Design Model of Subak Smart Irrigation

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Abstract– Water has many benefits for human life. One of the benefits lies on the agricultural sector. However, as the water source is decreasing, the needs of water for agricultural sector is increasing. Subak is therefore one of the solutions in agricultural field. Meanwhile, the existence of subak also rises some problems. In terms of water source management, subak can be very effective. Unfortunately, subak is not that efficient in the water use. Smart irrigation with fuzzy logic used becomes a solution which has been offered to manage the water use based on the needs the paddy. This system uses solar panel and battery. In addition, it is completed by the weather censor and humidity. This system works during rice planting period. The findings show that the water irrigation on subak rice field becomes more effective, efficient and optimizing the harvest.

Key Words– Subak, irrigation water management, fuzzy logic a

I. INTRODUCTION

Water is an essential component for the life of the plants, animals and humans. For the plans, water serves as a constituent body, raw materials photosynthesis, and gives to the plant cell turgor[1]. On the other hands, for the animals and human beings, water that becomes the body constructor, it also has functions to maintain the metabolism, the body temperature and it can help food digestion. In addition water is also one of the most important factors as the secondary needs for human, such as: bathing, washing cooking, and others. Almost all of the human beings need water.

The condition of water resources are getting more limited and suffered. It is as the result of climate change and the presence of environmental degradation cause water nelife of livineds will be difficult to be met. This condition will cause the imbalance between the needs and availability of water. According to the UN Water ”From Vision to Action” water needs on 2025 will increase, this will be a challenge for poor countries including Indonesia[2].

To solve this problem, water management is good in all sectors. One of the sectors that need to use water efficiently is the agricultural sector. This sector needs water as advocates of the growth of plants. According to the World Wildlife Foundation, this time around the world using 2.500 trillion liters of clean water every year to water plants. Unfortunately, estimated as much as 60\% are wasted because the irrigation systems that are less efficient [3]. Resolving the problem of the lack of water to increase their productivity and efficiency the use of irrigation water required the implementation of irrigation management technology that effective and efficient.

Various regions in Indonesia already has groups of farmer who is working to set up water distribution on rice field. In Bali, coordinating groups and settings system use of irrigation water is known with the pronunciation of the *subak*. In Law *Subak* has the meaning of a society of customary law that has characteristic sosioagraris-religious, which is the assembly of the farmers who man-age irrigation water in the rice fields[4]. *Subak* is a traditional organization that is able to manage irrigation water from empelan is a building with the taking of water from the river was built by non-governmental organizations in *subak*[5]. While on the rice fields grid incoming water will be managed using tembuku. In his role as a farmer *subak* organization apply "*Tri Hita Karana*" concept[6]. "*Tri Hita Karana*" concept is three causes the creation of happiness and prosperity. This concept is divided into three parts namely : (1) *Parahyangan* : harmonious relationship between man and God. The implementation of this concept is seen in the ceremonies of that done by the citizens of *subak*, like *Nanggluk Merena*. (2) *Pawongan* : a harmonious relationship between man and man. The implementation of this section we can see directly from the activity of mutual cooperation done *subak* citizens in the building and improve the channel irrigation water. (3) *Palemahan* : a harmonious relationship between man and nature and the environment. An example of its application is a division of water evenly so that the availability of water in the eyes of the water is still there. Benefits of the *subak* namely as an irrigation system that is capable of dividing the water evenly for its members. *Subak* water distribution system is a very effective, but from modern glass may not efficient [7].

In this study, researchers offers irrigation management technology solution by applying artificial intelligence. Fuzzy Logic is an artificial intelligence to draw a decision from a vague data (fuzzy) [8]. This method will set the tap water based on age inputs, the temperature and humidity around the plants.

