DEVELOPMENT OF AN INTELLIGENT AQUACULTURE CONTROL SYSTEM FOR FISH FARM

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Abstract
Fish farming has become an important practise worldwide and it has been existence for many years. The growing and cultivation of fish which is an important branch of agriculture has served as a source of protein, vitamin and oil for mankind. Manual method of feeding at any choice of time and inadequate water level monitoring device has been identified to be a limitation affecting the survival of fish in the pond. To this extend, there is a need to constantly monitor water level in the pond due to the fact that water can be lost as a result of seepage and inadequate watershed area which also interferes with fish movement to see and capture prey. In this research, an intelligent aquaculture control system using a fuzzy logic approach has been developed. The developed system is capable of providing feed to fishes at a selected time interval and also detecting and maintaining the level of water in the fish pond by pumping water if the need arises. The overall system performance was achieved base on system response from generated rules of the fuzzy logic system. This research can further be improved by using the internet and data transmission system for further analysis and remote monitoring of the fish pond.

Keywords: *Feed, Water, Pond, Fuzzy Logic, Membership Function*.

Introduction
World fisheries have grown dramatically in over 50 years. From production of few million tonnes within the early fifties, fisheries manufacturing in 2006 was cited to have risen to 143.6 million tonnes. This clearly indicates that fisheries sector continues to grow more rapidly than any other livestock growing activities. Demand for fish products continues to increase to meet the needs of consumers, reflecting recognition of the dietary benefits of fish in both developed and developing countries. The oceans of the world have a finite supply of environmental produce which assist human activities and needs. (Alagappan & Kumaran, 2013).

Aquaculture practice in terms of fish farming plays a first rate role in agricultural activities. In Nigeria, the technique of cultivating fish varies from using natural habitat to an artificial method which might also perhaps result to increase in studies for various existing situation that can enhance the high-quality of fish productiveness (solomon, 2010). The quality of fish production also depends on the availability of water, space and nature of fish pond in use as shown Fiure 1.1 (Nene & Aduabobo, 2015).

Figure 1.1: Nature of pond (Nene & Aduabobo, 2015)

However, the production of fish in Nigeria has been below intake with imports accounting for about 48.8 million united national statistics in 2012. Fish farming has also been recognized as a relevant way of growing domestic fish due to the fact that the delivery of fish from lagoons and open waters continue to decline. currently, the assistance from the Nigerian government towards fish production is increasing as a result of provision training and incentives to fish famers (Egware,2013).

One of the existing habitat for fish is water and it quality is one of the most vital circumstance that is commonly underneath investigation in fish pond management. The water in fish pound always measure the the important parameter that ought to be available for the aquatic organisms. The issue of water for aquaculture management normally accommodates the existence of chemical and organic factors which have to be definitely display to keep away from pollution (keremah *et al*, 2012). The position of water high-quality cannot be left out in achieving healthful management of fish pond because of the reality that aquaculture organism always relies upon physical and chemical traits of water (Adebola, *et al* 2015).

The request for fish is also increasing which implies more cultivation to meet such demand. The use of synthetic fish has resulted within the concentration of organic depend, nutrient and different strength within the fish pond that has an effect on sun penetration and oxygen availability inside the fish pond (Amakwaah *et al*, 2014). The need for decision making is in fish pond management is of paramount importance. Today, farmers, managers and planners usually undergo a decision making process for most of the emerging factors in in the fish pond. Some of those factors ranges from the time to manually feed the fish and also, when to increase the water in the fish pond incase of any drop of volume which is usually time consuming. To this extent, the need for decision support system will help in the area of water monitoring, feed as well as mechanical aeration (Moataz & Mohammed, 2013).

Methodology

The overall system comprises of a microcontroller from the arduino mega 2560 as shown in Figure 2.1 in which the fuzzy logic sytem communicate with to provide necessary rules that determine the request for action base on the condition in the fish pond. The circuit consists of sensor that determine the level of the water in the pond. The request of pumping water into the pond is performed by an electric pump and the supply of feed to the fish pond depend on three set up condition from the membership function (morning, afternoon and evening) which is carry out through the solenoid valve and display on the Liquid Crystal Display (LCD).

