

Intelligent Security Gate

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Abstract

Modern organizations have to use digital technology and digital transformation is the way to achieve this. Track employee attendance digitally and do not rely on outdated bookkeeping methods to improve the time spent during working hours, calculate annual leave for employees, and efficiently process payroll.

In this research paper, a gate has been proposed through which employees' departure and attendance are calculated. And prevent any unwanted person from entering and at the same time, a unit can be added through which individuals are sterilized to the Prevention of the coronavirus.

The proposed system showed high efficiency in recording the attendance and the departure of employees, as well as preventing any unwanted person from entering. The raspberry pi 4 model/ 8GB is used and the practical tests were conducted and applied to the system of employees of the Egyptian Academy of Engineering and Advanced Technology

Introduction

The process of securing important facilities usually takes place in multiple stages, where first a comprehensive study is conducted for the target institution in the insurance process, then after that, the insurance plan is designed according to the experts' vision after studying the facility, and then comes the stage of outputting the security plans to reality or its actual implementation at the end. All these stages are carried out under the supervision of a group of experts in the field of security of private and public facilities

The security and safety of citizens is the most important criterion, without the security gates, it will be very difficult to determine the violations of persons, which may affect the safety of others, so there must be an easy detection point that allows for rapid passage and at the same time the rapid detection of the presence of metal or weapons hidden in the person's body.

Electronic security gates are considered one of the security tools in securing many buildings, including factories, commercial malls, residential complexes, hospitals, and universities.

Through the gate's display screens, it is possible to identify the number of people who passed daily through the security gate and also the number of times a metal alarm occurred. Using surveillance cameras, the behaviour of the security personnel can be monitored with the incident as a review of the security situation in the facility.

Security personnel can easily deal with the security gate's operating system and evaluate people according to the sound and light signals issued by the gate easily and conveniently.

The types of security gates differ according to several factors, including Expected visitor volume, Entrance facility details, and weather tolerance.

There are Five Ways to Track Employee Attendance: Journals and paper timesheets, Punch cards, GPS, Biometric systems, and Facial Recognition

In this research paper, a security gate has been proposed that performs many functions. Including recording attendance and absence, controlling the movement of employees inside and outside the building, and also performing sterilization operations for any individual entering the building, in addition to the security function of preventing any unwanted individual from entering.

The idea of identification in the research paper is built on Facial Recognition and QR code and comparison with the previously prepared database, whether for employees or individuals who are denied entry

Literature Review

In [1], Evaluating the opinions of tourists on security measures and their impact on bringing the country back again. Notes that governments and companies must take into account the utmost safety factors while designing airports to provide safety standards for tourists.

Therefore, it was necessary to use technology in insurance operations such as the use of X-Ray [2], biometric e-gate technology [3], and Body Image Processing [4] Despite the use of technology in insurance operations, those who operate it must be at the highest level of training and by the policies of countries to complete the security system [5].

Another aspect of the insurance process is the use of gates to secure libraries [6] to keep their contents from being stolen. But it did not perform the required purpose in terms of cost and false alarms and others.

Among the most widespread means of tracking is the QR code [7], which is widely used in industrial and other uses. The importance of QR codes should be understood with individual use and not misuse. There is some research into designing malicious codes as directing users to some undesirable websites [8].

In [9], An improvement has been made in visual cryptography to reduce computational expenses and at the same time increase the recognition accuracy, which is close to the real image.

In [10], discussed how to use biometrics to identify individuals in ideal and non-ideal conditions and the challenges facing biometric identification and overcoming them to combat spoofing attacks. One of the most important methods was the use of robust algorithms.

Among how it is possible to maintain the attendance of employees and register employees through the use of GPS with the use of a mobile application [11].

Through the previous study, it is clear that:

- The insurance process has a significant impact on the economic side

- The importance of QR codes in the tracking process
- It is not possible to rely on individual Internet applications because with any failure the entire system will fall.
- The combination of two security systems increases the efficiency of the proposed system.
- The gates are not the best solution in all cases, as in libraries, but the choice is made according to the situation.

Therefore, it is necessary to search for a system that performs security functions and sterilization functions, as well as recording the attendance of employees.

This system consists of more than one security system and also the human element.

With the emergence of the Coronavirus, some countries have designed gates to carry out the sterilization process and detect temperatures. Table 1 illustrates a comparison between some of these gates in terms of cost, characteristics, and manufacturing materials.

