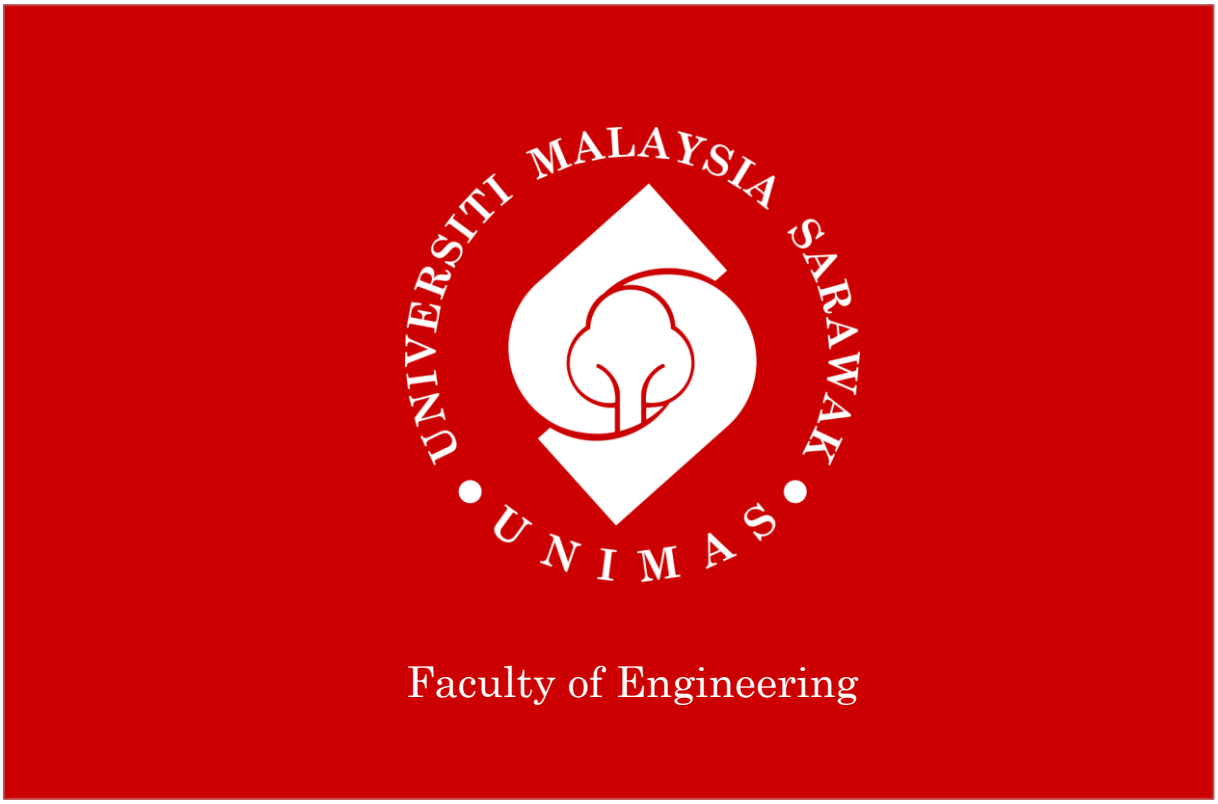

AUTOMATIC TOILET SEAT CLEANER

Narsheera Nidiya Rajapakse

Bachelor of Engineering
Electrical and Electronic with Honours
2022

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

Please tick (✓)

Final Year Project Report	✓
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PhD	

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This declaration is made on 26th day of JUNE, 2022 the

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(66906)

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AUTOMATIC TOILET SEAT CLEANER

NARSHEERA NIDIYA RAJAPAKSE

A final year project report submitted in partial fulfilment of
the requirement for the degree of
Bachelor of Engineering (Hons) in Electronical and Electronics

Faculty of Engineering
Universiti Malaysia Sarawak
2022

Dedicated to my beloved family and friends.

