Energy and Environment

Product Video:
https://youtu.be/W6b59vtbl-0

UV-C LED Sterilizing Toilet

Environmental Veterans:

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We are Environmental Veterans

We are Environmental Veterans, a passionate pair from Korea International School Jeju in South Korea. In the modern society, all of us depend highly on technology, which has been evolving rapidly ever since we could remember. Even though technology has permeated to every single part of our society, our team has been especially intrigued by the utilization of modern technology in social infrastructure.

We were eager to examine how our life quality would be elevated or the environment would be protected when modern technology incorporates into public facilities. Therefore, we truly feel grateful for the fact that we could design our own high-tech social infrastructure and present its technical and marketing aspects in Conrad Challenge 2018–2019. Even though our UV-C LED Sterilizing Toilet may not be immediately implemented in real life, our team strongly believes that our product is an innovative tool that secures public hygiene in public hygiene in public bathrooms which offers solutions to problems with similar products that are already in the market.

Hwajin Lee: Chief Technology Officer, Head of Product Design

Hwajin has infinite enthusiasm for product design. Through this Conrad challenge, Hwajin has expressed her vision and skills in product design. She was in charge of coming up with the design of the toilet and its technical functions.

Yujin Lee: Marketing Manager

Yujin was in charge of planning the marketing scheme of the toilet when it is implemented in real life.

Business Prospectus

Business Description

UV-C LED Sterilizing Toilet is an automated toilet sterilizer which, if implemented in public bathrooms, will ensure its users a clean toilet seat. Incorporating the newly discovered UV-C LED in its design, our product is innovative and has successfully considered the aspects of economic, social, and environmental sustainability to it. Its automatic operation and environmentally friendly design make our product more efficient and effective than similar products that already exist in the market.

The need for a better sterilizing device in public bathrooms is evident as people are becoming more concerned about public sanitation. The survival and proliferation of salmonella bacteria from toilets have been consistently examined, and the news have threatened many public bathroom users. 100 mW UV-C LED, which is going to be utilized in our product, was recently discovered by LG Innotek and is confirmed that this type of LED can sterilized 99.9 percent of salmonella bacteria, even in low temperature, which if left uncleaned, could lead to severe health problems such as diarrhea.

For years, companies in the market have been implementing various methods of sanitation in public bathrooms which includes automatic plastic seat covers, spray sanitizer, and manual cleaning. Unlike these existing methods which carry either economical or environmental disadvantages, UV-C LED Sterilizing Toilet has been created in such way that it demands the least economic and environmental costs, and yet provides the best user experience.

Best fitting in the *Electronics Manufacturing and Equipment* industry, our product has integrated advanced technology and natural

resources to design a product that is both ergonomic and environmentally friendly. By utilizing solar energy and converting it into a usable form of energy which barely uses electricity to generate, the UV-C LED Sterilizing Toilet offers an effective solution to problems with public sanitation.

The efficiency and effectiveness of our product makes it an innovative finding. Though the UV-C LED Sterilizing Toilet cannot be immediately implemented in public bathrooms, our team ensure that our product will bring positive changes to both the environment and public bathrooms users when people get access to it.

Market Analysis

The UV-C LED Sterilizing Toilet reaches for all bathrooms users, but especially targets public bathrooms users. Though our product could be implemented in households, our team through that our business is more applicable in public bathrooms, where sanitation is much worse. Public toilet facilities are provided by the local government or by commercial businesses. This suggests that our product can either be sold commercially or be approved through government contracts. When the UV-C Sterilizing Toilet is sold commercially, our team will contact the owner of the privately owned public space and ask for consent. If the public space is owned by the local or state government, our team should acquire direct approval from the government to implement our product in every public bathroom owned by them.

Although the UV-C LED Sterilizing Toilet has relatively low economic and environmental cost compared to several existing products in the markets, our business still faces drawbacks that any mass productions confronts. The first struggle is the price of installing the product. For a venture enterprise that starts its business with much lower fund than larger corporations do, producing and implementing its product in mass quantity is a common adversity. This explains the

significance of having funding sources that can consistently give financial support for our business to prosper. The second drawback is time. For now, though our team cannot accurately anticipate how much time it will take for our product to be implemented in public bathrooms, we don't think that it will happen soon. However, it is apparent that in the coming years, this technology will be available at lower price and made more simple while maintaining its functionality.

