Implementation irrigation system using Support Vector Machine for precision agriculture based on IoT

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Abstract. The industrial revolution 4.0 is driving increased production and automation of systems using the internet of things and data mining. Climate change and young farmers knowledge make it necessary to create an internet-based and Artificial intelligent farming system. Farmers need a system that can help the process of watering and fertilising for crop growth. In several previous studies, calculating the prediction of water density from moisture sensor data and to predict future moisture values using SVM, the implementation of artificial intelligence for precision agriculture to detect field-grown cucumber, in other studies determining the amount of water using fuzzy systems and neural networks, parameters used in determining irrigation systems consist of environmental data including ambient temperature, humidity and soil moisture several additional variables in determining irrigation control using crop water demand, soil evapotranspiration and weather condos, forecasting agriculture water uses LS-SVM to improve accuracy and speed in the forecasting process implementation of automated irrigation using IoT. In this paper, we propose the integration of water quantity predictions on plants using several environment variables for forecasting using linear Support vector machine. Accuracy rate of SVM reaches 95%, 94.3% precision, 91% recall, F1-score 92.7%. The results of the forecasting will be sent to the end node using the MQTT protocol.

1. Introduction
The industrial revolution 4.0 is driving increased production and automation of systems using the internet of things and data mining. Climate change and young farmers' knowledge make it necessary to create an internet-based and Artificial intelligent farming system. Farmers need a system that can help the process of watering and fertilizing for plant growth. In several previous studies, calculating the prediction of water density from moisture sensor data and to predict future moisture values using SVM [1,2], the implementation of artificial intelligence for precision agriculture to detect field-grown cucumber [3], in other studies determining the amount of water using fuzzy systems and neural networks [4], parameters used in determining irrigation systems consist of environmental data including ambient temperature, humidity and soil moisture several additional variables in determining irrigation control using crop water demand [5], soil evapotranspiration and weather condos [6], forecasting agriculture water uses LS-SVM to improve accuracy and speed in the forecasting process [7] implementation of automated irrigation using IoT [8]. In this paper, we propose the integration of water quantity predictions on plants using several environment variables for forecasting using linear vector machine support. The results of the forecasting will be sent to the end node using the MQTT protocol. The system will provide precision in providing the amount of water with pump actuators that
are distributed to each plant. Sensor data is obtained from sensor nodes that send data using the same protocol. With this system, it can provide convenience for farmers in the irrigation system because it is done automatically with water quantity decisions based on environmental data. Water demand can be estimated in accordance with the needs of plant growth, so as to optimize the use of water. In this system consists of 3 classes in determining the SVM prediction results, namely 10% pump valve, 25% pump valve and 50% pump valve.

2. Methods
The proposed system is integrated from the process of collective data with end nodes carried out periodically by sending data to the gateway. Data from the gateway will be subscribed by the MQTT server to predict data using support vector machine. Prediction results will be published to the broker to be subscribed by the actuator node.

![Irrigation system based on IoT](image)

Figure 1. Irrigation system based on IoT.

The system that we propose consists of multiple end node sensors that aim to conduct data sensing of soil, temperature and air. From the end node will publish using the MQTT protocol to the broker in the form of a gateway. Data communication used to use Lora radio. For an actuator using a water pump, the action can be obtained from the subscribe topic at the broker, with the action value specified by the SVM on the server side. SVM uses python base with a dataset that is adjusted to the condition of soil and plants in Indonesia, in this paper using horticultural crops. End node uses 32-bit MCU node, and for the gateway uses MQTT broker base on Linux and the server uses python. For backend system needs using NodeJS to be able to do MQTT pub and sub processes from end node to forecasting server.