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ABSTRACT

Public toilets are toilets that are placed in the middle of a busy area for public use. Therefore, it is frequently used and requires frequent cleaning to maintain the cleanliness of it. The cleanliness of a toilet seat determines the way a user uses it. A dirty toilet seat encourages users to use it in a wrong way which causes it to be filthy, unwelcoming and may also cause damage which would add on to the cost of maintenance. However, it is irrelevant to have a janitor to wash it after every use just to avoid this problem. Thus, this project aims to overcome the problem by developing an automatic toilet seat cleaning system that allows users themselves to automatically wash the toilet seat before or after using it. The simple toilet seat cleaning system that combines washing, drying and sanitizing is designed to operate automatically when it is triggered with a push button. A prototype of the system has been built by utilizing the convenience of Arduino Uno. The result reveals the efficiency of the automatic toilet seat cleaner which shows the practicality and the significance of the project for public toilet use.

ABSTRAK

Tandas awam merupakan kemudahan awam yang ditempatkan di kawasan yang sibuk. Ia dikhaskan untuk kegunaan orang awam. Oleh itu, tandas awam seringkali digunakan dan memerlukan akitiviti pembersihan yang kerap untuk mengekalkan kebersihannya. Kebersihan tempat duduk tandas akan menentukan cara ia digunakan oleh pengguna. Tempat duduk tandas yang kotor menggalakkan pengguna untuk menggunakannya dengan cara yang salah. Cara mengguna tempat duduk tandas yang salah akan menyebabkan tempat duduk tersebut menjadi lebih kotor, tidak disenangi dan kemungkinan besar juga akan menyebabkan kerosakkan yang akan menambahkan kos penyelenggaraan. Walaubagaimanapun, adalah tidak relevan bagi seorang penjaga tandas untuk mencuci tempat duduk tandas setiap kali ia digunakan. Maka, projek ini bertujuan untuk mengatasi masalah tersebut dengan membina satu sistem automatik yang boleh dikawal dan digunakan oleh pengguna tandas awam bagi membersihkan tempat duduk tandas sebelum atau selepas menggunakannya. Sistem pembersihan yang ringkas ini meggabungkan proses pencucian, pengeringan dan pensanitasian tempat duduk tandas yang akan dilakukan secara automatik apabila suis ditekan. Satu prototaip telah direka dengan menggunakan kemudahan Arduino Uno. Hasil daripada projek ini mendedahkan kecekapan pembersih tempat duduk tandas automatik, kepraktisannya dan kepentinganya untuk diguna pakai dalam tandas awam.

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ABBREVIATIONS

IDE	-	Integrated Development Board
PWM	-	Pulse Width Modulation
AREF	-	Analog Reference
LED	-	Light Emitting Diode
SPST	-	Single Pole Single Throw
IDE	-	Integrated Development Environment

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Public toilets or also known as restrooms and lavatory are often referred to a room or building that contains cubicles that are shared among the public. It is generally located in locations where there are many movements of people such as at tourist spots, in the middle of a city, entertainment venues, service stations, restaurants, hospitals etc. Public toilets serve various purposes and the main purpose of a public toilet in general is for people to relieve themselves. A clean toilet with functional facilities encourages society to use it comfortably. It also reflects on the civilization of the society. Unfortunately, in Malaysia, the public toilets have had a bad reputation among locals and tourist for many years. Malaysian public toilet is known to be dirty, unhygienic and disgusting. Based on an audit finding by the Local Government Department, it indicated that majority of the public toilets in Malaysia are rated to be in an unsatisfactory condition [1]. In regards to that, in another article [2] the writer stated that some of the most common unethical behaviour when it comes to using public toilets are:

- Not flushing the toilet after use;
- Squatting on toilet bowls;
- Wasting toilet papers; and,
- Wetting floor.

Though some users do use the toilet in a proper manner, but due to the dirt that was left by the previous unethical user who used it in the wrong way, the next user has no choice but to use it the wrong way as well to avoid themselves from getting dirty. This chain of action causes the toilet to be dirtier. It is without any doubt that a toilet needs

frequent cleaning to prevent contamination and provide comfort for users. However, it is impractical for a janitor to clean the toilet in public toilets after each use. Therefore, to avoid sitting in the dirt, some people might squat uncomfortably on the toilet seat with their shoes on. This sitting position not only would dirty the toilet seat even more, instead, it can also cause damage to the toilet seat. In addition to that, some people would line the toilet seat with toilet papers before sitting on it thinking that the toilet paper will acts as a barrier between the seat and their skin. What they fail to realize is that not only are they wasting toilet papers but, the toilet paper is the breeding ground for microorganisms. Some of them would wipe the dirt on the toilet seat using toilet papers instead which will only end up spreading the germs on the seat even more. Some would pour water along the toilet seat first before using it causing the floor to be wet.

