Implementation of Sensor Ph Meter, Ec Meter and Temperature on Smart Vertical Agriculture System.

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Abstract - In this study the area discussed is how to apply the sensor on the Smart Vertical Agricultural System. This system applies information technology on urban agriculture technique that utilizes water as planting medium. Application of technology is used to help human beings in controlling, maintaining the stability of the water content needed by plants in order to develop properly. Development of the Smart Vertical Agriculture System, will focus on hardware as a water stabilizer, as well as websites connected with the device, so that hydroponic owners will be able to monitor plant progress through the website. In this research we will build prototype of robotics device using arduino, raspberry pi 2, some sensors such as temperature sensor, nutrition sensor and Ph sensor, effector in the form of pump, water cooling device, and electric valve, data collection of plant knowledge for machine learning needs to make decisions, as well as centralized database mining to manage multiple devices. Keywords: Agent System, Smart Agriculture, Smart Vertical Agriculture, Hydroponics, Automation.

1. Introduction

Indonesia is an agrarian country with a tropical climate that allows many plants to grow well. One that can be well developed is a variety of vegetables, but this is inversely proportional to the amount of vegetable consumption in Indonesia, Healthcare Research and Development Agency (Balitbangkes) Ministry of Health 2014 and processed data in 2015. Indonesian society only consumes 91 grams (g) of vegetables per day per person. Whereas the number of standard sufficiency for healthy is to consume fruits and vegetables as much as 5 servings per day or a total of 91.25 kilograms / capita every year. From these data seen the presentation of other vegetables is still very low. One technique that can be developed to boost vegetable production is to include urban communities to increase vegetable productivity by applying urban agriculture through hydroponics techniques. In hydroponic systems, plants are planted without using soil. Plants receive all the essential nutrients from a nutrient-rich water-based solution. various hydroponic methods in which the plant can grow well in non-soil media as well as solution and water medium (fahey, 2012). Vegetable planting media with hydroponics technique is very possible to do anywhere because it does not land with the media that is difficult to meet in urban land, but the density of urban population activity and lack of knowledge in the world of farming makes urban communities reluctant to perform this activity. Seeing these problems then researchers try to find a solution with the implementation of Activity Theory by applying the agent system. systems that are autonomous and adaptive and are expected to be able to help the community to participate in increasing vegetable production with the concept of Smart Vertical Agriculture System.

In Activity theory, the agent can replace the subject where the agent will coordinate with the environment with the agent will not be able to do anything if not in the environment (zhang et al, 2005). Therefore, in some description of activity theory in this research is as follows Smart Vertical Agriculture System is a modern technology development on the vertical garden agriculture system where the control parameters on the plant is done by the sensor device and actuator to manage the treatment on the system, thus minimizing the human role so that it can reduce labor and work automation. In this system the application of agent system becomes the main points developed. seeing that agents need to adapt to uncertain environments with environmental changes requires agents to create agent-based simulations for decision-making under uncertainty (topcu, 2014).

