Design of automatic hand sanitizer with ultrasonic sensor

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Abstract. An automatic hand sanitizer allows the discharge of the sanitizing liquid without pressing any nozzle. The design of the automatic hand sanitizer is focused on the mechanism of pressing the nozzle of the hand sanitizer that involves conversion from a rotation movement into a translation movement. VDI 2221 method is used to design the automatic hand sanitizer, which uses Arduino Nano as the microcontroller, servo motor as the motor, ultrasonic sensor for detecting the movement from the environment, and rack and pinion system as the mechanism for pressing the nozzle from the hand sanitizer. The prototype of automatic hand sanitizer has worked well and has become a reference for further development.

Keywords: design, automatic hand sanitizer, ultrasonic sensor.

1. Introduction
Hand is one of the media that could spread diseases, such as skin diseases, diarrhea and respiratory diseases such as Upper Respiratory Tract Infection caused by germs or bacteria left on the hands after carrying out various activities, therefore cleaning hands is very important for everyone to prevent the spread of disease. Washing hands is a simple activity that aims to remove impurities and minimize the number of germs in the hands and palms. Washing hands using water requires humans to be close to water sources and if washing hands without hand washing soap that contains antiseptics, it will not be effective in removing the bacteria from the hands and not cleaning humans from the microorganisms on the hands. There is a more practical way, by using an antiseptic gel liquid called hand sanitizer \([1]\).

The automatic hand sanitizer is a smart device that is controlled by an Arduino microcontroller, in addition to working automatically this tool is also programmed to be able to adapt to user needs, this tool can be applied anywhere, such as in restaurants, hospitals, toilets, etc. Because this tool works automatically, our hands are more assured in cleanliness because users doesn’t need to touch the hand sanitizer lever to operate the hand sanitizer.

2. Method
The design method is using the VDI 2221 which is divided into 4 steps as follows: \([2-8]\)

a) Make the clarification of the task
b) Identifying the conceptual design and the embodiment design
c) Create the detail design
d) Choose the material used from the chosen design
e) Adjust the design specifications for the prototype
f) Create the prototype

3. Result and Discussion
As an initial reference in this design, specifications are determined by considering the requirements of demand and wish \([9-11]\).
Table 1. Demand and wish

| Demand and wish                  | Demand       | Wish          | Demand       |
|----------------------------------|--------------|---------------|--------------|
| The movement uses motor power    |              |               |              |
| Material is easily found at low prices |              |               |              |
| Good quality material            |              |               |              |
| Low cost manufacturing           |              |               |              |
| Easy manufacturing               |              |               |              |
| Low cost maintenance             |              |               |              |
| Easy maintenance                 |              |               |              |
| The use of the hand sanitizer is enough for one time use | Demand       |               |              |
| Rechargeable battery             |              |               |              |
| Automatic operation              |              |               |              |

Table 2. Design variant

| Variable                      | Automatic hand sanitizer design |
|-------------------------------|---------------------------------|
| Microcontroller               | Arduino Nano, Arduino Uno, Arduino Mini |
| Motor                         | Servo Motor, Stepper Motor      |
| Rotation movement             | 360°, 180°, 90°                 |
| Mechanism system              | Crankshaft Mechanism, Rack and Pinion |
| The material of the automatic hand sanitizer body | Aluminium, PLA (Polyactic Acid), Stainless Steel |
| Concept design of the automatic hand sanitizer body | |
Table 3. Solution principle

|                     | Variant 1 | Variant 2 | Variant 3 | Variant 4 | Variant 5 | Variant 6 |
|---------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Fulfill the         | NO        | NO        | NO        | NO        | YES       | YES       |
| demand list of      |            |           |           |           |           |           |
| needs               |            |           |           |           |           |           |
| Can be realized     | YES       | NO        | YES       | NO        | YES       | YES       |
| Easy to operate     | YES       | YES       | YES       | YES       | YES       | YES       |
| Safe to use         | NO        | YES       | YES       | YES       | NO        | YES       |
| Motor can handle    | YES       | NO        | YES       | NO        | NO        | YES       |
| heavy load          |            |           |           |           |           |           |
| Easy maintenance    | NO        | NO        | YES       | YES       | NO        | YES       |

From the results of the possible design variants. The results are obtained by using variant 6 using arduino nano as a microcontroller, servo motor as the type of motor used with a rotational motion of 90°, the type of material used for automatic hand sanitizer type PLA (Polyactic Acid) so that it can be manufactured in a 3D printing process, using concept design 2. The determination of the force required by pressing the hand sanitizer lever on a digital scale. This experiment was carried out 4 times with 4 different bottles and different viscosity level of hand sanitizer, with the average force obtained. The results that is taken can be seen in table 4 [12-14].

Table 4. Force test results

| Bottle Diameter (mm) | Bottle Height (mm) | Viscosity Level (cP) | Force (N) |
|----------------------|--------------------|----------------------|-----------|
| 85.5                 | 170                | 400                  | 21        |
| 72.55                | 200                | 520                  | 30        |
| 74.6                 | 175                | 400                  | 25        |
| 67.55                | 230                | 152                  | 15        |

The force obtained needs to be multiplied by 1.5 as a safety factor for pressing the hand sanitizer nozzle lever so that the above experiment can be concluded that the compressive force needed to press the hand sanitizer nozzle lever is 45 N.
The determination of the specifications for the rack and pinion by using the MG996R type of servo motor are shown in table 5.

| Parameters | Rack (mm) | Pinion (mm) |
|------------|-----------|-------------|
| Diameter   | -         | 45          |
| Width      | 20        | 20          |
| Length     | 11        | -           |
| Height     | 62        | -           |

The sliding bearing is used to hold the rack gear and is tested by performing a static stress simulation on Fusion Autodesk 360 with the following results shown in Figure 1 and Figure 2.

**Figure 1. Stress Analysis**

**Figure 2. Displacement**

The overall design of the automatic hand sanitizer can be seen in Figure 3.

**Figure 3. Automatic hand sanitizer design**

### 4. Conclusion

Based on the results of the automatic hand sanitizer design, it can be concluded that the automatic hand sanitizer can facilitate the use of the hand sanitizer without touching the hand sanitizer nozzle and more efficient maintenance by simply replacing the hand sanitizer bottle without having to open the bottle for refilling the hand sanitizer.
5. References

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