Data Article

Experimental push and pull force data utilizing self-developed automatic liquid dispensers

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\textbf{Abstract}

Dataset mechanical properties of an automated liquid dispenser are essential to study for proper design. Therefore, this article includes a push and pull force dataset collected via a load cell sensor on an automatic liquid dispenser self-developed. During one test, nineteen push and pull data were acquired. Measured data is transmitted and saved using internet networks on data cloud servers. The dataset is composed of three types of fluid (i.e., water, soap, and hand sanitizer), three levels of fluid volume (i.e., 50, 150, and 250 ml), and six levels of servo motor rotation angle (i.e., 30°, 60°, 90°, 120°, 150°, 180°). The raw dataset consists of 60 treatments from the 1857 test. This data also provides push and pull force testing of an empty automatic liquid dispenser. The raw data files have been provided. For researchers involved in designing automated liquid dispensers, the dataset may be used to be more reliable in its development. It is possible to prevent over and under design in deciding the energy consumption of an automated liquid dispenser by researching this push and pull force data more deeply. The dataset will be shown as Excel files.

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Specifications Table

| Subject                  | Engineering |
|--------------------------|-------------|
| Specific subject area    | Mechanical engineering, automatic liquid dispenser self-developed, push and pull force, water, soap, and hand sanitizer |
| Type of data             | Table |
| How data were acquired   | Push and pull dataset acquired thorough the load cell sensor was mounted on the automatic liquid dispenser self-developed. A servo motor will pull strings connected to a dispenser bottle's head while the push-button is pressed on top of the panel box. An IoT-based microcontroller (ESP8266 WiFi Arduino micro-controller) is used to record data and send it to private cloud servers. Communicating data using an internet network. |
| Data format              | Raw, Presented as .xlsx extension file formats |
| Parameters for data collection | Push and pull force datasets were collected during the automatic liquid dispenser performed. The automatic liquid dispenser is filled using water, soap, and hand sanitizer. A water sample was collected from the laboratory Research Center for Appropriate Technology. Soap and hand sanitizer collected from a modern market in Indonesia. |
| Description of data collection | Push and pull force dataset is the action and reaction force arising from an automatic liquid dispenser when it releases fluid. The force is measured using a load cell sensor with a comprehensive error of 0.05%. The dataset is composed of three types of liquid (i.e., water, soap, and hand sanitizer), three levels of fluid volume (i.e., 50, 150, and 250 ml), six levels of servo motor rotation angle (i.e., 30°, 60°, 90°, 120°, 150°, 180°). An empty load test is also carried out for comparison data. The raw dataset consists of 1857 tests with 60 treatments, repeated 30 times (with fluid) and 6 treatments repeated 10 times (without fluid). Especially for the fluid volume level of 50 ml, it was repeated 60 times. |
| Data source location     | Push and pull force data from automatic liquid dispensers were collected at the Research Center for Appropriate Technology, Indonesian Institute of Sciences (LIPI), Subang, Indonesia |
| Data accessibility       | Dataset are presented as MS Excel (.xlsx) extension formats and can be found in Mendeleay repository data: https://data.mendeley.com/datasets/vxf6b58fb/1 or http://dx.doi.org/10.17632/vxf6b58fb.1. |
| Related research article | Measurement push and pull forces on automatic liquid dispensers [1]. http://doi.org/10.11591/ijece.v11i6.pp%25p. |

Value of the Data

- The dataset provides information on the push and pull force from automatic liquid dispensers on some types of fluid, levels of fluid volume, and servo motor rotation angle.
- Push and pull forces can be used by industrial engineers as a reference in calculating electrical power requirements and predicting the refill period of automatic liquid dispensers. The dataset can also be analysed to determine the power consumption of automatic liquid dispensers with the liquid in them in the form of water, soap, and hand sanitizer. Besides, researchers and readers who focus on mechanical engineering can benefit from these data.
- In future studies, the data set may be reused to design and develop new prototypes of automatic liquid dispensers to prevent under and over design.
• To the best knowledge of the authors, there is no dataset and scientific paper to evaluate push and pull force data from automatic liquid dispensers.

1. Data Description

The state of the art of research related to automatic liquid dispensers has been widely described by Karn, et al. [2] and Edgar-Tanzil [3]. However, they are not representing the action and reaction force of the automatic liquid dispenser they reported. Therefore, in this paper, we present a push and pull force dataset from automatic liquid dispensers self-developed. The raw dataset consists of 1857 tests with 44 columns sorted as in Table 1. Pull and push force are numerical values expressed in kilogram-force (kgf) units. Besides, pull and push force testing is also carried out when the automatic liquid dispenser is empty.

