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Designing and Manufacturing the AI Robot for Water Resources Management

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***Abstract*—Information technology is nowadays developing strongly, especially the artificial intelligence field. These technologies are being applied to the manufacture of robots, the interdisciplinary combination has created more and more perfect, smarter robots which are applied in many different fields. Stemming from the actual demand in the irrigation industry in the field of water resources, we have researched, fabricated, and programmed artificial intelligence robots to manage water resources. Robots are designed with an interdisciplinary combination of the fields of Mechanics, Electronics and Information Technology. The robot has the main functions of being able to interact with verbal communication, and controlling peripheral devices of water pump devices. The successful robots manufacturing meets practical needs and can be applied in practice to help manage water resources scientifically and effectively.**

***Index Terms*—AI robots, intelligence, mechatronics, IT, water resources.**

I. Introduction

The current situation of water resource management in Vietnam is still limited, leading to the loss and risk of water depletion. There are many different tasks of water resource management, such as propagating policies and regulations to help people raise their awareness, managing infrastructure to regulate water sources, but these jobs are currently implemented quite simply without much innovation.

In order to solve the above problem for better water resources management, we have researched and applied advanced technologies to design and manufacture intelligent robots with functions that meet the requirements set out which are capable of communication, presentation, programmable to automatically open and close water pumping systems using IoT technology.

Water environment monitoring is attracting research attention. In [1], a system which is combined IoT and aquaculture. The monitoring system displays measured sensor values and optimizes energy consumption in sensor networks.

In [2], the author focuses on researching a monitoring system based on Raspberry Pi and Arduino to monitor the water environment. The system includes of wireless sensor nodes (WSNs) which is using the ZigBee protocol. These nodes send data to a webserver. The information is then accessed through handheld devices such as mobile phones or computers.

In this paper, a monitoring system to monitor and warning the pollution level of water will be presented. It is include the collecting sensor nodes and a central node which describing the model of the monitoring system, including: measuring station acts as sensor nodes to collect data, then transfer data to the central node through Lora wireless network. The parameters such as conductivity (EC), temperature, turbidity level, dissolved solids concentration (TDS), pH and DO levels could be measured by wireless sensor network nodes (measuring station). These data is transmitted through the wife internet to the robot for processing.

II. Research Objectives, Subjects and Methods

The research objective is to design, manufacture and program an artificial intelligence robot with both communication and information storage capabilities to automatically control water supply and drainage to serve the management of water resources.

The research subject is a robot with simple communication functions, presentation and information exchange. In order to achieve the stated objectives, the author has carried out research, design and manufacture at ThuyLoi University, where there are sufficient conditions for research and manufacturing.

Research Methods: combination of theoretical and experimental research, using expert method to get opinions of experts, using synthesis and analysis methods, verifying the research results by experiment on the product after manufacturing.

III. Research Results, Design and Manufacture Robots

Based on the goals set out, we have researched and used documents to look up technical specifications, calculate data to meet the technical requirements of the robot by using Solidworks software to design robots in sequence of work steps, research of the function of each part, detail assembly, then building system diagram, overall design robot, design each part of robots, assembly for simulation, programming, fabrication, testing.

A. Basic specifications of the robot

Dimension: height x width (1350x380) mm
Voltage: 12V DC
Weight: 30 kg
Possibility to charge 24 hours (continuously)
Capacity: 40W

B. Design and manufacture the mechanical part of the robot

Bases on requirements and goals set out, the author makes a research and design the details, parts, and mechanical structure of the robot. The robot is composed of 3 main parts:

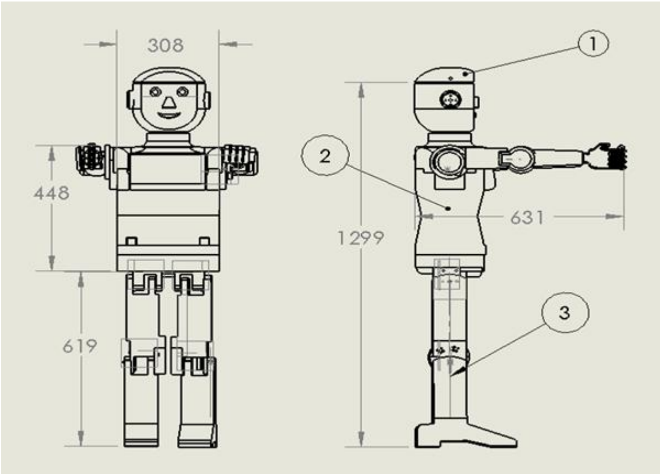

Fig. 1. Design of AI Robot for Water Resource Management

The face and head of robot where the robot's mouth can move.

The robot body which contains microchips and control circuits.

The robot legs are fitted with motors that help the robot move.

The solidworks software is used to design robots. The details of the robot after the design were made by 3D printing method, then fully assembled.

