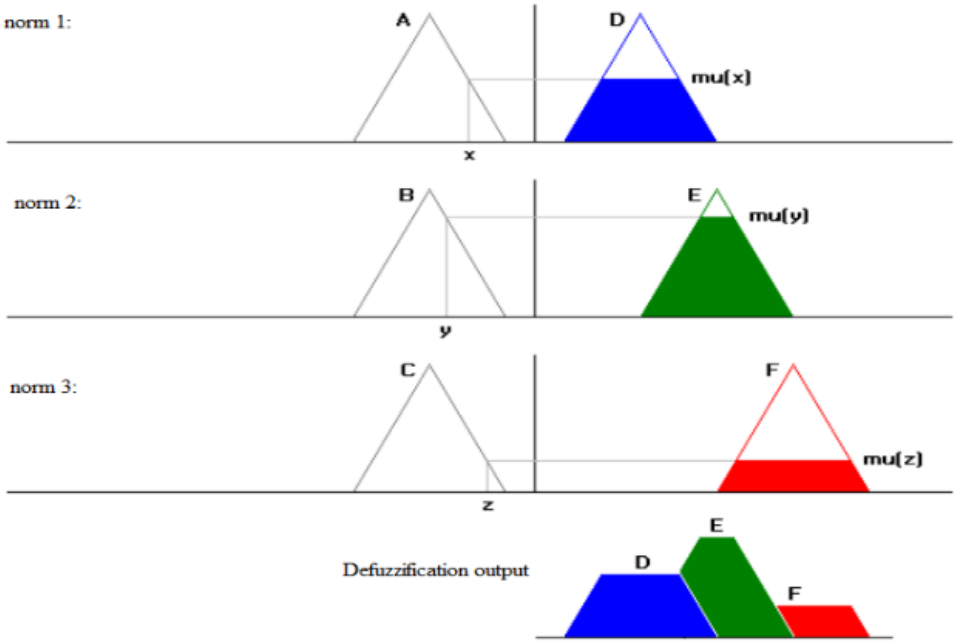

Fig.4. The defuzzification process

- Proposed App Design at Mobile Terminal

The app designed is called mobile SCADA app which specifically used to monitor the enrolment process. The design of the app is very simple and can be seen in Fig. 5. As seen in Fig. 5, the most important information has been displayed at the front page of the app. This is a quick report on the enrolment summary. Actually, the designer can choose their own design the interface. Fig. 5 just gives an idea on overall background design of the interface. The key of process still relies on the fuzzy logic process.

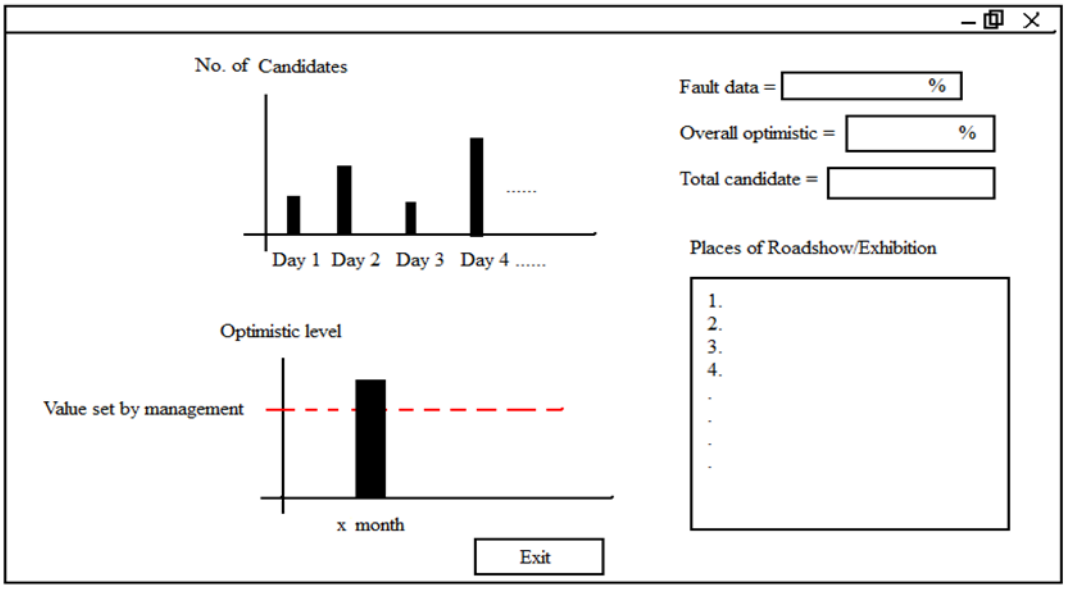

Fig. 5. The interface design to show the enrolment summary in the mobile terminal

RESULTS

Using the FL can accurately determine the correct enrolment results and show the optimistic results. Below are the results experimentally tested for April and August 2022 enrolment for the engineering programme.

TABLE I. TESTED OPTIMISTIC RESULTS BY FL IN COMPARISON WITH MANUAL CALCULATION

Month of Enrolment	Optimistic results for manual calculation in percentage	Optimistic results computed by FL in percentage
April 2022	80.23	81
August 2022	51.22	51.35

The "Month of Enrolment" refers to the specific month in which individuals or entities enroll in a program, service, or system. In this context, two sets of results are provided: "Optimistic results for manual calculation in percentage" and "Optimistic results computed by FL in percentage."

For April 2022:

- Manual Calculation: The optimistic results obtained through manual calculation for this month are 80.23%.
- Fuzzy Logic Computation: When Fuzzy Logic (FL) is employed for computation, the optimistic results for April 2022 are slightly higher at 81%.

For August 2022:

- Manual Calculation: The optimistic results achieved through manual calculation for this month amount to 51.22%.
- Fuzzy Logic Computation: Utilizing Fuzzy Logic, the computed optimistic results for August 2022 are slightly elevated at 51.35%.

These values represent the optimistic outcomes expressed as percentages for the respective months. The comparison between manual calculation and Fuzzy Logic computation suggests a nuanced difference in the results, with FL showing a slight improvement over manual calculations for both April 2022 and August 2022. This indicates the potential effectiveness of Fuzzy Logic in generating more optimistic outcomes in these scenarios.

4. CONCLUSION

SCADA concept, as presented, has broader applicability beyond its current focus and extends to various fields, not limited to the specific application under consideration. In the realm of Engineering, particularly within the power system network, this concept finds additional relevance. Traditionally, power system SCADA systems are stationary, relying solely on sensors installed within the network to detect faults and transmit essential signals. The innovative approach of introducing mobility to the SCADA system, as explored in this paper, breaks away from this conventional model. By incorporating mobile terminals and leveraging Fuzzy Logic, the system gains adaptability and accessibility, potentially transforming the way data is collected, monitored, and responded to within power system networks. This dynamic shift toward mobile SCADA holds promise for enhancing efficiency, responsiveness, and overall functionality in comparison to the static and sensor-dependent nature of current power system SCADA setups.

Mobile SCADA system presented in this paper is used for testing purposes and still under research. The main idea is to promote the concept of using FL in the interface with mobility of terminal. The concept of the mobile SCADA can also applied to other fields not only limited to this application. Perhaps in Engineering, it has more application and, especially when it is applied to the power system network. This is because the current power system SCADA system is stationary and depend solely on the sensors installed in the network to detect the fault and signals that are necessary to be shown in the computer room of SCADA.

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