In the dataset, there are three types of fluid, three levels of fluid volume, six-step motor rotation angles, and a set of tests on empty fluid volume. Testing with empty fluid volume is necessary to determine the existing push and pull forces required for these self-developed automatic liquid dispensers. Each treatment is repeated ten and above times. The code in the dataset describes the abbreviation of each treatment in the experiment. Pull and push force describe the force obtained during the work of the liquid dispenser. This dataset can be reusable to determine the precise electrical power in designing automatic liquid dispensers for water, soap, and hand sanitizer.

2. Experimental Design, Materials and Methods

The schematic of part for the acquisition of pull and push force dataset from the automatic liquid dispenser is shown in Fig. 1. These components can be divided into two main parts, i.e., the automatic liquid dispenser unit and the control box unit.

The automatic liquid dispenser unit consists of a dispenser bottle, electric motor and load cell sensor. A string connects the three sections at a certain angle (see Fig. 1). The servo motor, and load cell sensors are controlled from the second part of the unit, namely the control box.

To use self-developed automated liquid dispensers, the bottles must first be filled with a specific amount of liquid to be tested. Furthermore, the string is connected to the hook on the servo motor, and the control box unit is connected to 5 V voltage. Next, a rotation angle of servo motor is adjusted with a potentiometer knob according to the experiment’s needs. The push-button on control box can then be pressed to command a servo motor to rotate. Data from servo motor execution (push and pull forces) were then recorded by a load cell sensor, which is immediately sent to cloud data server via internet network.

The control box uses an IoT-based microcontroller (ESP8266 WiFi Arduino micro-controller) to do its performance. A push-button is used to signal the servo motor to rotate. A potentiometer controls the servo motor’s rotation angle.

Table 1
Description of the raw data columns.

| Column number | Parameter           | Type or Levels                          | Unit   |
|---------------|---------------------|----------------------------------------|--------|
| 1             | Fluid type          | Water, soap, and hand sanitizer        | Unitless |
| 2             | Fluid volume        | 0, 50, 150, and 250                    | ml     |
| 3             | Angle of rotation   | 30, 60, 90, 120, 150, 180              | “      |
| 4             | Repetition          | 10 and above                           | times  |
| 5             | Code                | -                                      | Unitless |
| 6–24          | Pull force          | -                                      | kgf    |
| 25–44         | Push force          | -                                      | kgf    |
The data recorded by the load cell sensor is then transmitted through the internet network. Data is saved in a private cloud server. This data can be accessed and downloaded via mobile devices and personal computers.

The types of fluids tested in this paper consist of water, soap, and hand sanitizer. It is chosen based on the fluid commonly used in a liquid dispenser. Based on this, the engineers who will develop automatic liquid dispensers already have a basic design for the need for pull and push force, at least for the three types of fluids commonly used during the COVID-19 pandemic. This becomes important to avoid over or under design in constructing automatic liquid dispensers. The water used in this experiment was distilled water. Soap used a liquid soap type, with the main ingredients being deionized water, sodium laureth sulfate, and viscosity around 4.0 Pa-s. The hand sanitizer used was a gel type with a composition of 70% ethyl alcohol, deionized water, carbomer, TEA, glycerin, color, and viscosity around 3.5 Pa-s.

Each type of fluid was tested at volume conditions, i.e., 50, 150, and 250 ml. For each type of fluid, its volume level, and servo motor rotation angle, i.e., 30°, 60°, 90°, 120°, 150°, and 180° is conducted. Testing without fluid is also performed at each servo motor rotation angle. The volume level and step rotation angle of the experiment were selected by a trial method. It is intended that these treatments can be analyzed and optimized before arriving to the right choice that is used in a liquid dispenser. There are 60 sets of experiments carried out by measuring push and pull force using a fluid where each experiment is repeated 30 times. In particular, for the 50 ml treatment level volume, its repetitions were performed 60 times. In addition, push and pull force tests were carried out without fluid in six sets of experiments, where each experiment was repeated ten times.

The fluid type, fluid volume, and servo motor rotation angle are not used to optimize one of the parameter levels in this work. However, it is more about providing an overview of each treatment parameter’s pull and push forces. The maximum force to release water, liquid soap, and hand sanitizer gel were 19.52 N, 19.60 N, and 19.80 N, respectively. The maximum force by volume for the various fluid types was 19.52 N (50 ml), 19.80 N (150 ml), and 19.60 N (250 ml). The maximum force at the servo motors’ rotation steps (180, 150, 120, 90, 60, and 30) were 19.62 N, 19.80 N, 19.45 N, 19.64 N, 11.14 N, and 4.95 N, respectively.

CRediT Author Statement

Agustami Sitorus was responsible for setting up the data collection experiment and gathering the data. Agustami Sitorus and Devianti wrote the original Draft. Agustami Sitorus, Irwin Syahri
Cebro, Ramayanty Bulan contributed to the Writing - Review & Editing. Irwin Syahri Cebro, Ramayanty Bulan, and Devianti revised and gave advice to improve the research.

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**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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