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Invited Paper

Improvement of System for Automatic Exchanging Toilet Paper

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Abstract. In this paper, we discuss the toilet paper automatic exchanging system that we have developed and improvement. This system can exchange toilet paper automatically only installing on ready-made goods toilet paper holder. Measurement of the color of the toilet paper and its core is using the color sensor and depending on its measuring RGB value, an automatic exchange of toilet paper to move the servo motor by using the Arduino. This system also can stock some spare toilet paper in the back of the system. By developing toilet paper exchanging system, toilet administrator or cleaning company replenishes toilet paper only and user who uses the restroom doesn't need to exchange toilet paper.

1. Introduction

Everyone use toile at home, station and public facility. However, some people often don't exchange toilet paper though toilet paper runs out. Reasons for people who don't exchange toilet paper are some next matters. They are "They have habit to exchange by environment in which they grew up.", "They can't find that toilet paper run out." and "It is dirty to exchange toilet paper after relieving themselves.". However, most of reason is "It is bothersome.". Although we can exchange toilet paper in about 10 seconds to 20 seconds, some people feel frustrated. Due to some people never replaces the toilet paper run out, other people feel shitty [1]. That some people don't replace the toilet paper gets on other people's nerves, and sometimes they have trouble about that. Also, there are some previous researches about assisting to use toile for physically challenged persons [2]. However, exchanging toilet paper is not much studied in those researches. Therefore, it is difficult for physically challenged persons to use toilet if the toilet paper is run out.

Taking out toilet paper becomes problematic in the restroom at the station and the public facilities. This is because toilet paper is easy to exchange in the general toilet paper holder. The rate of people who had taken out that is a few, but a lot of people troubled by taking out toilet paper [3]. There is almost antitheft toilet paper holder with key [4]. Also there is special toilet paper that length eight time of normally one for saving the trouble of exchanging toilet paper [5]. But they have hard to use, for example that takes labor of exchange toilet paper with key and buy special toilet paper that compatible with those toilet paper holders.

From these backgrounds, we had developed toilet paper holder for automatic exchanging. By using developed system, toilet administrator or cleaning company replenishes toilet paper only and user doesn't need to exchange toilet paper. In addition, it could detect moment when the toilet paper is stolen. However the previous system couldn't stock some toilet paper. Therefore, this system can exchange only one toilet paper.

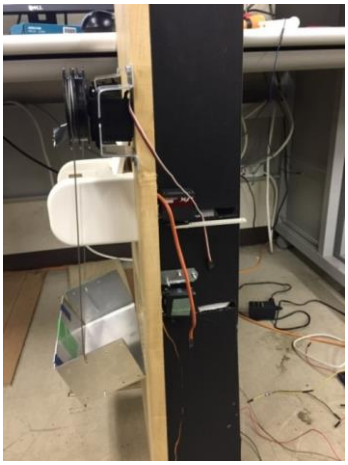
In this study, we have improved the system to stock some spare toilet paper for saving the trouble of replenishing toilet paper.

2. Construction of the System

2.1 Appearance of the system

Overview of this system is shown in Fig. 1. The body is composed of toilet paper holder (W373 by SAN-EI Faucet Mfg co.,ltd), color sensor (ColorPAL 28380 by Parallax Inc.), servo motors, and Arduino (MEGA 2560). Arduino is performing all of the control. Spare toilet papers are stocked in the back of the system. One of spare toilet paper is put in aluminum case below the toilet paper holder. The system exchanges that toilet paper for run outed toilet paper when the toilet paper that is set in toilet paper holder is run out.

(a) Front of the system



(b) Side of the system

Fig. 1. Appearance of the system

2.2 How to exchange toilet paper

The exchanging system is roughly divided into two: the moving unit and the sensor unit. The sensor unit is composed of a color sensor, and Arduino. From the viewpoint of privacy, using camera is not appropriate [6]. Therefore, we use color sensor for detecting the toilet paper is run out. The color sensor is placed on the inside of the toilet paper holder as shown in Fig. 2. When the color sensor irradiates light to an object, the sensor receives the reflected light. The reflected light is different by the color of the object that is irradiated light. The color sensor is measuring the color of the toilet paper. Usually, the color sensor detects the white color of the toilet paper. However, when the toilet paper is used up, the core of toilet paper appears. In that case, the color sensor measures toilet paper core's color. Due to that, the different RGB value is sent Arduino by the color sensor. By

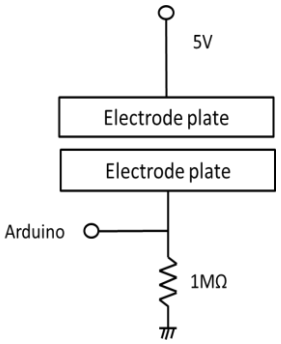
Fig. 2. The color sensor

detecting this difference of value by the Arduino, the system can know the timing of changing toilet paper. Also, if the RGB value sudden change, the system can predict toilet paper is stolen. When the system detects the toilet paper core, the system transmits the instruction to the Moving unit thorough the Arduino program.

Moving unit is composed of servo motors, Arduino and toilet paper holder. Arduino has a role to control the moving part. The direction of rotation of the servo motors is controlled by the signal submitted by Arduino. The servo motors rotate the pulleys based on the instruction from Arduino. The aluminum case attached pulley with wire. The stock of toilet paper is placed in the case. When the servo motor is rotated, the stock of toilet paper is moved upward with aluminum case by pulleys and wire. Due to that, the toilet paper core is pushed the stock of the toilet paper and exchanged. The timing of exchanging the toilet paper is detected by the Arduino. The electrode plates are attached toilet paper holder's arm. The 5V is applied to electrodes. Usually, each electrode plates are contacting and molding the circuit, but when exchange the toilet paper, the electrode plates are move away. So, the circuit is disconnected. However, when the system has finished exchanging toilet paper, the toilet paper holder's arm returns former state. Due to that, the timing of stopping rotate servo motors is determined by measuring the voltage of the circuit by the Arduino. The electrode plates and circuit are shown in Fig. 3.

2.3 Replenish spare toilet paper to aluminum case

We have made the stock case for stocking some spare toilet papers. This stock case is attached the back of the system. The system replenishes toilet paper to aluminum case from stock case. Two servo motors are attached stock case and two arms that are attached motor are put into case as shown in Fig. 4. The arms work like prop. If arms are open, the toilet paper is moved to aluminum case. The system controls those arms open and close for replenishing spare toilet paper one by one to aluminum case.



(a) Circuit diagram

(b) Electrode plates attached to the holder

(c) Electrode plates are contacting

(d) Electrode plates move away

Fig. 3. The circuit that detect exchange toilet paper

Fig. 4. Servo motors that are attached stock case

3. Experiment

We tested the exchanging system whether it can exchange toilet paper as shown in Fig. 5. As a result of the experiment, the system could drive properly. The toilet paper core was pushed the stock of the toilet paper and exchanged. The stock case could stock 4 spare toilet papers and it could replenish spare toilet paper one by one to aluminum case.

(a) Start of exchanging

(b) Toilet paper core is pushed the spare toilet paper

(c) System finished exchanging

(d) Replenishing spare toilet paper to aluminum case

Fig. 5. The system exchanges toilet paper

4. Conclusion

We developed and improved the system to exchange toilet paper in automatically. The system could detect used up toilet paper. After detecting that the toilet paper is already used up, the system could the exchange toilet paper. Also the system could put some stock of toilet paper. We still have problems. Future issue is enhancement of anti-theft function.

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