II. RELATED RESEARCHES

A. Design System a Handler Water Gate Automatically Using Fuzzy Logic based on the height of the surface of the river and Radio Frequency Communication

Automatic door control system simple who are able to regulate the width of the opening of the water gate based on the level of the water. The level of the water is measured using the ultrasonic sensor. The results of the calculation of this sensor will then read by microcontroller Atmega128 to do calculation process swing level from the entrance of the water by using the fuzzy logic method. Fuzzy Logic process set up from the entrance to the opening of the water based on the results of read from the sensor and some parameters that can be specified to suit your needs. Suppose that when the water level in a region are high, then the door of the main water can be arranged to close to securing the water intakes and water waste door wide open to be able to throw the water again water level back in accordance with the needs. On this last task will be made prototype modestly only using 3 fruit motor servo assist depends on road as a prime mover and diorama simple made from arcliric. By using the automatic door on the water level, it is surely more efficient because it works in an exact time based on the water level. Besides, it is also added with the way of communicating through wireless so that the water level and the level of the water door will be easily checked. The automatic door can minimize the unexpected dangers. [8].

B. Decision Support for Smart Irrigation by Means of Wireless Distributed Sensors

The pervasiveness property of wireless sensor network technology makes it suitable to collect heterogeneous sensor data in the application field of precision agriculture. On the basis of the collected data, smart and adaptive irrigation strategies have been proposed to estimate the optimal water quantity needed by cultures. This paper is aimed at presenting a wireless system architecture for smart irrigation, which adaptively evaluates the irrigation time according to the environmental conditions. A selected set of experimental results are presented to show the potentialities of the system to adaptive control the irrigation procedure toward water saving and product quality optimization [9].

C. A Fuzzy Approach For Water Security In Irrigation System Using Wireless Sensor Network

Water is one of the most important elements on earth, if there will no water there will be no life. It is inevitable to conserve and save water for future security and sustainability. Several technological approaches have been formulated in past but depicted substantial mark. During last decade concept of Fuzzy logic was introduced with implication towards water conservation; being wasted in manual irrigation. Fuzzy based intelligent irrigation control system could recover water deficiency using wireless sensors. This system access the moisture level of soil and temperature of surrounding area with the help of wireless sensors controlling the sprinkler to irrigate the field within the requirement. To control the irrigation system efficiently this system consists of soil moisture, temperature sensors, and an intelligent controller using fuzzy logic approach for irrigation. Mamdani type Fuzzy Inference System is used to design fuzzy controller in MATLAB and then run its simulation to check the characteristic of the system when inputs vary. This new irrigation system which is based on the combination of WSN with fuzzy logic has many advantages over a traditional irrigation system with binary control said system holds tendency to help in better improving agricultural productivity delimiting water utilization. State should make sure accessibility of such technologies to small farmer that represent major population of farming community not only for empowerment and facilitation of small farmer but also for the development and prosperity of the country [10].

III. DISCUSSION

Subak for centuries have been able to provide the water supply needed by the members of its members. *Tembuku subak* citizens use to divide the water into the harvesting of rice field. *Tembuku* used to irrigate parcels of rice field varies according to the area of harvesting the rice fields are. To construct the rice fields of the size of 25 acres used *tembuku* with the width of 2 fingers adults or 5 cm. While the ricegrid has the size of the 50 acres will be used *tembuku* with the width of 4 fingers adults or around 10 cm. *Subak* citizens apply 2 times crops, namely at the time of the rainy season apply *kertamasa* planting time (time rice planting as much as 2 times and the plant crops 1 times) and at the time of the drought (water) apply the crops *meabian* (grow crops). The system that is offered today is a system that is used at the time of the crops *kertamasa*. The use of water in the tiny parcels of rice fields are not adjusted with water needs for rice. Water distribution using tembuku will allow farmers to get the harvest is not optimal because the water needs of plants is not in accordance with their needs. Rice plants need water that volume is different for each phase of growth. Variation of the needs of water depends on the rice variety. Excess water is touched to the gridlines paddy fields will be removed or to be transmitted to the flow of the *subak*. The flowing water will pass through a long journey to get to the other fields. In the journey of this water will experience evaporation or evaporation of water. So that the reduction of the volume of water from the water that is removed with the water until in other fields.

The method is offered on this research is setting the volume of water in accordance with the needs of the rice plants using fuzzy method. Fuzzy Logic is a branch of the science of artificial than mothers, namely a knowledge that makes your computer can imitate human intelligence with the concept of the truth of some. Now the steps are is the fuzzification, evaluation, and defuzzification rules. Water Needs on plants adapted to

the age of the temperature and humidity of the rice. The planting time Bali rice plants are as follows in table 1:

TABLE 1 Paddy Planting Season

Season	Time(day)
Tillage	-
Breeding - Start planting	20
Flowering	85
Establishment of Seed	35

From the breeding time until the establishment of the seed Balinese paddy needs approximately 4 months. On the paddy planting time, it is suggested to use the better temperature in order to get the good result. Table 2 below shows the temperature used based the paddy planting time [12].