It is apparent that products designed to enhance public sanitation are commonly expensive and take years to implement. For this reason, our team is convinced the the majority of entities who purchase the UV-C LED Sterilizing Toilet are governments and large corporations, not average consumers.

Competitive Analysis

Never was an automated sterilizer that utilizes UV LED sold in the market. It is a pioneer entry.

After extensive research on our main competitors, automatic plastic seat cover and spray seat sanitizer, our group learned that both of these products require huge economic and environmental cost if they are to be implemented ubiquitously. Although they were initially developed as a solution to problems with unsanitary public bathrooms, both products leave a tremendous amount of waste per use. Also, creating, installing, and maintaining these systems in public bathrooms are not easy jobs. Moreover, although they perform similar functions as the UV-C LED Sterilizing Toilet, they are both outdated and irrelevant to the current generation technology.

i) Automatic Plastic Seat Covers

The automatic plastic seat covers is one of the major solutions for sanitizing toilet seats that rotate into a hidden compartment after each use. Within an open loop system, the plastic seat cover dispenses from

one side and the user rolls up the cover and either disposes it in the trash can or flushes away. Though such an automated system is innovative, because plastic toilet seat covers are absorbent and bacteria and viruses are microscopic, they can penetrate through the plastic covers. Also, using plastic seat covers has an environmental cost; the added paper used to manufacture these items and the additional water that may also be required to flush away and break down the plastic. Acknowledging the fact that toilets can use up to 1.6 gallons per flush—and up to 7 gallons for older toilets—use of plastic seat covers significantly contributes to water loss and pollution. Also, considering the fact that plastic is produced from toxic materials such as benzene and vinyl hydrochloride, it is naturally toxic—it causes cancer and contaminated air and soil.

ii) Toilet Seat Sanitizer Spray

Toilet Seat Sanitizer Spray is a container that contains fluid that is intended to clean and sanitize toilet seats. There are two major commonalities to this product. The first is its inconvenience. The spray toilet seat dispenser can be considered an old technology because users should manually spray a tissue and clean the toilet seat by themselves. Based on personal observation and research, it was apparent that since it is unlikely for users to perfectly distribute the sanitizer on the toilet seat. Even if the spray sanitizer dispenser was automated—the seat automatically lifting up and a device spraying the seat with a sanitizer—the device

will only spray a small portion of the sanitizer on the seat right before it reaches the water tank.

Cost

Our team's budget was used for multiple purposes: purchasing materials, to make a brief prototype of our product, our team gathered every equipment necessary in the process of making the UVC LED sanitizing toilet. The following are the main components of the product: UVC LED strips, toilet seat, automated flush sensor, rotating sensor. To make each of these components, our team will utilize 3D printer to fabricate components of our design. We performed our market research and fabrication components adds up to be about 100 dollars. When we consider fixed costs such as fabrication tool and 3D printer and variable costs we estimate our first market price at about 180 USD. We will have small payroll expenses in the beginning but will not spend any marketing related expenses. It will stay a minimal as possible. This is because in the beginning of our business we will target public markets such as installing products in public and governmental building through lobbying. Once market realizes the effectiveness of product the transition to the private sector will be seamless. Having toilets in these locations automatically serves as a form of marketing. Once we hit to private market which we project to be somewhere between 3rd to 4th year of our business, we will kick in the marketing expenses aggressively and effectively. Our differentiability will be how fast we penetrate the market. We will market this product as one of mandatory products in home appliances.

Team budget to attend the Innovation Summit (April 23-27, 2019): We expect per person to be around around 2000 dollars. Travel and transportation expenses including airfare takes about 1000 dollars and we expect per day expenses to be around 200 dollars including food and accommodation. Although at the moment we will use our parents fund

to pay for this expense if we are lucky enough to receive small amount of investment funding before April we will include that as well.

Funding Sources

Our business is based in South Korea. South Korean government is currently promoting startups among entrepreneurship in their 20s and 30s. They have aggressive governmental funding invested in providing them with seed money. It is not difficult to obtains those funding after a process of application. Some of these funding are unconditional meaning there is no henceforth requirement to be met. We will apply for the funding once we meet the requirement. We will then search for small private investors that are our acquaintance who can chip in small amount of supports around 300-500 dollars each. In reality it is difficult to contact venture capitalist without a prototype. So we expect some time until we reach formal investors. Until then will we survive from governmental fundings. Due to our underage status we will also have to use our "parents fund" to launch this project and also to attend Innovation Summit as described as above.