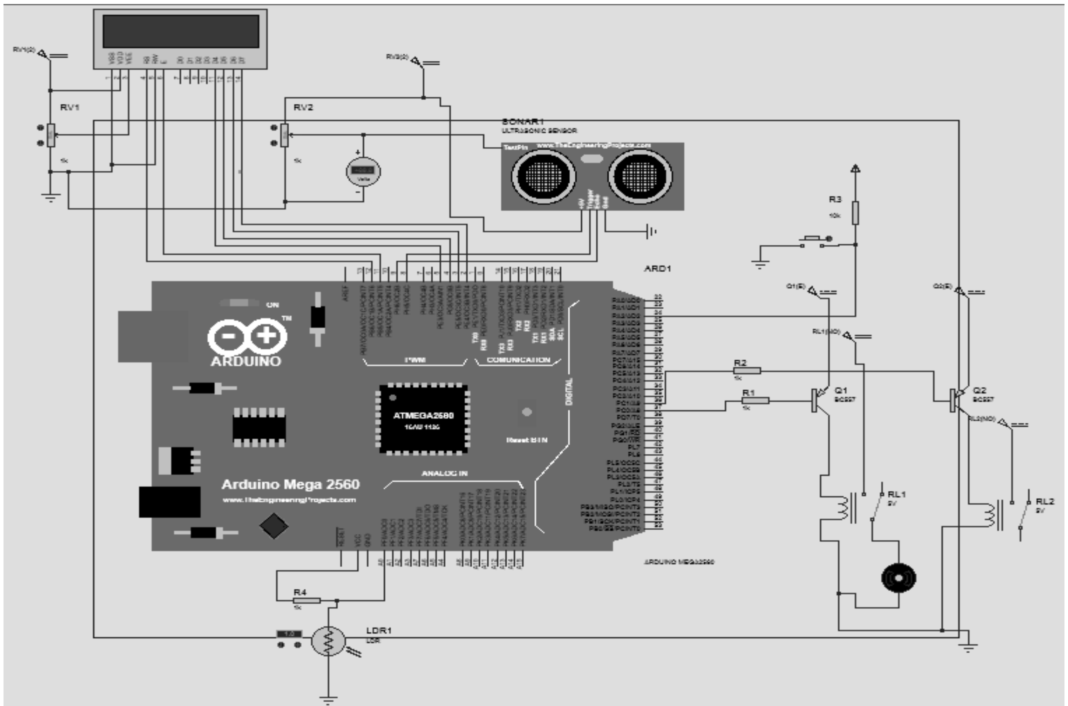

Figure 2.1: Developed circuit diagram for the system control unit

The implementation of the fuzzy logic system is carried out using MATLAB in order to control the feeding of the feed and to determine the quality of the water in the pond. Mamdani type of fuzzy logic is used for the development of the intelligent system and likewise the generation of the membership function. The experimental setup that include the physical hardware is shown in Figure 2.2.

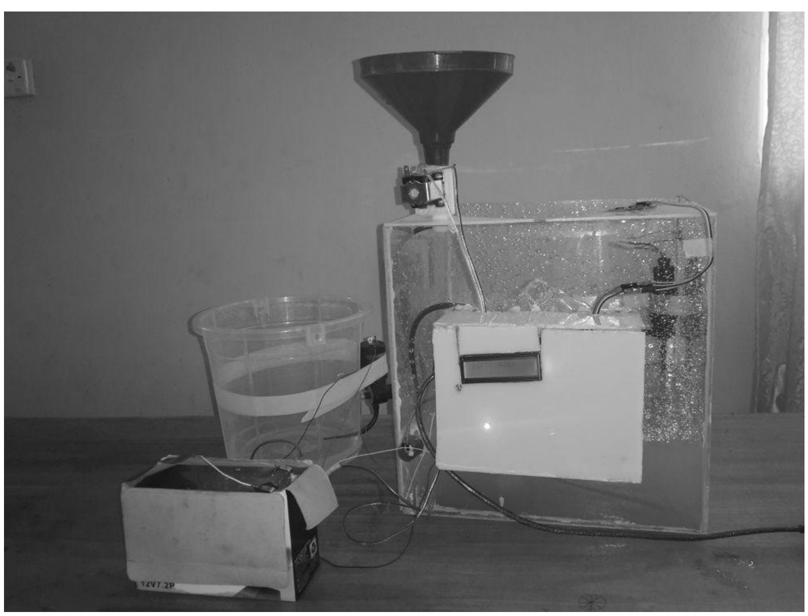

Figure 2.2: Experimental set-up

Two input variables are used for development of the Fuzzy Inference System as shown in Figure 2.3. The triangular membership function is use to develop the input membership function for Feed time and Water as showed in Figure 2.4 and Figure 2.5, respectively.