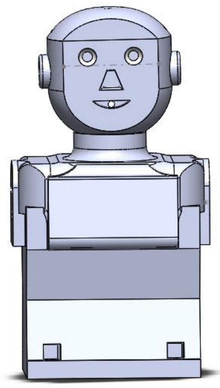

Fig. 2. Design head and body of the robot

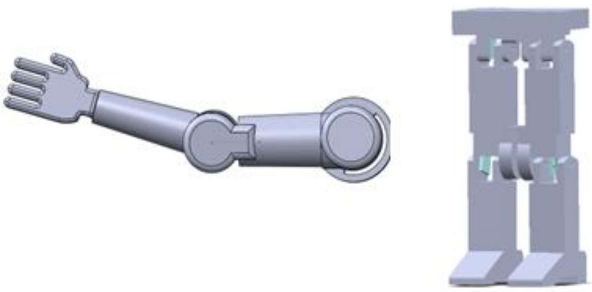

Fig. 3. Design arm and leg of the robot

Fig. 4. Robot after fabrication and installation

C. Design of Control circuit design [3]

The robot uses Rasphberry Pi3 to control the robot's operation as well as store data, program the robot voice communication.

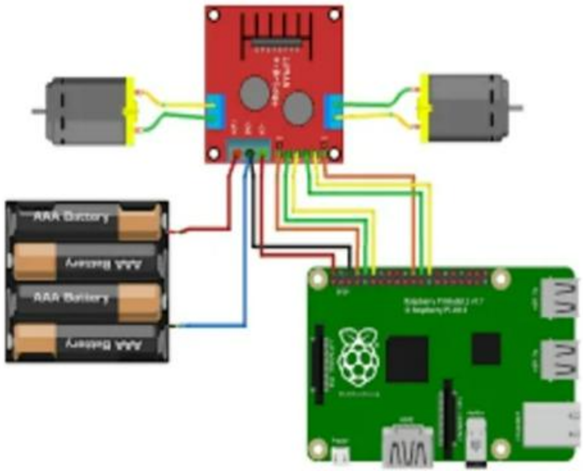

Fig. 5. Raspberry module for motor control

D. Programming communication control, voice presentation

The program to process data from the related peripherals is written in Python language and is executed on the Rasberry Pi embedded board. After being programmed, the robot can listen and receive audio signals and then convert to text files, the built-in program will find data and answer in text file format and text data will be converted to voice spech. Therefore, humans can communicate with robots and robots could accurately answer questions with pre-programmed data.

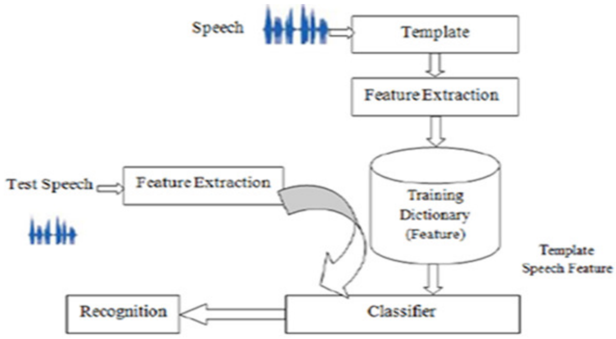

Fig. 6. Algorithm diagram of the program

Data collection (listening)

```
may_nghe = speech_recognition.Recognizer()

while True:
    with speech_recognition.Microphone() as mic:

        print("Robot: Tôi đang lắng nghe bạn")
        may_nghe.adjust_for_ambient_noise(mic)
        audio = may_nghe.record(mic, duration=3)
    try:
        you = may_nghe.recognize_google(audio,language="vi-VI")

    except:
        you = ""

    print("Bạn: " + you)
```

Fig. 7. Code helps the Robot hear and convert data into writing

Send a reply (speech)

```
print("Robot: " + nao_may)


output = gTTS(nao_may,lang="vi", slow=False)
output.save("output.mp3")
playsound.playsound('output.mp3', True)
```

Fig. 8. Code converts the answer from text to audio

When someone appears in front of the robot at a distance of 3m, the robot will automatically recognize through the sensor, then the control circuit will control so that the robot emits a greeting voice, at the same time the lights in the robot's eyes will turn on, the robot hand will wave hello. Users can talk to the robot to find out information about water resources, the robot will answer based on stored data or expand the search for information related to water resources on wikipedia. All conversations are communicated in Vietnamese and English. The robot can connect to the internet to update information and communicate with management agencies related to water resources. The robot can also present itself with stored information.

The effectiveness of communication in Human-Robot Interaction will be greatly affected by noise in the surrounding environment. If a loud noise occurs, the robot cannot distinguish, recognize the voice, the volume of the subject that is speaking and it cannot listen and answer questions correctly.