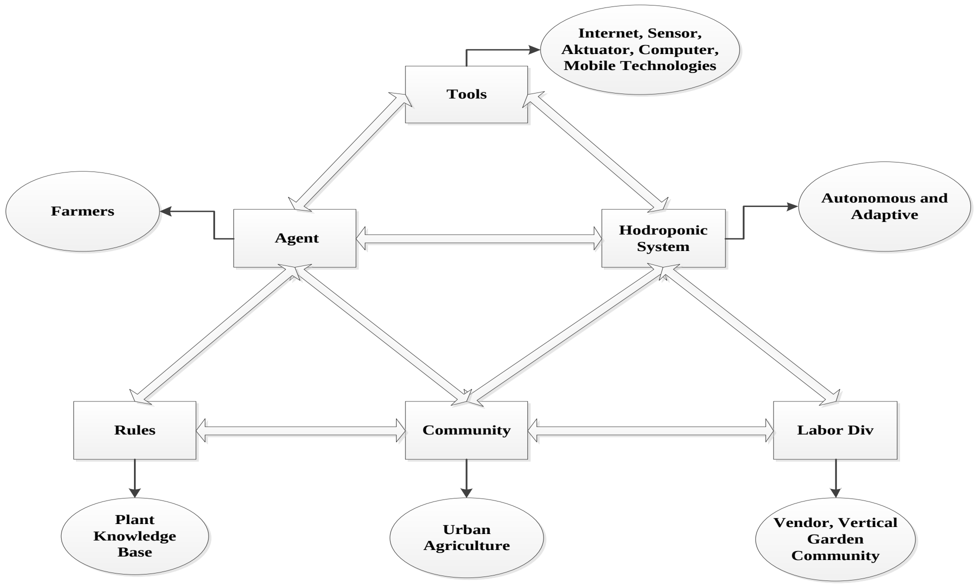

Figure 1. Activity Theory of Smart Vertical Agriculture System Agent

Why the agent system required the development of this system, the system will use sensors that identify the temperature, nutrients and ph levels in the water, send data to the data server in the form of the value of each get the sensor, the server will receive data that will likely vary, and the complexity will increase, as the hydroponic device is installed, in addition to centralized and increasingly large data, this is in accordance with the agent's application characteristics of increasing system complexity (Macal et al, 2010).

2. Agent System

In 1995 Russell gave understanding to an agent that started a new research trend in the realm of intelligent computing. "An agent that can see and receive its environment through the sensor and act on the environment through the effector. A human agent has eyes, ears, and other organs for sensors, and hands, feet, mouths, and other body parts for effector. A camera replacement robot agent and infrared device for sensor and various motors for effector. A software agent has encoded bit strings as perceptions and actions. "(Russel, 1995) With the concept of computer agents can act rationally, the computer is able to choose the best step by looking at the environment, the computer can adapt to the environment where it is located, receive input through various sensors, identify inputs, and provide the most appropriate decision with the data in the can. The next research is how autonomous agents and multi-agent systems can work better to produce more rational decisions and influenced by different environments, so that the agent system can adapt to the environment.

Research on adaptive agent developed by Ya'akov Gal and colleagues, that the ability of agents to negotiate with humans has been developed like bidders in online auctions , but the negoisasi that occurs only fixated on the static user, Gal tried applying systems to dynamic users, which have different cultural cultures, requiring agents that can adapt to the background of human culture, by applying the PURB-based agent (the Personality Utility Rule Based) with its components (Gal et al, 2010) recent research on one agent pioneered by okan topcu, topcu sees that agents need to adapt to uncertain environments, environmental changes require agents to make adaptive decisions create an architecture for agent-based simulations by promoting deliberative coherence and extensions for decision making under uncertainty (topcu, 2014). Adaptive agent can be applied in various jobs such as SCADA (Supervisory Control And Data Acquisition) application of a computer-based industrial control system, multi-agent System (MAS) is used to build adaptive agent based on SCADA system by component modeling system as agent at micro level and organization or multi agent at the macro level. (abbas et al, 2015). In this study raised the case study indoor tracking, MAS which is in the humanoid robot in the setting to be able to study the condition of a room, where in it there are some objects that become obstacles (Obstacle) either move or not, then in the room there are objects in the direction such as exits or other positions, previous research singh and friends, tried to apply adaptive agent in steering simulation to overcome a bottleneck and scenarios to be able to find the exit. (singh et al, 2011)

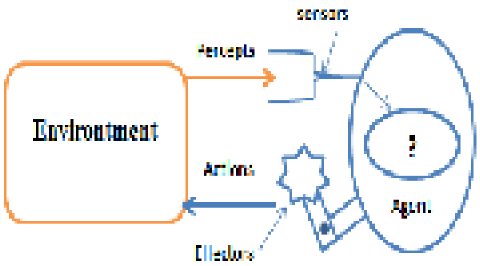

Figure 2. Ilustration intelligent agent by Russel

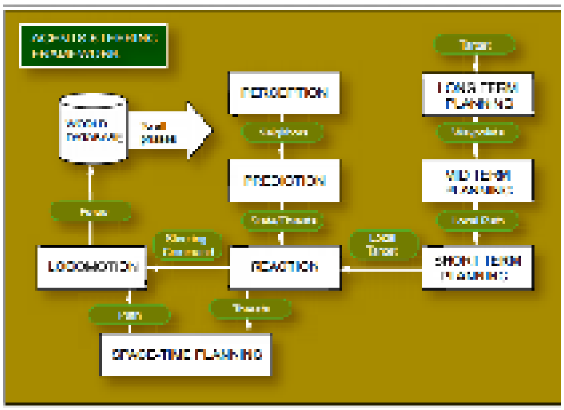

Figure 3. Model Agent steering framework (Singh, 2011)

3. System Architecture

In designing this architecture will be explained through the block diagram representing the design of the hardware.