TABLE 2 Ideal Temperature For Paddy Plants

Season	Recommended Temperature
Breeding - Start planting	11º - 25º
Flowering	20º – 25º
Establishment of Seed	25º – 32º

On the sprout time it needs very high temperature in order to be able to absorb the mineral to the soil quicker. So that the quantity of water that is needed by paddy plants will be reduced. However, the humidity on paddy is supposed to below. When the humidity of surrounding paddy plants low, the evapotranspiration is increasing, If the humidity is high the evapotranspiration is reduced. Evapotranspiration is the level of absorb time of Hara by the plants. Both variable mentioned above such as temperature and humidity will be used as the components in Artificial Intelligent. In fuzzy logic algorithm variable used will be made category table as table 3 below.

TABLE 3 Temperature Category

Temperature	Category
11º - 25º	Low
20º – 25º	Moderate
25º – 32º	High

Table 4 below shows the humidity category.

TABLE 4 Humadity Category

Humadity	Category
<25%	Very Low
25% - 35%	Low
35% - 45%	Moderate
45% - 55%	High
>65%	Very High

Based on the variable above, the researcher decides the output from fuzzy logic that is how long the flip of the tap will be opened to water the rice field. The fuzzy output will be described in table 5.

TABLE 5 Fuzzy Output

Output	Category
T	Water valve does not open
P	Valves open for 30 minutes
M	Valves open for 1 hour
L	Valves open for 2 hours

Based on the interview done by the researcher about the criteria of temperature and humidity in order to make the ideal growth of paddy plants, it will described in three different fuzzy rules tables. Table 6 describes fuzzy rules on the seedlings until it becomes sprout. (It is interviewed by the expert). Table 7 shows the rules of fuzzy on the flowering period. Table 8 explains the rules of fuzzy on the seed establishment period.

TABLE 6 Fuzzy Rules The Seedlings Until Sprouts

Humadity/Temperature	Low	Moderate	High
Very Low	P	P	M
Low	P	M	M
Moderate	M	M	L
High	L	M	L
Very High	L	L	L

TABLE 7 Fuzzy Rules Flowering Period

Humadity/Temperature	Low	Moderate	High
Very Low	T	P	P
Low	P	P	M
Moderate	L	M	L
High	M	L	L
Very High	P	L	L

TABLE 8 Fuzzy Rules Estabilishment Period

Humadity/Temperature	Low	Moderate	High
Very Low	T	T	T
Low	T	T	T
Moderate	T	T	T
High	T	T	P
Very High	T	P	P

The plan of smart irrigation system will be developed as figure 1 below. The censor will get the data from the environment or the rice field. The data can be in the form of the temperature and the humidity. The censor gets the data and then transfers it to the artificial intelligent system. The system will keep the data then do the processing. During the process, the system will decide how long the water tap will be opened to adopt the fuzzy logic method. After that the system will transfer the decision to the actuator (the water tap). The process will be done gradually until the end of the paddy planting period is over.

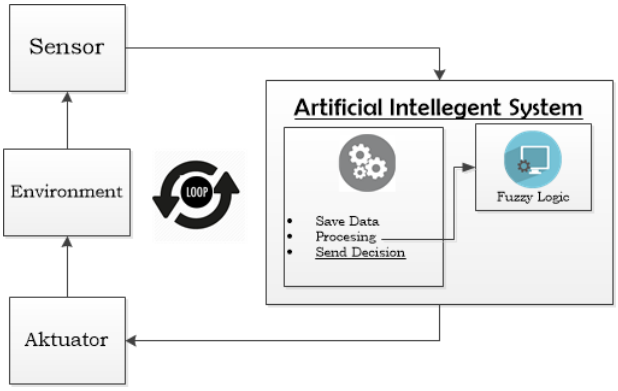

FIGURE 1 Design Smart Irrigation System

The construction of the building artificial intelligent system can be illustrated by the flow cart as figure 2 below. First, the data taken by the censor from the environment in the form of temperature and humidity. Then, the data used to be the components that will be processes on the system. Based on the rules of fuzzy as it is decided, the output result will be about how long the

water tap opened. After the instruction is working by the actuator, the system will check the condition of the censor and battery. If there is a problem with the censor or the battery, or it is possibly the censor and the battery do not work probably, the system will remind *Pekaseh* or *Kelihan subak* (the leader of *subak*).