TABLE 1 COMPARISON BETWEEN DIFFERENT GATES

Compare Gates	Country	Components	Body material	Cost (USD)
SANI-GATE	Italy	360-degree disinfection	According to the material of the pipe	2,075
ALASSRI IND	United Arab Emirates	Camera, Temperature sensor, Ultra-sonic, Display screen, hand sanitizing & 360-degree disinfection	External cladding (PPGI sheet), Internal cladding (Starz PVC) & Floor (Aluminum)	3,809
Gates sterilizing military production	Egypt	Temperature sensor, Ultra-sonic, LED & 360-degree disinfection	Stainless Steel, Alumital & steel	3,823 1,274
SANITIZING GATE	India	360-degree disinfection & sensors.	Waterproof poly	667
Disinfection Channel	China	Camera, temperature sensor, Hand sterilization, display screen, Indicator light, 360-degree disinfection	Aluminum	3,509 4,010

Proposed Structure

- The person enters the gate and look forward to the box in the gate as shown in figure 2.
- Measuring the temperature to ensure that there are no symptoms. The temperature sensor reads the person's temperature If the person approaches the box with a distance of less than 5 cm.
- After measuring the temperature, the identity of the person is confirmed by the camera and his QR Code.
- If the person is an employee of the organization, he enters the sterilization stage.
- If the person is not an employee of the organization, the security officer will give a QR code to the visitors. The identity of the visitor is checked using the entrance camera and comparing the visitor's

face with the recorded images of the unwanted peoples, if it does not represent any threat, it enters the sterilization stage, but if it represents a threat, it is dealt with by the security employee.

- If a person has a good temperature below 38 degrees. The arrival time and date are saved in the database.
- After the person crosses the security gate, the ultrasonic sensor will give feedback to the system to pass the person and to close the security gate.
- After completing the security part, the sterilization process begins and consists of 7 nozzles to form a complete body Sterilization (360°) as shown in figure 3.

The first step in the manufacture of the gate is to choose the appropriate material that can resist the surrounding conditions and weather factors. To be able to list the materials that can be used, a search was made for the gates currently available in the market and the materials used for manufacturing, the most famous were iron, aluminium, tin, and stainless steel. Each metal was studied, and it was found that each of them has its negative and positive aspects that appear in Table 2.

TABLE 2 COMPARISON BETWEEN DIFFERENT MATERIALS

	Stainless Steel	Iron	Tin (Saj)	Glass	Plastic
Weight	Heavy	Heavier	Light	Heavy	Lighter
Interaction	Low	Higher	High	Lower	Higher
Fragility	Low	Lower	Low	High	Low
Stability	Low	Higher	Low	High	Lower
Cost	High	Higher	Low	High	Lower

It is possible to overcome the interaction with the outside atmosphere by using some paints that work as a buffer layer to prevent or reduce the reaction. As for the tank, we found that the best solution for it is stainless steel, because it does not interact with the sterilization liquid, and it is better than making a tin covered with an anti-reaction material, so the best solution was for the tank & body to be stainless steel.

The second step is the choose the ideal shape for the gate. Figure 4 and figure 5 show the proposed structure and its dimension respectively.

The third step is the design of the temperature sensor. The MLX90614 is used, the main function of the IR sensor MLX90614 sensor is to measure how much the temperature of an object with no physical contact. The MLX90614 sensors calculate the temperature of an object by measuring the quantity of IR emitted from it. Figure 6 shows the physical structure of the MLX90614 sensor.

The fourth step is the facial recognition step. The raspberry pi camera with flexible cable for connection between the camera and raspberry pi 4 b is used. The camera is a high-definition 5MP shoot photo and video. The camera operates two operations at the same time in this security part, face recognition and QR-code reading.

The fifth step is the internal gate. To increase the control of the gate, an internal gate was designed similar to the gates of a metro station that opens when verifying the identity of people.

The sixth step the attendance recording. The MySQL database is used, it's simple and free.

All employee data and photos are stored and used for comparison during the entry process. Because the raspberry pi with Linux operating system is used, the best provider is MySQL to be compatible. Also, because python is used for coding, the best way is MySQL, and to connect it with python is easy. Anyone in the network who has access to the database can easily see the tables and the attendance report.

The last step is the sanitizing step. There are different methods for sanitizing like heat, steam, and chemical techniques as shown in Figure 7.