1.2 Problem Statements

According to a survey conducted by [3] to gather information regarding on the public toilet user's needs for toilet seat cleaners, majority of the users prefer having a dried toilet seat and a toilet seat that is cleaned using water. Besides that, they also prefer using automatic control system to clean the toilet seat. Thus, to meet the needs of the public, these functionalities need to be incorporated into the design. Also, to make it suitable to be used for all toilets, the current toilet seat cover dimensions and shape must be used instead with only a slight modification to it. Therefore, the system should be simple so that it can all be embedded onto the small surface area of the lid.

1.3 Project Objectives

The objectives of this project are:

1. To analyze the types of automatic toilet seat cleaner designs and its pros and cons.
2. To design a simple Arduino based system that cleans the toilets seat automatically.
3. To evaluate the usability of the automatic toilet seat cleaner.

1.4 Project Scopes

A dirty and unhygienic toilet seat in public toilets can prompt the users to make an attempt to use it in a wrong way just to avoid themselves from getting dirty. This will only cause the toilet to be dirtier and cause damage to it. By developing this automatic toilet seat cleaner, unwanted situation like those can be avoided by maintaining the cleanliness of the toilet seat automatically. At the same time, public toilet owners can also spend lesser on the maintenance of the toilet system.

The main focus of this project is on the development of a combined toilet seat cleaning system in which the washing, drying and sanitizing can be done automatically without the need of manual labour. This project is designed to maximize the surface area of the toilet seat cover by minimizing the complexity of the system using Arduino and a toggle switch. This smart appliance utilizes the convenience of Arduino Uno to develop a battery-operated smart toilet seat cleaner that sprays the toilet seat automatically with water when it is prompted by the user. After spraying the toilet seat with a jet spray for several seconds, a blower will automatically be triggered to blow dry the surface of the seat for 15 seconds before the ultrasonic water atomization humidifier start to blow non-alcoholic sanitizer for sanitization. Finally, the switch will toggle to shut the whole system until it is prompted again. This invention is to ensure a better hygiene for the comfort of users. The targeted usage of the automatic toilet seat cleaner are public toilets.

At the end of this project, a simple automatic toilet seat cleaner that can be easily installed and is efficient is produced.

1.5 Project Schedules

This Final Year Project report comprises of five major chapters that is introduction, literature review and methodology, result and discussion, and conclusion. Each chapter will be discussed in detail to have a better view regarding on the topic for this project. This project is conducted in line with the schedule shown in **Figure 1.1** and **Figure 1.2** respectively in the Appendix I section.

1.6 Project Outline

This report will be explaining on the methods used to overcome the main cause of problem that led to this automatic toilet seat cleaner project. The report consists of detailed explanations and examples which is related to this project. All the explanations will be based on thorough research and studies that is done. This report consists of five chapters.

Chapter 1 is the introduction to this project. This chapter will be discussing on the overview of the project, the problem statement, objective and the scope of this project. The project schedule for this final year project will also be described briefly here.

Chapter 2 is literature review. In the literature review an overview of past works and studies that was done and is related to this topic will be explained. The various designs of automatic toilet seat cleaner will be described and analysed in terms of their benefits and limitations in this chapter. In addition to that, the various methods of drying along with the types of valves will be reviewed to determine the most suitable ones to be used for this project. A brief study on ultrasonic water atomization will also be conducted to understand its mechanism better.

Chapter 3 is methodology. In this chapter, the focus will be given to the process of developing a prototype for this project. The process will include explanations on the design overview, theory of operation, flow chart, block diagram, circuit diagram and hardware prototype. A brief explanation regarding on the specifications of the components and software that will be used for this project will also be given.

Chapter 4 is result and discussion. This chapter gives a detailed explanation on the outcome of the project. Discussion will be done regarding on the effectiveness of the system. Moreover, this chapter also discusses on the problems faced during the experimental process and the methods used to overcome it.

