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Using Fuzzy Logic Control System as an Artificial Intelligence Tool to Design Soap Bubbles Robot as a Type of Interactive Games

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Abstract: The presented paper discussed augmented reality for converting industrial chemical spraying robots into soap bubbles robots as an interactive game augmented robot. Also, a fuzzy logic control system (FLCS) designed and structured as an artificial intelligence tool for soap bubbles robot and implemented in programming logic control (automated operating system). Fuzzy system used for predicting the level of soap-water mixture inside the robot.

Keywords: Artificial intelligence and robot; Augmented reality and robot; Augmented robot; Fuzzy system.

1 Introduction

Augmented reality (AR) transforms an industrial robot work cell to an augmented or enhanced environment, which allows the ones experienced in programming robot to create tasks for serial robot [1].

AR is a technology where different robotic devices in industrial processes can wireless communicated and users can understand the status of the robots and performed operation via advanced visualization [2].
Robot programming simplified through commercially available augmented reality headsets, like HoloLens methods for improving the accuracy and speed of manipulation and positional control tasks [3].
Fuzzy control system proposes as control methods for intelligent behaviors of robot to determine whether the surrounding environment is suitable for walking through bio-current signal and discrete event control through the primitive simulation of the organism [4].

Design and implementation of a fuzzy system for robotic arm programming logic control done, it used for calculating speed of robot tool center point. Fuzzy logic used as a form of a fuzzy PI controller to achieve the desired velocity via load compensation [5].
Fuzzy control was created for a robotic arm and then integrated into the programming logic control that served as the robot's control system via a joystick. The goal of the fuzzy system is to calculate the joint motor rotation speed based on the angle size of the joystick inclination [6].

In the presented work augmented reality used to convert industrial chemical liquid spraying robot to soap bubbles augmented robot as an interactive games type. Artificial intelligence especially fuzzy system used for improving soap bubble robot' performance by predict and control quantity of soap-water mixture used through the robot.

2 Industrial Chemical Liquid Spraying Robots

Figure (1) shows the mechanical, hydraulic, electrical, and control systems of our industrial robot that designed and structed to spray the chemical liquids. That industrial robot converted to gaming robot or soap bubbles robot through applying augmented reality.

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Fig. 1: Experimentally Industrial Chemical Liquid Spraying robot.

2.1 Mechanical System

Movements of the industrial robot is carried out through its mechanical components.

- Metal base (robot base).
- Base wheels drive.
- Robot chassis sheet metal structure.
- Aluminum box (for saving electrical and control systems components inside it).
- Vertical and horizontal aluminum tubes.

2.2 Hydraulic System

Robot hydraulic system draws chemical-water mixture from the liquid tank and pumps it in the form of spraying liquid.

- Polypropylene tank of chemical-water mixture (3 liters capacity).
- Water pump for drawing soap-water mixture from liquid tank and connecting it to bubbles maker (1 bar pressure, 12 V power, and 95L/hr. flow rate).
- Bubble's maker.
- Rubber tubes.

2.3 Control System

The main task of control system is to control movements of robot mechanical components, speed of motors, rotating angles of robot's head, and the amount of chemical liquid that it pumps.

- Unit of process logic control system (PLC).

2.4 Electrical System

Electrical system is the main source of electricity that operates motors of robot.

- Drive motor for movement robot (base' wheels drive) with 24V and 15 r.p.m.
- DC stepper motor moving robot head in semi-circle X direction (12 V, 270 deg.).
- Electrical cables.
- Electrical Battery with 12 V power.
- Liquid level sensor.
- Three LED with green, yellow, and red colors.

2.5 Operating System of Chemical Spraying Robot

The robot starts with switch on for on-off key to work automatically through all the steps of produce spraying chemical-water mixture. Moving of robot starts by wheels' electric motor which move the base of the robot, at the same time the water pump draw the liquid from the tank to connect it to the nozzle for spraying it through semicircular domain around 270 degrees.

3 Augmented Realities (AR)

The AR technology combines realistic and between-worlds defaults, allowing users to engage in real time while precisely recording virtual items and realism in a three-dimensional image. It was once used to improve the natural settings and provide enjoyable experiences from the cognitive. Real information on the world may become interactive and digitally modified using computer vision and include cameras enhanced in smart phone applications [7].

3.1 Augmented Robotics

Depending on the terms of (Augmented Robotics), it can be used on a computer to create or simulate three-dimensional computer visuals for usage in real-world surroundings, allowing the user to interact with it. Microsoft HoloLens in 2016 explored the potential of AR approaches that enable robot programming and simplified for more than a decade. The product is by default collected by the user and physically by the robot. The user performs a step assembly by default moving component [8]. It is displayed by the virtual component HoloLens which is in the same position of the real component, which is determined by tracking the position marks as in Figure 2.