The main parameters in the sanitizing system are discussed as follows:

The pressure of the pump (P)	125 psi
Diameter of nozzle (D)	6 mm = 0.23622 inches
Orifice diameter (d)	0.3 mm = 0.011811 inches
Nozzle flow rate	0.05 LPM
Distance from the nozzle (W)	10 cm = 4 inches
The density of Ethanol-Water Mixture	0.863 g/cm ³ = 863 kg/m ³
Spray coverage (C)	29.9 inch
Atmospheric velocity deceleration coefficient (V _c)	0.85

$$\text{Spray coverage (C)} = 2D \tan\left(\frac{\theta}{2}\right) \quad (1)$$

$$\text{Flow rate (Q)} = 28.9 * d^2 * \sqrt{P} \quad (2)$$

$$\text{The impact force of the solution (F)} = \rho * Q * V_c * V \quad (3)$$

$$\text{Flow velocity immediately after nozzle (V)} = k \sqrt{\frac{2P}{\rho}} \quad (4)$$

Proposed Structure Results

To control the operation of the gate, raspberry pi 4 model/ 8GB is used. 7-inch LCD Capacitive Touch Screen compatible with the Raspberry Pi is used to show the employee face and QR code. The target of the proposed structure is to register employee attendance for any building by using a camera and QR code. The face, recognition step recognizes all faces that cross near the camera module and gives feedback to the system. This feedback includes the name of the employee and the arrival time. Figure 8. Illustrates the face recognition process.

The steps for face recognition can be summarized as follows:

- Insert two folders on raspberry pi, these folder includes all images for employees in one folder and the blocked peoples in another one, each image has the name of the employee.
- Read images from employees and blocked folders that have been added before on raspberry pi.
- Save the names of all images in two arrays, one of them for the employees, and the other one for blocked persons.
- Get the face locations for all the images like figure 9, and crop the face, then after that encode the face to get the dimensions and the outlines of each person's nose, mouth, eyes, and chin like figure 10. Then save the encoding of the image in an array.
- Repeat step 4 again but now for the current frame only, if the current frame does not have any faces the code goes to the next frame until finding the face.
- Compare the dimensions of the face by all dimensions in the dimensions array of all images saved in step 3.
- Get the face distance between the face and all saved faces, the minimum distance is the correct face from faces.
- Get the name of the image that has the minimum distance and this name is the name of the person.
- Repeat the last 3 steps if any more faces in the current frame.
- After we have the names of the person or more, we go now to check if the person is in the blocked array or not, if the person in the employees array the system detect his face with a green box and write his name on the box if the person in the blocked list the system detects his face by a red box and write blocked on it. Figure 11 shows the output of the system.

This process has some lag, to solve this problem camera with 5MP is used.

After confirming the identity of the person, another means of verification was added via the QR code. Figure 12 shows the final result of the last two steps.

As soon as the person is allowed to enter, the internal gate is opened. The cost has been taken into account and depends on only one motor. Figure 13 shows the design of the internal gate.

And finally, the sterilization process . The chemical sanitizing method is used because it is available, cheap, and effective in sanitizing gates. The proposed sanitizing system consists of a spray nozzle, diaphragm water pump, Plastic hoses, T and L connectors, and solution tank as shown in Figure 14.

7 spray nozzles made from stainless steel as shown in figure 15 because it bears the presumed rust due to sanitizing solution.

A Water Pump machine that is shown in figure 16 is placed on the tip of every gate that picks the 70% of alcohol solution from the tank. Because the system is automatic it senses if anybody is entering the gate. When anybody enters the gate, the Water Pump becomes started for 4 seconds. So that the person can go through that gate, and if there is no person pass through the gate, the pump will be off to conserve the water and electricity. The foggy sanitizing spray preserves citizens from taking bacteria along a time of at least 60 minutes. Besides, it sanitizes the air, exposed skin, and human clothing.

By comparing the practical results with the ideal results, we find a great convergence. For the ideal case, the Spray coverage (C) is 29.9 inches, the Flow rate (Q) is 0.2 LPM (For 7 nozzles), the Flow velocity immediately after nozzle (V) is 14.47 m/s. For practical case, the Flow rate (Q) is 0.5 LPM (For 7 nozzles), the tank volume is 25 Liters, Time to use all solution in the tank is 3000 secs, one person can take 4 seconds to achieve all body sanitizing, Number of persons per tank is 750 persons.

ISSG aims to implement a security gate equipped with a sanitizing system that can overcome the problems in the gates shown in Table 1 with the suitable cost as shown in table 3.