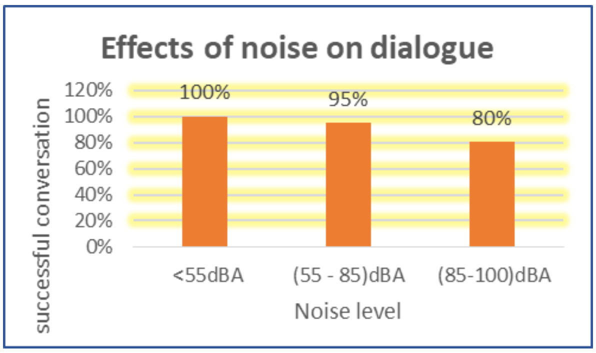

Fig. 9. Effects of noise on dialogue

After completion, the robot is operated and tested for question recognition and answer ability. Tests show that the robot will give the wrong questions when it gets incorrect identification. The robot will respond correctly to the scenario in the training set if it gets correct speech recognition. The author conducted the test by communicating with the robot through 200 questions in laboratory conditions. To evaluate the effectiveness of the robot's level of listening, receiving and processing the sounds of speech, collaborative authors have tested for robot communication at different noise levels with 1.5 m distance from the speaker to the robot position. The result is shown in the chart in Fig. 9.

E. Control the water pump system through wifi internet

To be able to regulate the irrigation system, the Robot is connected to peripheral devices, the relay opens and closes the water pump through a wifi device connected to the internet. The robot can automatically open and close the water pump motors in different places according to the pre-programmed program.

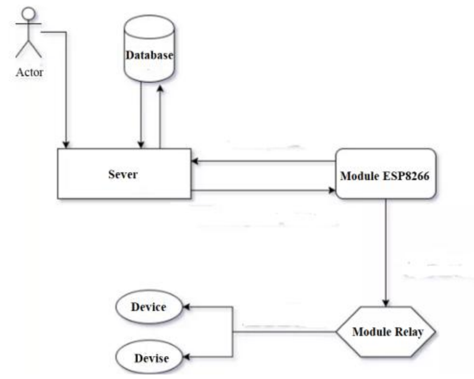

Fig. 10. Diagram of the IoT (Internet of things) control system

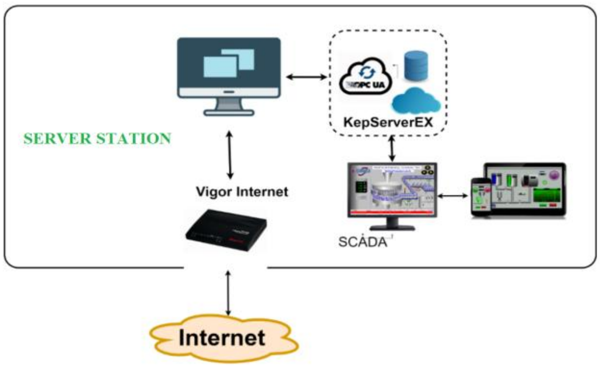

Fig. 11. Connection model at server

Connection configuration at unit station

At the units, each PLC or control device will be connected to the router to connect to the server. Fig. 12 shows the connection model at the units. In fact, the system can connect multiple unit stations. In the content of the research, the authors design a model consisting of 2 unit stations. The model will have 2 motors (pump in and pump out): The inlet pump will pump water from the reservoir or the underground water line into the tank, after the water is cleaned, the pump motor will go to the domestic water supply. … There are 2 sensors arranged at 2 positions of pumping in and pumping water out of the tank. At the pumping position, an inlet flow sensor is placed on the lid or mouth of the tank to measure the amount of water pumped in. In addition, the sensor can be used as a relay value when the pump motor is turned on.

At the pump in position, an inlet flow sensor is located on the lid or mouth of the tank to measure the amount of water injected. In addition, the sensor can also be used as a value relay when the motor is pumping in is enabled. At the pump out position, the pressure sensor is located behind the pump pipe of the pump out motor to measure the pumped water pressure. Sensor value for feedback tells the PLC whether water is being pumped out or not.

In one unit, because there are two motors which is used to pump out and pump in, so the control signal from the server will be the 2-ways signal. Therefore, at each unit, the router will be configured in the dial-in and dial-out way. In this system, 2 independent unit stations have the same function of pumping water out and in. So the configuration of two stations is the same, but the IP address for each units is different.