Technical Concept Report

Technical Summary

The UVC LED sterilizing toilet is an automated system which functions according to the input of a touch sensor that will be installed in the toilet. Since our product operates and resets itself automatically, it guarantees user's convenience. By utilizing a highly stable and strong sterilizer, the UVC LED, our team optimized the product's ability to sanitize the toilet seats in microscopic level. The newly discovered

technology grants a full rate output which requires no warmup time. This ability allows the UVC LED to be “turned on” only when on-demand and still perform its disinfection function without delay.
The cycled on/off of the UVC LED and the rotational toilet seat will both be controlled by a touch sensor which will successfully acknowledge its user pushing the flush button, begin its operation, and will be grounded after the current has cycled the circuit once. By incorporating a micro-controllers into the product’s design, our team allowed the product to follow a specific set of order and operate accordingly without any technical errors.

The simplicity, accuracy, efficiency of our product provides the best user experience and therefore distinct itself from multiple existing technologies, which are partially or entirely operated manually.

Need Statement

The UVC LED sterilizing toilet disinfects toilet seats 99.9% while consuming considerably less energy and leaving no physical waste. In the midst of public anxiety which stems from experience with unsanitary public bathrooms, the development of UVC LED sterilizing toilet satisfies the public need for antiseptic bathroom condition and has environmental and energy-wise efficiency, which doesn’t contribute to the already-existing environmental pollution/destruction. While our society seeks to develop and innovate every scope of it, it totally misses enhancement of public bathrooms since many of them are still very much conventional and antique. The need for the development of our product is apparent not only for the sake of user experience but also to reduce any sort of unnecessary and in-disposable waste created in public bathrooms--which includes tissue and plastic.

While the need for this technology is obvious with the prevention of further environmental pollution and user experience, it also reduces the cost of up-keeping and operation public bathrooms. Considering the

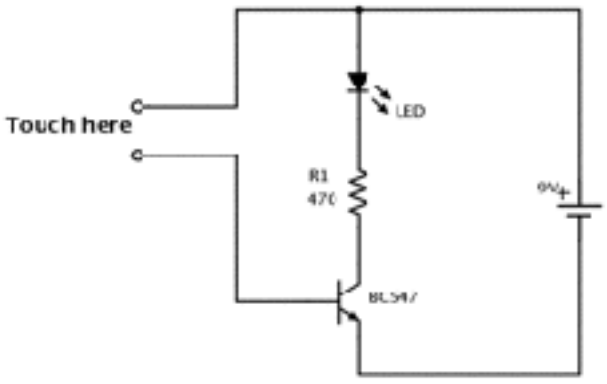
fact that our product is entirely automated with tightly controlled spectral quality, power output stability, and consistent lifetime performance over years, UVC LED sterilizer doesn't easily break; once the product is installed, there probably is no additional cost demanded the product to maintain its operation.

By granting simplicity, stability, and low maintenance cost to its design, UVC LED sterilizing toilet will emerge as "preferred option" for government sectors which are seeking for a solution to unsanitary public bathrooms.

Background Technology

Resistive Touch Sensor

A touch sensor, or a tactile sensor, will be implemented in the UVC LED sterilizer to sense the touch, pressure, and force of the user's hand when it touches the toilet flush button. The working of the touch sensor is simple. When user makes contact with the surface of the touch sensor, the initially-open circuit closes and allows a flow of current, which powers and turns on the operation connected to the circuit. The resistive touch sensor specifically senses the pressure done on the surface of the sensor. Consisting of two conductive layers, top and bottom, a voltage is applied to the surface of the conductor. When a user makes contact with the resistive touch sensor, the surface experiences a mechanical bouncing from the vibration of the pressure; and this reaction powers the sensor.