TABLE 3 THE TOTAL COST OF THE PROPOSED GATE

Components	Quantities	Cost	Total cost
Raspberry pi 4B - 4GB RAM	1	1825	117
Raspberry pi camera wire	1	35	35
Relay	1	40	40
Raspberry pi camera case	1	48	48
BPI4 BOX FAN (Raspberry pi case)	1	175	175
RPI4 Adaptor ON OFF	1	90	90
HS. P4 (Heat sink)	1	25	25
Micro HDMI to HDMI	1	40	40
SD card 32 GB	1	195	195
KIT MLX90614 with pins	1	427	427
HC-SR04 Ultrasonic Sensor	3	38	114
Raspberry pi camera	1	375	375
HDMI LCD 7" 1.24*60	1	1250	1250
Pump & Adaptor	1	450	450
Sprinkles	7	50	350
Hoes	1	35	35
L connector	2	5	10
T connector	6	5	30
Pump components	3	10	30
3-24V Buzzer Alarm	1	15	15
330-ohm resistors	3	0.25	0.75
Led	3	0.25	0.75
Breadboard	1	20	20
Stickers	1	60	60
Wires	1	44	44
Hoes, connector & sprinkles	1	111	111
ISSG body	1	25,000	25,000
ISSG component cost in L. E			30,795.5
ISSG component cost in USD			1962

During the manufacture and implementation of the proposed portal, there were some problems that were overcome among these problems: (1) lag in the process of face recognition due to the high-definition image from camera and solved by reducing the resolution of the input image (2) how to connect between python code and MySQL and solved by adding the python as a user has the full access permission in MySQL (3) The camera takes more than one frame of the same person, so it will be recorded in the database more than once and solved by a feedback process between the database and the python. So that the database is not allowed to register again (4) The detection range of the IR sensor is limited by the operation voltage. When connect it on the raspberry pi with 5v, the detection range becomes too small to detect the incoming person. To solve this problem the IR sensor is replaced by ultrasonic sensor because the detection range of the ultrasonic sensor is more than the IR sensor and it need only 5v to work. (5)

How to control on the pump (AC) using the raspberry pi (DC), to solve this problem a relay is used to control pump powered from 24V DC supply.

In Figure 17, the final shape of the gate with all its parts after the completion of the manufacturing process is shown

Conclusion

To reach the final design of the proposed gate, meetings were held with specialists in the security field and the field of human resources. The proposed gate records the attendance and the departure of the employees, based on which the annual leave and salaries were calculated. The human element and technology were also combined in the security process to reach a precise security system. The proposal is tested in the Egyptian Academy of Engineering and Advanced Technology, and the results showed great effectiveness in the work of human resources for employees, in sterilization operations, and in controlling the entering and exiting the academy. One of the most important features of this gate is that in the event of the end of the Corona pandemic, the sterilization part can be separated, which will reduce the total size of the gate by more than half, as well as reduce the total cost.

Also, one of the most important features of the proposed gate is the cost, which is evident by comparing the actual manufacturing cost with the gates in the global market, despite the many advantages that characterize the proposed gate.

Declarations

Conflicts of Interest: No potential conflict of interest was reported by the author(s).

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Data Availability: The datasets and the codes generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Hassan, T.H., Salem, A.E.:The Importance of Safety and Security Measures at Sharm El Sheikh Airport and Their Impact on Travel Decisions after Restarting Aviation during the COVID-19 Outbreak. Sustainability.(9). 5216. (2021). <https://doi.org/10.3390/su13095216>
2. Naji, M., Abdelhalim, S., Al-Ani, A., Al-Kilidar, H.: Airport security screening process: a review. CICTP 2017: Transportation Reform and Change—Equity, Inclusiveness, Sharing, and Innovation, 3978–