For forecasting needs the irrigation system uses a dataset that has been normalized using fuzzy and already has a label column which means the output action of each record has been determined. Input consists of soil moisture, air temperature, air humidity, air temperature with an output label in the form of a percentage of the solenoid valve from the irrigation pump.
Table 1. Dataset irrigation system.

| DataID | Date       | Time         | Devices | Soil Moisture | Air Temperature | Air Humidity | Label |
|--------|------------|--------------|---------|---------------|-----------------|--------------|-------|
| 1      | 05/01/2015 | 12:00:00 AM  | 1       | 17,995        | 12,2            | 71           | 20.5% |
| 2      | 05/01/2015 | 12:00:00 AM  | 4       | 15,96         | 11,599          | 71           | 20.7% |
| 3      | 05/01/2015 | 12:00:00 AM  | 5       | 24,683        | 12,2            | 68           | 7.2%  |
| 3      | 05/01/2015 | 12:00:00 AM  | 6       | 26,718        | 13,299          | 66           | 8.3%  |
| 4      | 05/01/2015 | 12:15:00 AM  | 1       | 17,995        | 12,2            | 73           | 20.5% |
| 5      | 05/01/2015 | 12:15:00 AM  | 4       | 15,96         | 11,099          | 73           | 20.9% |
| 6      | 05/01/2015 | 12:15:00 AM  | 5       | 24,683        | 11,599          | 71           | 6.6%  |
| 7      | 05/01/2015 | 12:15:00 AM  | 6       | 26,421        | 12,7            | 68           | 7.7%  |
| 8      | 05/01/2015 | 12:30:00 AM  | 1       | 17,995        | 11,599          | 75           | 20.7% |
| 9      | 05/01/2015 | 12:30:00 AM  | 4       | 15,675        | 11,099          | 75           | 20.9% |
| 10     | 05/01/2015 | 12:30:00 AM  | 5       | 24,683        | 11,099          | 68           | 6.1%  |
| 11     | 05/01/2015 | 12:30:00 AM  | 6       | 26,421        | 12,7            | 70           | 7.7%  |
| 12     | 05/01/2015 | 12:45:00 AM  | 1       | 17,995        | 11,599          | 76           | 20.7% |

Next is the stage of forming machine learning. In this study, the application used to assist research is Jupyter Notebook. Label column (output action) of the inputted dataset consists of 3 data classes, namely; 10% of valves totalling 627 data records, 25% of valves totalling 297 data records, and 50% of valves totalling 76 data records.

Classes used as training data on SMV include devices, Soil moisture, Air Temperature, and Air Humidity only, for data about time are ignored, this results in the accuracy of the prediction that will be get smaller. Sensor data will be at variable x, and action valve output data will be stored at variable y.

Training data is randomly divided into training data and 1000 test data, the test data used is 0.1, or 10% random data from the total dataset, while the training data used is 90% random data.
The SVM parameter used is the kernel support vector classifier using linear with gamma auto value and cost (C) 2. This parameter uses standard parameters. In this study have yet to determine a maximum value for the gamma value and c effective.

3. Results and discussion
Based on data training and SVM, results of this forecasting can be seen in Table 3.

| Parameters     | Value      |
|---------------|------------|
| Support vector classifier | Linier     |
| Gamma         | Auto       |
| C             | 2          |

Table 2. SVM parameters.

The accuracy of SVM is 95% with 1000 training data. The average value of precision is 94.3%. whereas for 91% recall with the lowest recall in the class 50% valve pump with a recall value of 82%, F1-score an average of 92.7% with the lowest F1-score in the class 50% pump valve with 88%. In class 10% the pump valve and 25% pump valve have a good recall precision value and f1 score so that it is good to use on the system, but in class 50% the pump valve still gets a recall value of 82% and f1-score 88% in class 50% is 88%. this is because the training data is still as little as 76.

The results of this forecasting will be sent to the broker using the MQTT protocol using a publisher. And will be subscribed by the actuator node to perform the action of the valve of the pump working. Thus, the water needs of the irrigation system can be adjusted to the water needs of corp.

4. Conclusion
This irrigation system is based on the internet by using the SVM system as a data processor and the results of forecasting are sent as a reference for the pump actuator in conducting irrigation in early agriculture. The communication protocol uses the MQTT protocol for communication between nodes, gateways and server estimates. The result of the prediction is that the accuracy rate of SVM reaches 95%, 94.3% precision, 91% recall, F1-score 92.7%. In the class of 10% valve pump and 25% valve pump has a recall precision value and a good f1 score is used with good on the system, however in the 50% class still gets an 82% recall value and the f1-score of 88% in the 50% class is 88%. this is because training data from classes 50% is still small. For further research, optimal datasets and gamma and c values will be developed.

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