Figure 4. System Architecture

From the chart above will be set some scenarios that will be developed, namely the transmission of data derived from sensors that involve the componon controler such as Ardiono and the use of mini PC (Raspberry pi 2) to be able to manage the system workflow and can send data into the database server.

3.1 Design of Agent System.

The data will be sent to the server, the existing data data will be input by mechine learning to get the decision and forward it to actuatr like the chart below. In the figure above how agent works on a system, simultaneously and autonomous system will monitor the water element, the input will be compared with the knowledge base containing the rules and rules, then will be in search of the most appropriate water conditions to give on the diversity of plants that exist on the media. Knowledge base will be embedded on the server side so that the knowledge base will be in use by many media to be controlled by the agent, so the agent will be able to adapt to various media connected with the server. Illustrative use of many devices that will be managed by agents like the chart below.

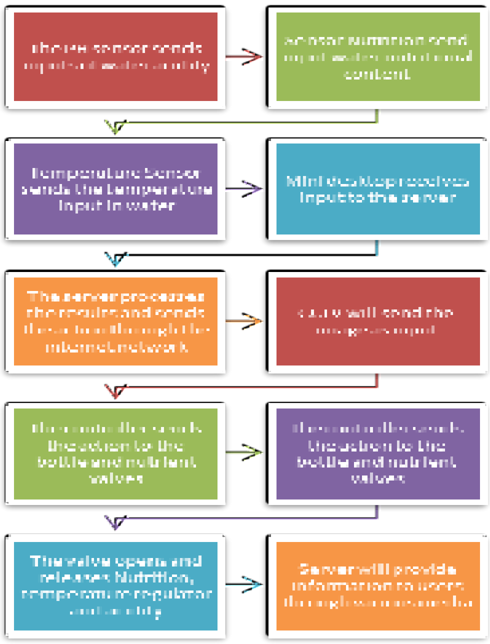

Figure 3. Smart Vertical Agriculture System

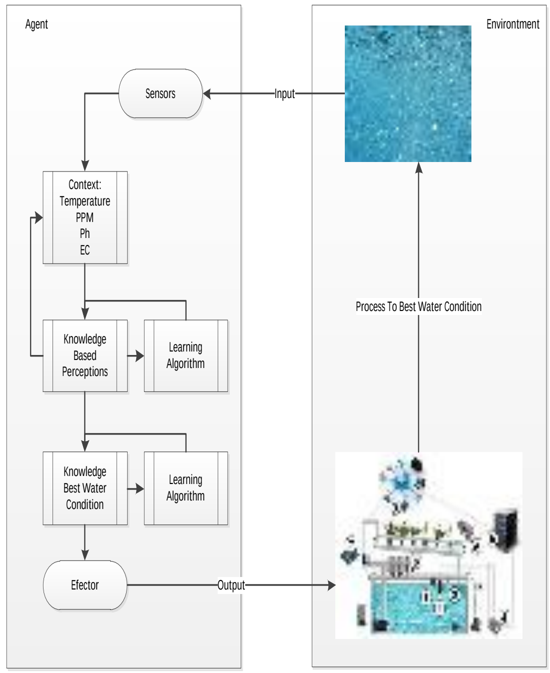

Figure 6. Model Agent System

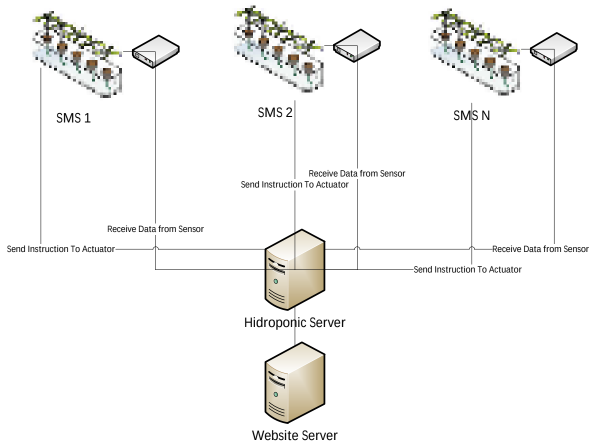

Figure 7. Sistem Flow Illustration

4. Result And Discussion

Based on the test results using temperature sensor, EC sensor and pH sensor obtained the following results. Figure 5.4 below describes the output obtained from the process run by the arduino, including temperature values, nutrition / ec and pH.

4.1 System Testing

At this stage will be discussed about testing the system both hardware and software system. Components that have been integrated will be tested separately and integrated as a whole to ensure the system is running properly. Tests conducted at this stage include:

1. Testing the accuracy of reading sensor data from Arduino uno.
2. Hardware endurance testing
3. Testing the system as a whole.