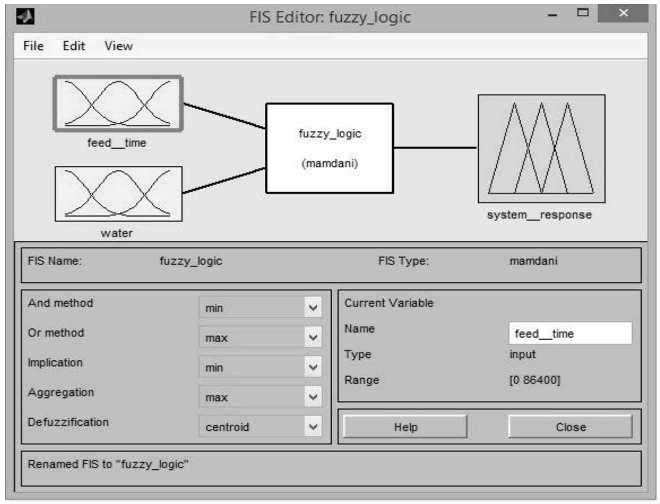

Figure 2.3: Two Input Fuzzy Inference System

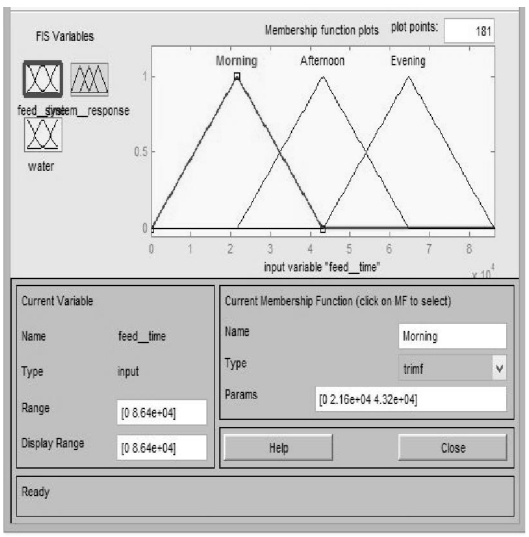

Figure 2.4: Feed Time Membership function

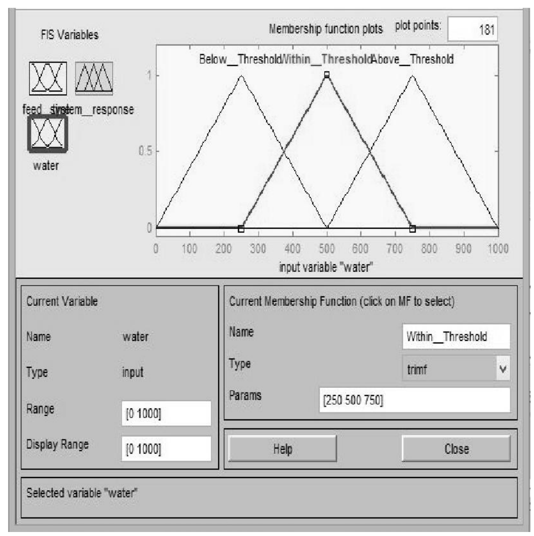

Figure 2.5: Water Membership Function

The feed control parameters are the selection of time variation for morning, afternoon and evening while for the water level control parameters includes below, within and above the threshold of water level marks. The output membership function in Figure 2.6 shows the behaviour of the system being dependent on the different input variables. The three-triangular point comprises of Redundant position in which no action is taking by the system, Dispensing feed and Pumping water which requires an action to be taken depending on the condition of the pond at a particular point of time. The fuzzy rules determine the overall operation of the system which comprises of the IF THEN rules as shown in Figure 2.7 with a total number of nine rules. The criteria that was follow in formulating the rules was based on Mamdani fuzzy inference system and the rules justification depends on responds of feed time and water level condition of the fuzzy logic rule viewer.