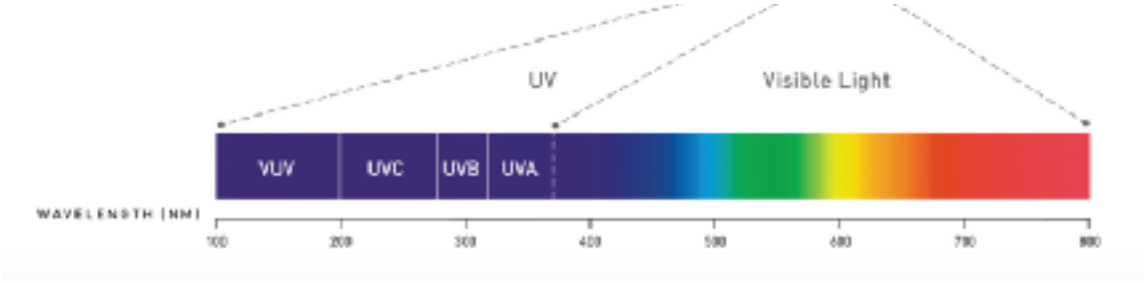
The resistive touch sensor operates based on a basic touch sensor circuit. The basic components of the touch sensor circuit are circuit board, transistor, resistors, battery, touch pad, and LED. The BC 547 npn transistor, a semiconductor device, is implemented as a switch. Two resistors are used in the circuit. One allows the circuit to be grounded

when no contact is made. The other resistor prevents the transistor from sending too much current.

Resistive touch sensors are less expensive than other touch sensors—Capacitive, Infrared, and Surface Acoustical Wave—and thus is more affordable.

UV-C LED

UV-C is a form of UV light with wavelengths between 200-280 nm. UV-C light can be used to disinfect water and air, sterilize surfaces, and kill organisms in microscopic level. When micro-organisms are exposed to UV-C radiation, they instantly lose their reproductivity and are destructed.



Concept Details

Function and Operation

The UVC LED sterilizing toilet is an automated toilet seat sanitizer which reduces the need for manual bathroom cleaning or public anxiety that stems from unsanitary public bathrooms. Our product satisfies people who want access to clean and convenient public bathrooms. Every time the user flushes the toilet, our product senses the absence of its user and automatically rotates a full circle (360°) under the UVC LED light strip installed above the toilet seat. Although the group initially planned to utilize a mercury lamp, which is known to sanitize, after acknowledging the fact that mercury is a low-level disinfectant and that it mounts to environmental pollution, our team was determined to implement UVC LED to our design. Not only is UVC

LED supplied from solar energy, which is reusable and doesn't leave solid waste, but it also requires little to no energy/electricity to generate.

The functionality of our product simple and straight. A sanitizing module that utilizes UVC LED beaming diode is installed above the toilet seat. With a performance of 100mW, single-chip UVC LEDs have a meticulous design that optimizes the UV output, while effectively discharging waste heat, and therefore guaranteeing stable performance for the extensive period. By emitting intense ultraviolet light at 278 nm for more than 10,000 hours, UVC LED rises as one of the most innovative and original approaches to keeping sanitation in public bathrooms. UVC LED, which has powers of milliwatts, is most suitable for sterilizing air, water, and surface--which makes it a perfect sterilizer for the toilet seat. Our product will specifically use the 100 nW UVC LED, which was recently discovered by LG Innotek, that can destroy 99.9% of salmonella viruses--a type of infection that prevails in public bathrooms—even in a shallow temperature. The second primary compartment of our product is the toilet flush sensor. This sensor enables the toilet seat--specifically designed for our product--to rotate every time the user flushes the toilet. For the prototype, our group utilized the Arduino touch sensor. Whenever a user touches the toilet flush button, the touch sensor that is installed under the flush button will sense the impulse. When this happens, the programmed Arduino circuit creates a closed system in which a current flows through and ultimately turns on the UV-C LED. A reset timer will be connected to the circuit so that if the time for the toilet seat to make one full revolution has elapsed, the program automatically resets and files back to its original state: an open system. Although the UV-C LED Sterilizing Toilet is currently only applicable in bathrooms, the technology itself is relevant to wide range of businesses.

Development

The actual production and manufacturing of our product will begin after the government or a larger corporation agrees to fund our

business. Factories directly in link with our funding source will manufacture the UV-C LED Sterilizing Toilet based on our final prototype by utilizing necessary machinery—fabrication tool and 3D printer. If we face any problems with our final design during the manufacturing process, our group should take necessary steps to solve them. Our team believes that the UV-C LED Sterilizing Toilet, when sold in the market, will be marked as a highly innovative and efficient solution to unsanitary conditions in public bathrooms.

Graphic Concept Representation

Final Sketch

First Prototype