Finally, chapter 5 is the conclusion of the project. The conclusion will give a summary of the overall project and the main findings in the project. It also discusses on the improvement that can be made to the project. Recommendation for future research will also be provided.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are several toilet seat cleaning devices that was proposed by researchers. Toilet seat cleaning devices helps promote graciousness among users. Users can use them to clean the toilet seat whenever they doubt the cleanliness of it and at the same time maintain the cleanliness of the toilet without the need of manual cleaning. Toilet seat cleaners not only help to eliminate germs, but it also provides assurance and protection to users

2.2 Review on Automatic Toilet Seat Cleaning System

Automatic toilet seat cleaning system is a system that makes use of the benefits that IoT offers to carry out a specific task by itself with just a trigger. The trigger can be in the form of sensors or manual switches. There are various automatic toilet seat cleaning devices that has been produced. All these devices vary slightly from each other although it does serve the main purpose that is to clean the toilet seat. In this sub chapter, the differences in the design of the automatic toilet seat cleaner along with its advantages that it has to offer, and the disadvantages will be analyzed.

2.2.1 Rotating Toilet Seat

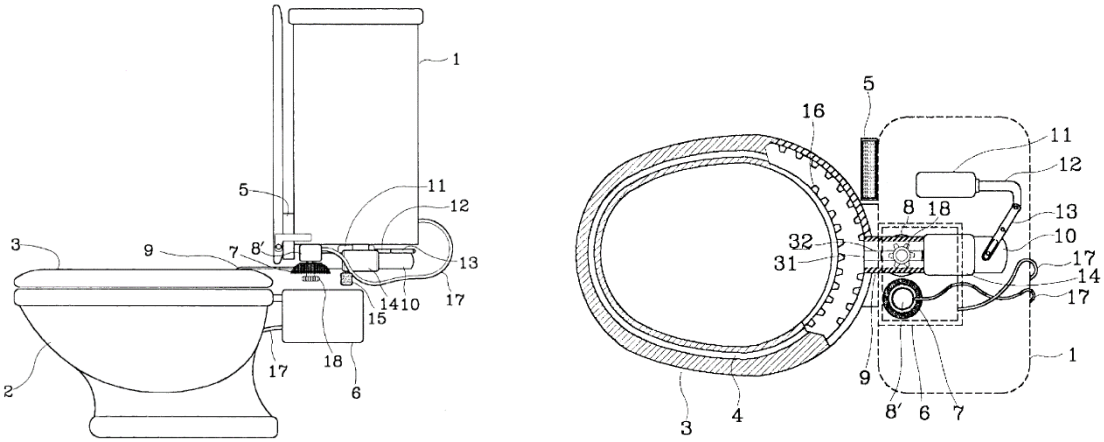
Cleaning toilet seat using a movable toilet seat system is a well-known automatic toilet seat cleaning method. The design comprises of a fixed brush that brushes the toilet seat while the toilet seat oscillates horizontally with the aid of a motor. Researcher [4]

designed a toilet seat cleaning system that uses this concept. The side view and top view design of the automatic toilet seat cleaning system is as shown in **Figure 2.1**. The toilet seat is designed to be movable and is supported by a toilet bowl. The shape of the toilet seat is also modified to suit the functionality of the toilet seat cleaning system whereby it takes the shape almost similar to a horse-shoe. This system uses two motors. The first motor is used to control a transmission mechanism that comprises of two racks that acts as a guide to turn the toilet seat horizontally. When the toilet seat moves to the rare side position, the second motor is activated. The second motor controls the wheel brush that cleans the toilet seat while water is sprayed from a nozzle above the brush. In this design, a waste water tank is incorporated below the brush to collect the water that has been used to clean the toilet seat. The water collected in the waste water tank is directed into the toilet bowl through a water tube to empty the tank. An electrical dryer is also incorporated to dry the surface of the toilet seat quickly as the seat rotates to its original position after being cleaned. A heater is also mounted underneath the toilet seat to keep the seat warm.

There are few advantages to this movable toilet seat cleaning system. Firstly, the toilet seat cleaning system uses water to clean the seat which is environmentally friendly. The water can also be used to indirectly clean the brush that is located below the water tube. Hence, no manual cleaning is needed to keep the brush clean as it is hygienic enough. Since the system uses brush for cleaning, it's hard brissels along with the rotating motion helps to easily scrub of the dirt that is present on the seat. In addition to that, the dryer helps to keep the seat dry after cleaning to ensure the comfort of the users. The waste water tank helps to keep the floor dry. Dry floors helps in preventing the floor from getting soilled easily.