4.2 Testing the Accuracy of Sensor Data Readings to serial monitor

At this stage will be tested the data read by the sensor and sent to the serial monitor. After all the tools are installed and connected, the following test results system.

4.3 Testing the accuracy of sensor data readings from Arduino

In this test is checked the level of accuracy of the data read the sensor with a measuring instrument in accordance with the sensors used. The test performed at this stage uses a PH-meter to measure whether the value read by PH-meter is equal to the value read by the sensor. Prior to testing the PH-meter was first calibrated using a 4.01 pH buffer power and deionized water. After the sensor is installed then check on the serial monitor Arduino IDE. If the value of the data read the sensor is the same as the value of PH meter means the system is running well and correctly. Analogue test results of pH meter kit and PH-meter are shown in Table 1.

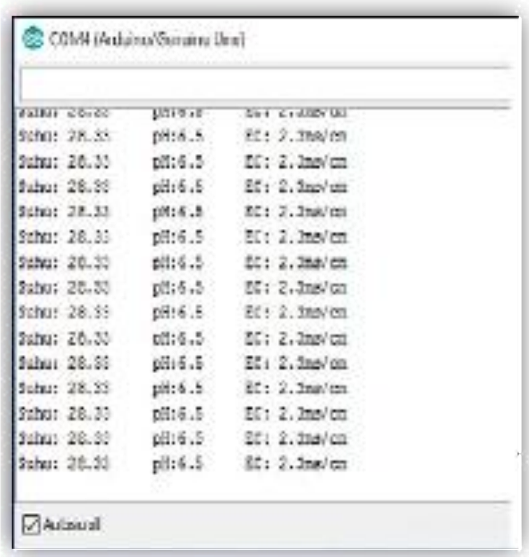

Figure 8. Arduino Output

Tabel 1. Analog pH meter kit. Testing

Testing	***Sensor PH***	***PH-Meter***	***Error***
1	4.0	4.0	0 %
2	4.0	4.0	0 %
3	4.0	4.0	0 %
4	4.0	4.0	0 %
5	4.0	4.0	0 %
6	4.0	4.0	0 %
Error Average			0 %

Error = ((Sensor Value –PH meter Value) /PH meter Value)*100%

The second test is to test the sensor of Electroconductivity by using EC solution 12.88 ms / cm solution as the test standard. To know the sensor has read the data correctly, the value of the sensor is the same as the solution EC solution. The next process is the same as the PH test that is doing the monitoring on Arduino IDE serial monitor. Figure 4.4 shows the value of the data read the sensor is the same as the liquid solution EC solution. Data from Electrical Conductivity Meter test results with EC solution are shown in Table 2. Error = ((Sensor Value –EC meter Value) /EC meter Value)*100%

Conclusion and accuracy of sensor data readings, acidity (PH) and sensor read values are in accordance with standard measuring instrument (PH meter) used while for Electroconductivity (EC) test obtained an average error of 0.42%.