3988. (2018)
3. Kim, C., Costello, F.J., Lee, K.C.: Integrating qualitative comparative analysis and support vector machine methods to reduce passengers' resistance to biometric e-gates for sustainable airport operations. *Sustainability*. **11**(19), 5349 (2019). <https://doi.org/10.3390/su11195349>
 4. Almazroui, S., Wang, W., Zhang, G.: Microwave imaging for security applications University of Sussex.(2015)
 5. Gillen, D., Morrison, W.G.: Aviation security: Costing, pricing, finance, and performance. *J. Air Transp. Manage.* **48**, 1–12 (2015). <https://doi.org/10.1016/j.jairtraman.2014.12.005>
 6. Harwell, J.H.: Library Security Gates: Effectiveness and Current Practice. *J. Access Serv.* **11**(2), 53–65 (2014). DOI:10.1080/15367967.2014.884876
 7. Smith, E.J., Kollars, N.A.: QR panopticism: user behavior triangulation and barcode-scanning applications. *Inform. Secur. Journal: Global Perspective*. **24**(4–6), 157–163 (2015). <https://doi.org/10.1080/19393555.2015.1085113>
 8. Appl, C., Ekelhart, A., Fenz, N., Keiseberg, P., Leo, H., Kirrane, S., Polleres, A., Taudes, A., Treitl, V., Singer, C.: Big Data, Innovation und Datenschutz. Studie für eine DS-GVO kompatible Vorgangsweise zur Entwicklung einer Big Data Anwendung. (2017). <https://epub.wu.ac.at/id/eprint/6410>
 9. Ibrahim, D.R., Teh, J.S., Abdullah, R.: Multifactor authentication system based on color visual cryptography, facial recognition, and dragonfly optimization. *Inform. Secur. Journal: Global Perspective*. **30**(3), 149–159 (2021). <https://doi.org/10.1080/19393555.2020.1817633>
 10. Arora, S., Bhatia, M.: Challenges and opportunities in biometric security: A survey. *Information Security Journal*. 1–21. (2021). <https://doi.org/10.1080/19393555.2021.1873464>
 11. Khan, M.Y., Ram, S.A.: GPS enabled employee registration and attendance tracking system. 2015 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICT). (2015). <https://doi.org/10.1109/ICCICT.2015.7475250>

Figures

Figure 1

System block diagram

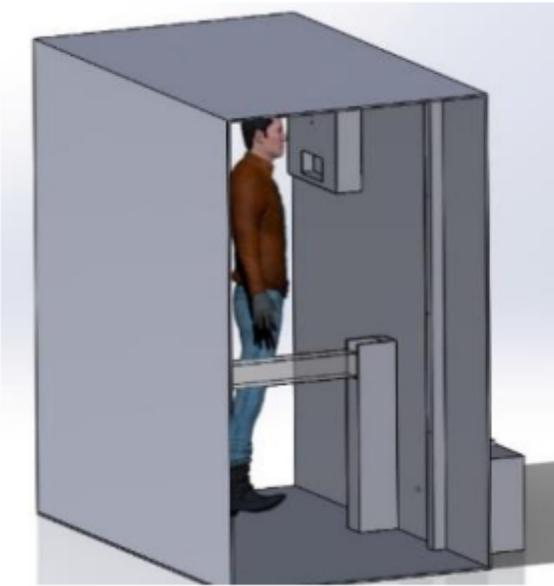


Figure 2

The person in the security section.



Figure 3

The person in sanitizing section

Figure 4

(a) 3D view (b) Cross-section.

Figure 5

Dimensions of the proposed structure.



Figure 6

MLX90614 sensor.

Figure 7

Sanitizing techniques.

Figure 8

Face recognition Process.

Figure 9

Face location of the images.

Figure 10

Face outlines.

Figure 11

The output of the face recognition stage.

Figure 12

The results of the face recognition and QR code together.