Fig. 2: Augmented Robots (playing funny robot) [8].

3.2 Augmented Reality of Soap Bubbles Robot

In this step, the industrial chemical liquid spraying robot uses AR to convert it to soap bubbles robot. Augmented reality technology is used for producing interactive games that depend on robotics technology, computer programs, and visual tools. The soap bubbles augmented robot replaced chemical liquid with soap-water mixture and spraying nozzles replaced with bubbles maker. Figure (3) shows that the soap bubbles robot has movement parts (wheels of base and rotating joint between head and body of robot) and stationary parts (all robot body). The base of robot moves in linear direction, while the robot head moves in rotating direction and bubbles spraying is done automatically through orders of PLC unit.

Quantity of soap-water mixture in the liquid tank inside the robot is predicted by fuzzy system, which appears as a change in the colors of the robot eyes.

4 Artificial Intelligence (AI)

Artificial intelligence is intelligence displayed by machines; it is the study of any technology that detects its environment and takes actions that increase its chances of attaining its objectives.

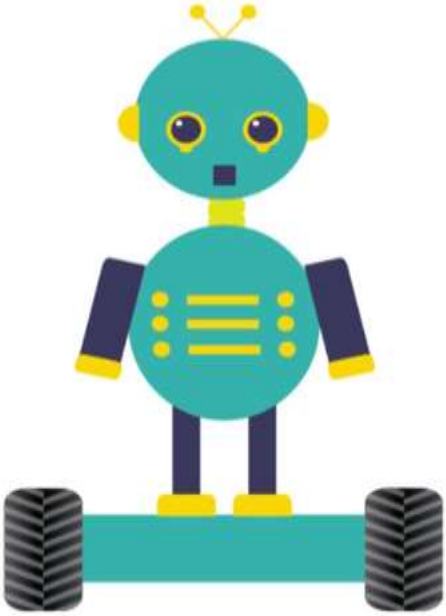

Fig. 3: Our Bubbles Augmented Robot.

Both artificial intelligence and robotics can and do exist independently of each other. If AI combine with robot, the result will be an artificially intelligent robot with a high level of autonomy, able to optimize tasks it is assigned to do and "learn". The artificial intelligence like the "brain" of the robot, while the sensors and mechanical parts of robot act as the "body" and that will greatly optimize their performance [9].

4.1 *Fuzzy System and Artificial Intelligence*

Fuzzy system is a tool of artificial intelligence tools. Due to the use of Gaussian system in artificial intelligence, it can accommodate several types of inputs. It also can solve the problems of complex algorithms blur. Using less data does not occupy a large area of memory to make decisions accordingly if sensor feedback control system stops working in hardware [10].

4.2 Fuzzy System for Soap Bubbles Robot

A Sugeno fuzzy logic system designed and structured by using fuzzy toolbox of MATLAB, with one input and one output to predict and control the soap-water mixture level in the liquid tank inside the robot. The input of fuzzy system is the reading of the liquid sensor which express the quantity of soap-water mixture stored in the liquid tank, and the output is green, or yellow or red color (change in robot eyes color) as shown in figure 4.

The triangular membership function of the input appeared in figure 5, while the three colors of fuzzy system output appear in figure 6.

Figures 7 and 8 show the If-Then rule of fuzzy system and its result (decision or robot eyes color) respectively.

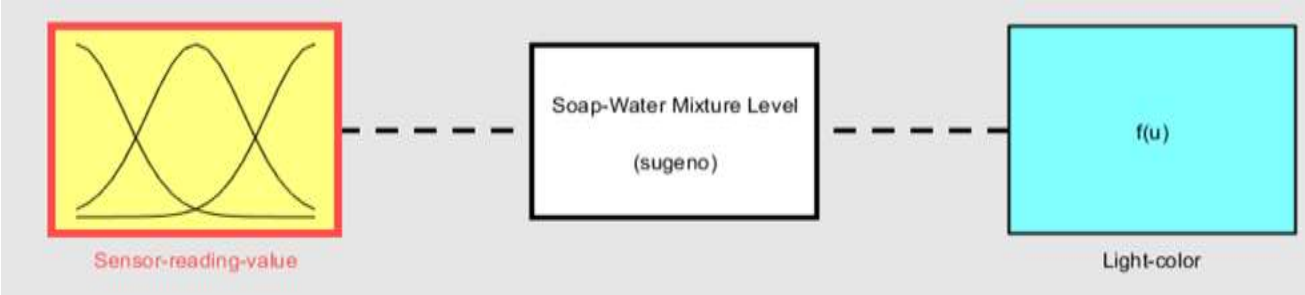

Fig. 4: Sugeno Soap-Water Mixture Level Fuzzy System.