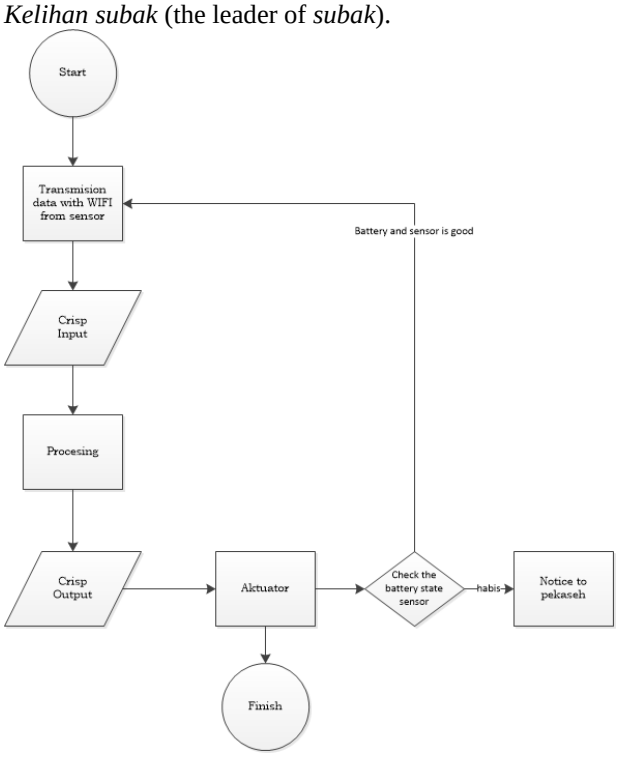

FIGURE 2 Flowchart Smart Irrigation System

After the planning system is ready, the hard materials used to implement the system such as raspberry pi, censor of humidity, sensor of temperature, GSM module, water tap, the water flip, clock module, battery and solar panel. The scheme can be seen in figure 3.

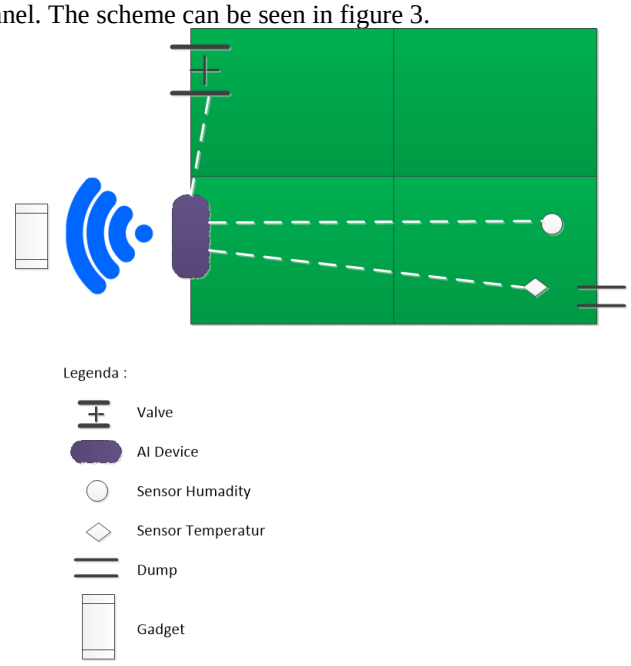

FIGURE 3 Hardware Design Scheme

IV. CONCLUSION

From the modern view, *Subak* irrigation system is very effective to manage. *Subak* has proved that it can be effectively used to differ the water to the members of *subak* equally. However, the use of water cannot be that efficient. On the paper a new method is introduced to manage the use of water on the *subak* rice field through fuzzy logic as the controller. The water needs on paddy plants used for this system is based on the age and the plants condition. Besides the system is completed by the feature warning which tells pekaseh about the condition on the field. This irrigation system is not only to use the water meaningfully but also to help the farmers to harvest the ideal paddy plants.

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