Water Spray Painting Robot: Image Input and Output Process

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***Abstract*—This paper presents how to do an image input and output process that I developed for a water spray painting robot. When a person approaches the right side of the robot, a LiDAR sensor detects, and the robot's head is turning toward the user. The user can then draw on a screen and the image is processed with an adjusted resolution. The processed data are transmitted via CAN communication to a relay, which activates the water sprayer to create a line-by-line dot painting. Due to LabVIEW as a graphical programming language, it can be difficult to fully show the logic through images. For example, in the case of nested if-statements, this report only presents the most fundamental parts of the logic for clarity.**

I. Introduction

Through the Robot Design Engineer course at the Seoul Robot Academy and Hongik university team, each team can design and build our own robot. The robot we created, named Wade, is a service robot that draws on the ground using water by drawing dots. When a user draws an image on the touchscreen, the robot performs water-based drawing. This service can bring enjoyment to users, and by using water it remains environmentally friendly and easy to erase regardless of the surface. Wade was designed to be used in event spaces such as amusement parks and festivals.

My main role was software development. We used a programming language called LabVIEW and operated the system through a LattePanda. This robot included detecting the presence of a person, rotating the robot head, processing the input drawing by adjusting its resolution to be represented as dots, and sending commands to a relay to control the solenoid valves to inject water. This paper focuses on the image input and output processes that I developed.

Working with my team to build this robot was a valuable experience, and we participated in RoboWorld 2023. I am grateful to my teammates for their work.

II. Methodology

A. *image input process*

When the robot detects a person on its right side using LiDAR, it turns its head and tilts it at an angle to make the touchscreen easier to use. The user can then draw an image in the blank space on the touchscreen and press the send button, after which the robot waits to receive the drawing.

Fig. 1: Normal State

Fig. 2: Activation State

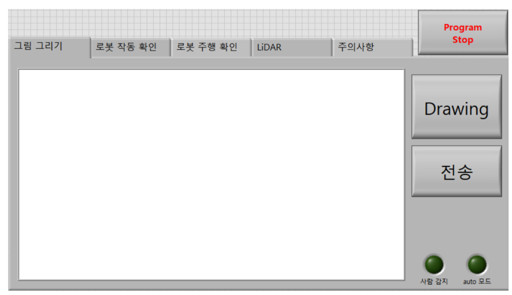

Fig. 3: Head Screen Interface

B. *Downscale resolution*

When the user finishes drawing and presses the send button, the original 720×396 pixel image is downscaled to a resolution of 20×11. Each pixel in the reduced image represents a 36×36 block from the original. For each block, if more than 300 of the 1,296 pixels (36×36) are drawn, the each pixel of the new block (20×11) has a value of 1. This binarization process enables the creation of a simplified, dot-based representation suitable for water-spray rendering.

C. *Using relay to water injection*

To draw the 20×11 resolution image, the robot used 11 arranged solenoid valves to spray water for each row. It moved across 20 positions, spraying one line at a time to complete the full image. To control the 11 solenoid valves, we use an 8-channel and a 4-channel relay

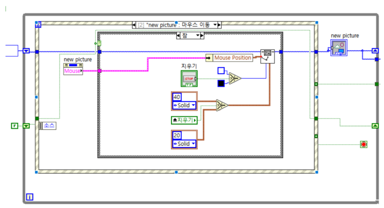

Fig. 4: Source Code of Drawing Panel

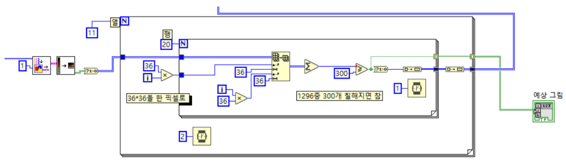

Fig. 5: Source Code of Downscaling (720×396 to 20×11)

simultaneously. Each solenoid valve that received an input signal of 1 is opened for 0.2 seconds to inject water. After each row was printed, the robot advanced forward for 2 seconds at a speed of 0.03 m/s to position itself for the next row. Before starting the drawing process, we add one row that all the solenoid valve could be open to ensure that water was evenly distributed through the tubes connected to each valve.

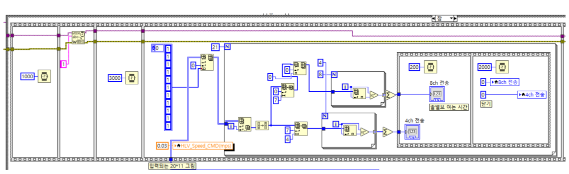

Fig. 6: Source Code of Using Relay and Solenoid Valves

III. Results and Discussion

Our team operated the robot at the 2023 RoboWorld event, allowing visitors to experience our robot. its cute exterior design attracts many children. We designed the size of robot as children can use our robot touchscreen easily. However, due to limitations in relay channels and the size of the solenoid valves, reducing the image resolution made it difficult to render detailed drawings. Simple shapes like arrows and hearts were printed successfully, but more complex figures such as stars printed different with child drew. Additionally, the robot injected water well when the water in internal water tank was enough, however As the water level dropped, the pressure that can move water to valve became weaker or uneven, affecting the overall output quality.

IV. Conclusion

Participating in the Robot Design Engineer program hosted by the Seoul Robot Academy was a valuable opportunity. Before the course, I had limited understanding of robotics, but through this program, I was able to design and build a robot, and even operate a booth with it at a large public event. I was fortunate to work with great teammates. We shared ideas, defined the concept of robot, and carried out the design process. Over the course of just two months, we made roles such as design, control, software, and mechanical parts, and successfully built a working robot.

The program was affiliated with Hongik University, where professors provided valuable guidance and supported us with various components. Not only building our own robot, we were able to explore fundamental concepts such as four-wheel drive systems and operate machanical things that hard to use usually such as LiDAR, GPS, and CAN communication.

At the RoboWorld, we participated as booth operators and show our robot to visitors. That experience gave me broader perspectives by showing our robots and exploring other robots showcased at the event. Although it was only 2 months to make robots in university vacation, it offered a comprehensive and rewarding experience in robotics.

Fig. 7: User Interacting with the Robot in Roboworld

2023 로보월드 참가 확인서

< 행사개요 >

기 간 : 2023. 10. 11(수) ~ 2023. 10. 14(토)
장 소 : 킨텍스 1~3 홀
참 가 자 명 : 황정민

< 업체개요 >

업 체 명 : 홍익대 산학협력단
참 가 규 모 : 미래인재관 2 부스

위 업체는 2023 년 10 월 11 일부터 10 월 14 일까지 개최되는 「2023 로보월드」에 참가하였음을 위와 같이 확인합니다.

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