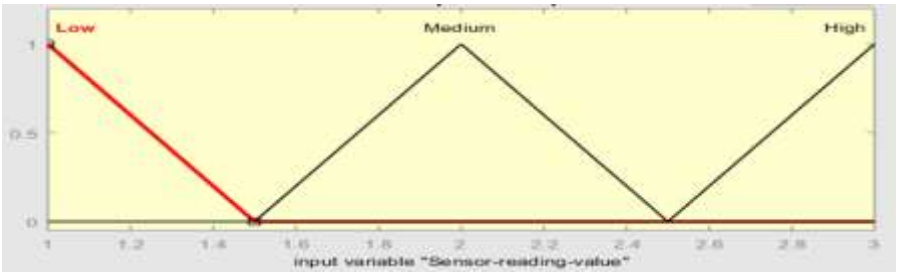

Fig.5: Triangular Membership Function for Input with Low, Medium, and High levels

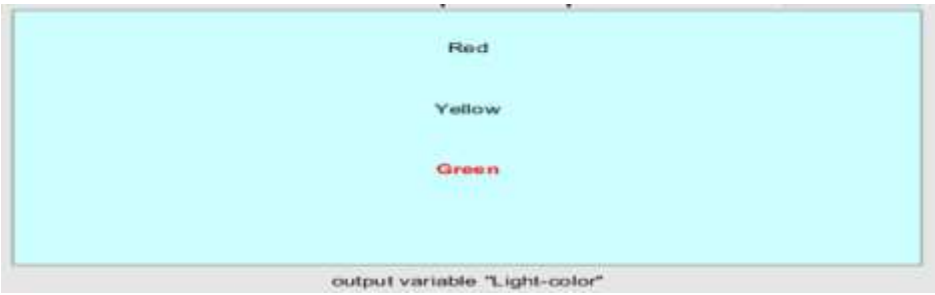

Fig.6: Output of Fuzzy System. (More information is needed).

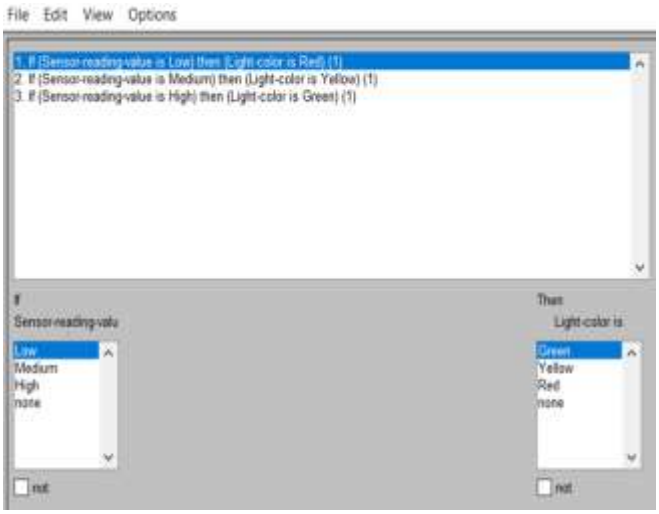

Fig. 7: If-Then Rules of Fuzzy Logic System (relation between inputs and outputs of fuzzy model).

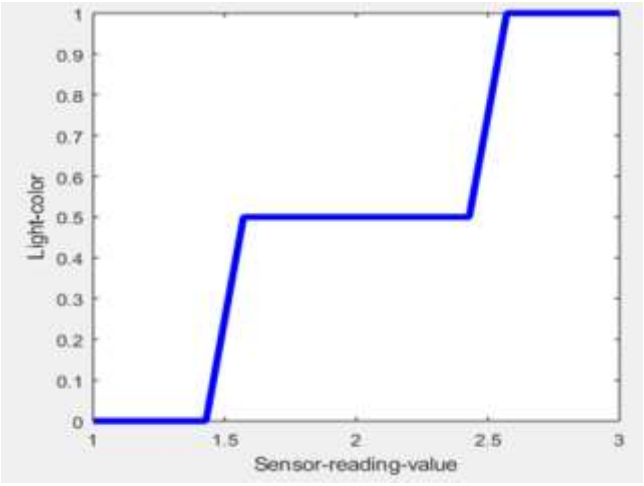

Fig.8: Result of Fuzzy System (increasing in light color related to increasing.

5 Conclusions

The augmented reality technology was used to convert industrial chemical liquid spraying robot to augmented robot or soap bubbles robot as an interactive game. Artificial intelligence was used to improve the performance of the augmented soap bubbles robot. The soap bubble robot or augmented robot proved the benefit of AR in facilitating and handling the industrial products as well as their appropriateness for other purposes.

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