In contrary, the disadvantage of this design is the design of the toilet bowl itself. The toilet seat cleaning system is directly connected to the toilet bowl and the water tank as a unit. Therefore, users will have to replace the the entire toilet bowl if they wish to have an automated toilet seat cleaning device. There are also many mechanical and electrical components that is embedded into the system which requires a skilled person to fix it whenever problems arises. Thus, this design is costly in terms of its design and the maintenance it requires. In addition to that, the horseshoe design of the toilet seat creates a dead zone that cannot be reached and cleaned by the brush. This causes the toilet seat to not be cleaned thoroughly. To overcome the problem of dead zone, a similar device

was proposed by [5]. The researcher came up with a circular toilet seat design instead. A circular toilet seat has equivalent radius troughout the seat allowing every part of the seat to reach the water nozzle for washing. This design attenuates dead zone areas and allows thorough cleaning on the seat to be done.



(a) (b)

Figure 2.1 Design of automatic toilet seat cleaning system (a) side view; (b) top view [4]

Table 2.1 List of components corresponding to **Figure 2.1**

No.	Components	No.	Components
1.	Water tank	11.	Electromagnetic valve
2.	Toilet bowl	12.	Reciprocating rod
3.	Toilet seat	13.	Link
4.	Heater	14.	Sleeve
5.	Electrical dryer	15.	Rubber wheel
6.	Waste water tank	16.	Racks
7.	Wheel brush	17.	Water tube
8.	First motor	18.	Gear
9.	Bar	31.	Opening
10.	Guide rod	32.	Sliding rod

2.2.2 Washing Mechanism Embedded in Toilet Seat Cover

Another approach to designing an automatic toilet seat cleaner was described by [6]. The design is as shown in **Figure 2.2** whereby the overall design of the automatic toilet

seat cleaning system and the bottom view of the toilet seat cover is shown. The purpose of this design is to wash, sanitize and dry the toilet seat automatically. It consists of a control unit that is connected to the main water supply and embodies a reservoir for disinfectant. This design consists of three independent tubes that is pivotally connected to the toilet seat cover. Two of the tubes carries water or disinfectant. These two tubes have holes on it and is located at the interior and exterior part of the toilet seat rims. It is to ensure that water reaches every part of the rim for thorough cleaning. The other tube which is located in between the tubes that carries water, is a tube that carries hot air to blow dry the toilet seat after washing. The water that is collected after cleaning is directed into the toilet bowl using a run off collector that is located along the outer circumference of the toilet seat. The cleaning process starts when a button is pressed or when the proximity switch/photosensor is triggered after the toilet seat cover is closed.

Comparing this automatic toilet seat cleaner design with the previous toilet seat cleaner proposed by [4], this design is found to be simpler. It does not have any moving mechanism to do the cleaning. Aside from that, using a jet spraying technique can easily remove stains from the seat although this technique is not recommended. This is because the splashes of water can cause germs to spread more unless disinfectant fluid is used instead. In addition to that, using a hot air blower to blow dry the seat can also help to kill the remaining germs that are present on the seat. Apart from that, the focus that is given to the toilet seat cover makes it cheaper and more affordable to be installed in public toilets as it does not require major modification to the existing toilet bowl. The simplicity of the control unit too makes maintenance easier.

Nevertheless, this device has its drawbacks despite of its simple design. The toilet seat cover must be lowered for washing, sanitizing and drying to take place. However, there is no indicator to indicate that the cleaning process has started or ended. This can be confusing for users as they would not know when the toilet seat is ready to be used or when the toilet seat cover is ready to be lifted up. To overcome this issue, [7] came up with an automatic toilet seat cleaner that uses proximity sensor to detect the presence of a user. When the user is away from the seat, the toilet seat cover will automatically be lowered, and the cleaning process starts. After the cleaning has completed, the toilet seat cover will automatically open by itself. Therefore, users will not have to manually lift it up. This is important to ensure that a thorough cleaning has been done first before the user