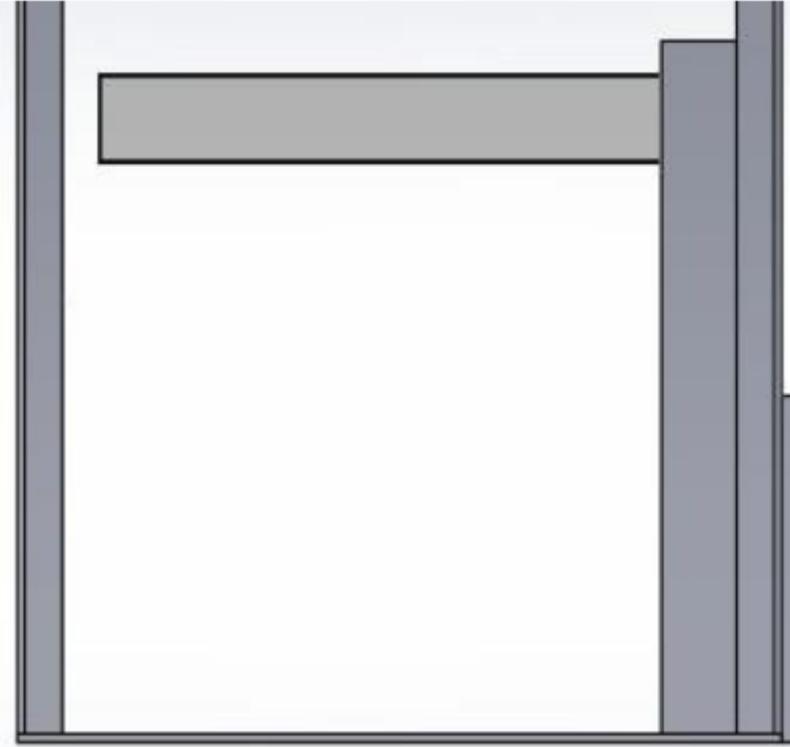


Figure 13

The design of the internal gate.

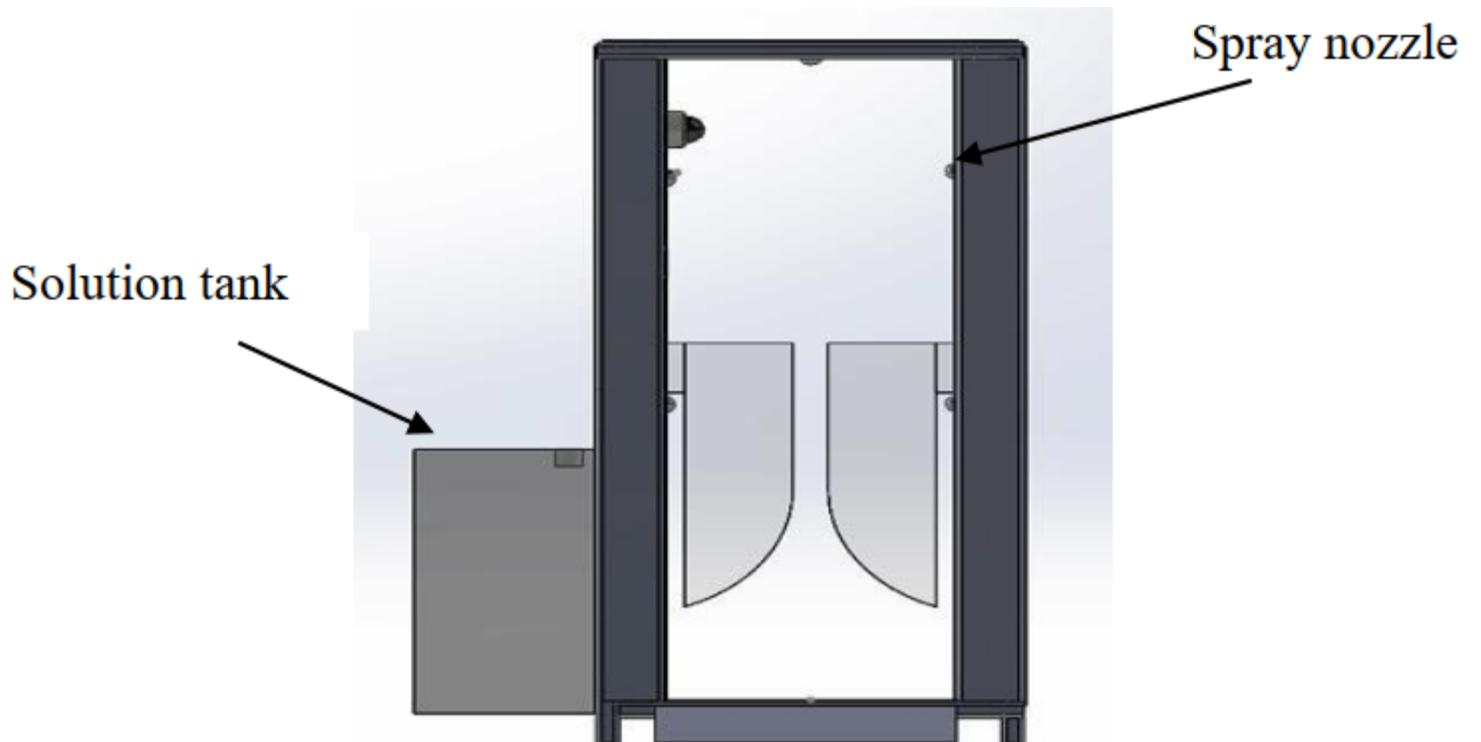


Figure 14

Sanitizing system in the gate.

Figure 15

Nozzle components.

Figure 16

Diaphragm water pump.

Figure 17

The final shape of the gate.