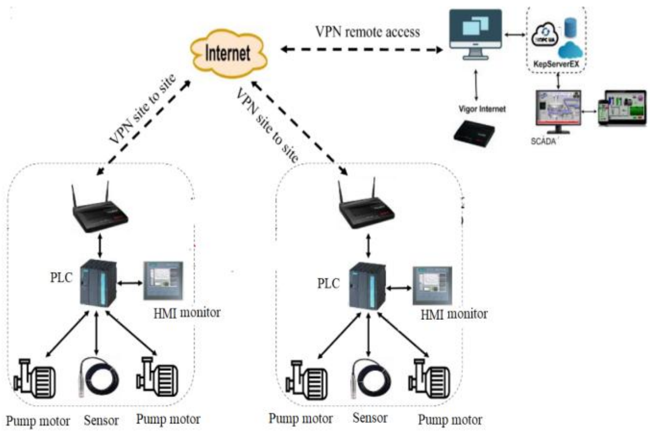

Fig. 12. Conection model in the unit station

Water flow measurement

The PLC receives the sensor values and displays them on the HMI control screen. Water flow and pressure are measured, so that the operator can operate the system through the control screen HMI. The flow meter sensor generates the pulse output signal. Accordingly, with one liter of water flowing through the sensor in 1 minute, the sensor generates 480 pulses. Or when one liter of water through the sensor in 1 minute, we get the frequency F = 8Hz, so the water flow can be calculated as the equation:

$$Q = \frac{F}{480} \tag{1}$$

Here: F - frequency (Hz)

Q - flow rate (litle per second).

Similarly, the out put of pressure sensor will be current in the range of 4 - 20 mA, corresponding to a pressure of 0 - 10 bar. According to Ohm's law in closed circuit, we have: $V = R.\ I$ with $R = 120\ \Omega$. Using the linear straight-line method, the pressure can be calculated as:

$$P = \frac{V - 0.48}{0.192} \tag{2}$$

Here: P - water pressure (bar)

V - sensor voltage (volt)

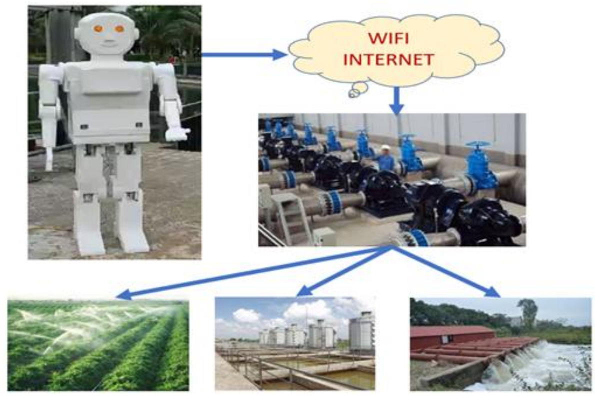

Fig. 13. Robots after being manufactured and put into use

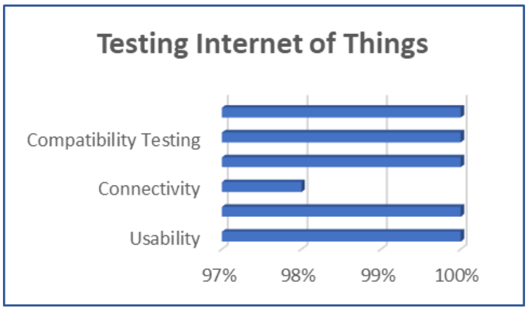

Fig. 14. Testing Internet of Things

As the results of testing water quality, the Temperature, TDS, pH, DO, TSS (Turb), TIME, Latitude, Longitude of the tested water sample is shown on the robot screen with the values as the Fig. 15.

VALUE TABLE:

ID	TEMP (°C)	TDS (ppm)	PH	DO (%)	TURB (%)	TIME
668	25.5	35.5	7.1	14.7	0.9	2018-05-28 10:53:18
667	27.5	32.5	7.2	13.7	0.8	2018-05-28 10:52:33
666	28.5	33.5	7.3	14.8	0.4	2018-05-28 10:51:51
665	28	35	7.2	15.5	0.4	2018-05-28 10:51:07
664	26	35	7.2	14.2	0.3	2018-05-28 10:50:34

Fig. 15. Data obtained from the monitoring system

The robot has been successfully tested with functions that work according to the set goals. The robot can give presentations and answer questions related to water resources, through the robot's computer system, which can be programmed to control water pumps and peripherals via wifi.

IV. CONCLUSION

The product of research results is an artificial intelligence robot applied in water resource management. Robots can also be applied in teaching and presenting topics on water resources. With new and intelligent features, the robot can be applied in water resources management agencies, supporting information search, asking and answering questions about water resources, regulating water sources at pumping stations through the Internet. This is also one of the first artificial intelligence robots applied in water resource management in Vietnam. Bases on these studies, it can be further developed to make the robot more complete and widely applied in the field of water resources management as well as environmental management. The water pollution monitoring system will be connected with the robot and wireless sensor network nodes operate based on Lora technology and process data transmitted to the robot. These parameters are very important in monitoring water quality which is comparing with standard values to show the pollution level of the water source. The analyzing, comparing, synthesizing data will bo calculated by robot and then issuing the warning to the person in charge.

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