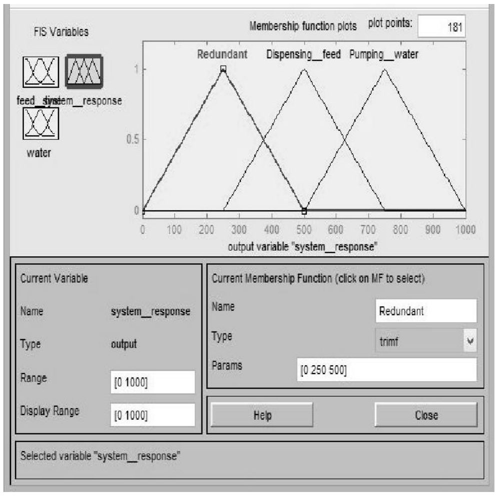

Figure 2.6: Output Membership Function

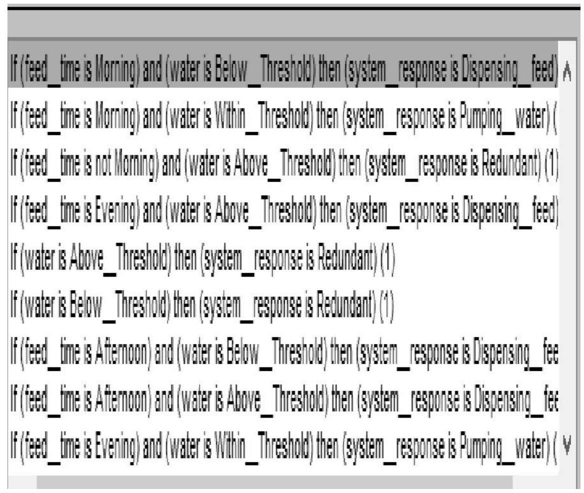

Figure 2.7: Intelligent System Rule Editor

Results and Discussion

The behavior of the system is given in Figure 3.1 and Figure 3.2 respectively. The system relationship with redundant position in which no action is taken, Rule 7 and Rule 9 are activated which implies that condition at the fish pond for both water level and feed is normal. Rule 3, Rule 7 and Rule 8 are activated with a systematic response of request at feed time.

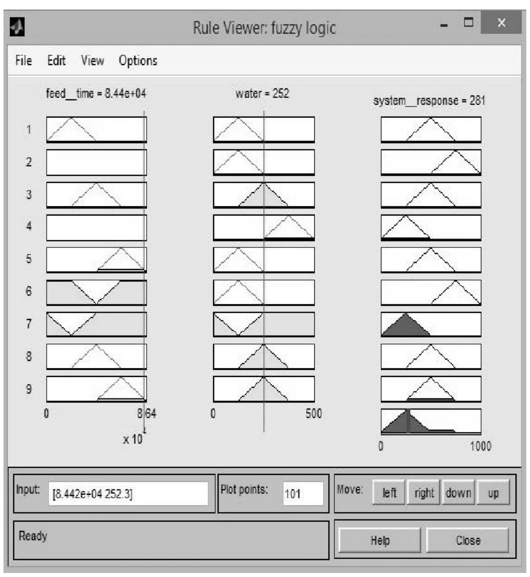

Figure 3.1: Rule viewer for Redundant

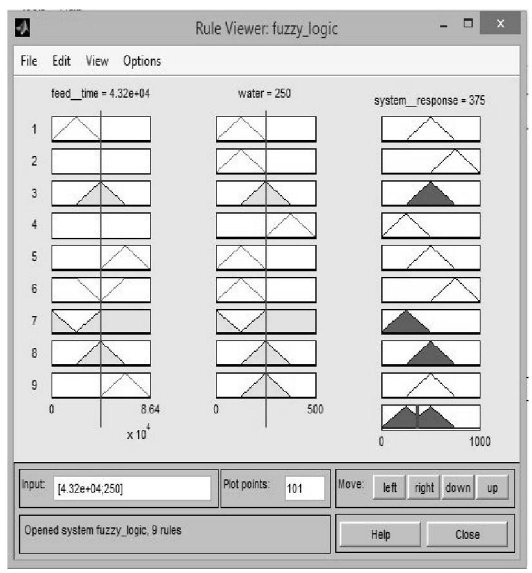

Figure 3.2: Rule viewer for feed time

The 2-D relationship originating from the rule viewer as a result of the system response is shown in Figure 3.3 and Figure 3.4 respectively. The response serves as an indication of single input with respect to output relationship.