Tabel 2. Electrical Conductivity Meter Testing

Testing -	***Sensor EC***	***Ec solution***	***Error***
1	**12.78**	**12.88**	**0.77 %**
2	**12.88**	**12.88**	**0 %**
3	**12.85**	**12.88**	**0.23 %**
4	**12.84**	**12.88**	**0.31 %**
5	**12.85**	**12.88**	**0.23 %**

6	**12.75**	**12.88**	**1.01 %**
Error Average			**0.42 %**

4.4 Hardware Testing

At this stage testing will be tested the performance of the system. The system will run within 2 minutes. This test is done by looking at the incoming data from the sensor through the serial monitor Arduino IDE and test the performance of the controlling system on a DC motor. From the testing of the hardware resistance obtained the test results data as shown in Table 5.3. system run for 2 minutes. Testing was done twice, for the first test with PH Meter Kit and second test was done by using Electrical Conduictivity Meter. The data sent sensors amounted to 46. Here the results of data read sensors with average calculations shown in Table 5.3.

Tabel 3. Testing Data From Hardware to Monitor

Testing ke-	**Average *PH***	***Average EC***	***Average Temp***	***Second Data***
1	4.11	13-14	27.00	1-50
2	4.11	13-14	26.80	50-100

From the table above can be drawn a conclusion sensor has been working consistently in reading and send data to serial monitor.

4.5 Testing Data Delivery and Pause Delivery Time Data

At this stage will be done Testing data transmission and time required hardware send data to serial monitor. Testing aims to see the stability of the hardware to send data to the serial monitor. From Testing data delivery and time lags obtained results as shown in Table 5.4.

Tabel 4. Testing Data From Hardware to Serial Monitor

Testing	***Serial Monitor***		
	PH	***EC***	***Temp***
1	Y	Y	Y
2	Y	Y	Y
3	Y	Y	Y
4	Y	Y	Y
5	Y	Y	Y
6	Y	Y	Y

From the table above nial "Y" shows the data successfully sent and if the data successfully sent is indicated by "N". in Table 4 it can be seen that all data read by the sensor successfully sent to the serial monitor with no error. From the Testing results obtained the results as shown in table form as shown in Table 4 and Table 5 where the data has been read by the sensor successfully sent to the serial monitor with a time delay of delivery of 1 second average. Conclusions on this Testing data reads the sensor successfully sent to the serial monitor with a stable time lag.

Tabel 5. Pause data transfer time to the monitor

Testing	**Data ke -**	**Time**
1	1	20:44:27
2	2	20:44:29
3	3	20:44:30
4	4	20:44:32
5	5	20:44:33
6	6	20:44:34
7	7	20:44:35
8	8	20:44:37
9	9	20:44:38
10	10	20:44:40

4.6 Overall Testing

In Testing the whole Testing starts from reading the data by sensors sent to serial monitor then proceed with controlling process which will be done at two stages of Testing, first Testing controlling relay ch 1 and 2 to value of acidity degree (PH) and Testing phase two to relay ch 3 and 4 in controlling electroconductivity (EC). From Testing to the process of controlling the degree of acidity (PH) and electroconductivity by relays, controlling fluid is able to control the changes that occur on the value of acidity (PH) and electroconductivity (EC) and make the PH and EC again stable. The results of this Testing are presented in tabular form as shown in Table 6 below.

Tabel 6. Testing controllong relay

Testing	***PH* Parameter**	***PH Control***	***EC* Parameter**	***EC Control***
1	4.01	6.02	5.33	1.34
2	4.01	6.08	5.27	1.23
3	4.01	6.33	5.39	1.22
4	4.14	6.55	5.40	1.33
5	4.92	6.88	5.62	1.33
6	4.98	6.97	5.62	1.33
7	5.11	7.12	5.62	1.33
8	5.30	7.40	5.70	1.33
9	5.35	7.51	5.73	1.33
10	5.55	7.77	5.22	1.33

From the table above can be seen the work of the controlling system can change and provide stability of the value of acidity (PH) and Electroconductivity (EC) to be at normal limits.

5. Conclusion

After all stages of research done, from the study of theory, system design, and system implementation, then obtained the result of a tool that is able to monitor and automate the changing factors affecting the development of the plant that is the degree of acidity (PH) and electroconductivity (EC). With the hydroponics system as has been produced in this study can help users to monitor PH and EC while providing restrictions so that water conditions in hydroponics remain stable.

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