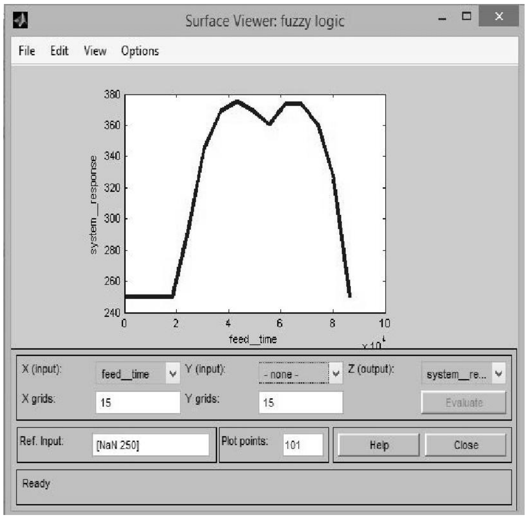

Figure 3.3: 2-D Surface viewer of feed time

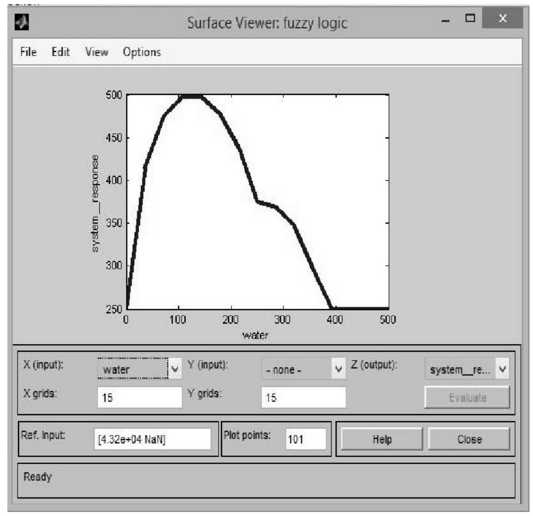

Figure 3.4: 2-D Surface viewer of water

Transition from one surface to another is dependent on the type of membership function been implemented that is the triangular membership function. The overlapping of the membership function determines the distance between each surface. However, the number of surfaces is dependent on the number of rules generated. The X-axis represents feed time, Y-axis represents the water and Z-axis represents the output. Different instances of input variables can be used to predict the response of the system as showed in Figure 3.5.

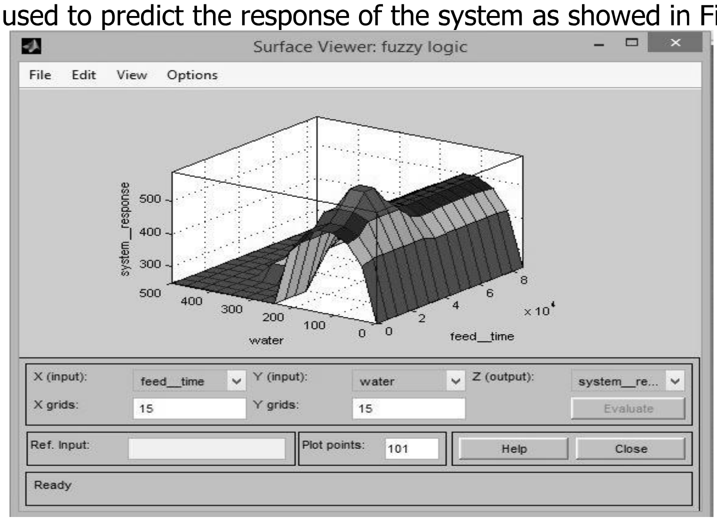

Figure 3.5: 3-D Surface viewer of two input

The Surface viewer from Figure 3.3, Figure 3.4 and Figure 3.5 shows both 2D and 3D relationship of one and two input parameters with respect to time and output which implies different system behaviour base on certain input parameters of IF THEN rules of the developed triangular membership function.

Conclusion

The intelligent system has been developed and designed using Fuzzy logic. The water level detection unit was developed using a sensor, dc pump and a storage tank. The feed dispensing aspect of the system was accomplished using a solenoid valve, relays, and the feed container to hold the feed ready for dispensing. The control system controls the water level and fish feeding successfully by responding to different input conditions with respect to the rule viewer. The control system which the tendency to remedy the challenges of high involvement of human attempt and stress in preserving fish farm using fuzzy rules.

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