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Smart Tissue Dispenser

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***Abstract*:** Smart Tissue Dispenser is a project developed for Scanpap Company in an effort to improve their management in managing toilets. The system was built following a problem that workers often face in tissue replenishment, where it requires them to manually monitor the quantity of tissues at all times to ensure there are always enough tissues in each toilet. The main objective of this Smart Tissue Dispenser is to design a system that gives users the ability to monitor tissue usage anytime and anywhere as long as they have internet access to their device. In addition, it also aims to analyze the appropriate amount of tissue rolls to be inserted into each tissue dispenser that uses this system. This model will also be monitored and tested through a system where data captured through sensors will be sent through the network to be shown to users through the system. User can refill tissue after receiving tissue level notification from the system. By using the sophistication of IoT technology, distance sensors such as VL53L0X, ESP8266 microcontroller and others to build this project, it is hoped to reduce the burden of cleaners who are responsible for providing the best facilities to public toilet users.

***Keywords*:** ESP8266 (NodeMCU), internet of things (Iot), sensor, tissue dispenser, toilet management.

1. Introduction

Nowadays, tasks and systems are combined together with the power of IoT to produce more efficient and faster work systems. The Internet of Things (IoT) can seamlessly and seamlessly integrate a large number of different systems, while providing data for the use of millions of people. Developing a common architecture for IoT is a very complex task, especially because of the enormous variety of devices, link layer technologies and services that may be involved in such a system [1].

Referring to the way of work from the past and even now, cleaners have to check the availability of tissues in the toilet themselves, maybe on a weekly or monthly basis [2]. There is no denying that they most likely have trouble remembering which toilet needs a refill of tissues. There are also cases where cleaners may overlook toilets that are out of tissue. This can cause problems for users who necessarily need to wipe their hands before leaving the toilet, even worst for urgent cases. The detection, monitoring and management of toilet work is one of the main problems of the building. The traditional way of manually monitoring toilets is a cumbersome process that consumes a lot of human energy and effort, time and cost that can actually be avoided with today's technological innovations.

This initiative is built to help those who are responsible for always ensuring that the supply of tissues in the toilet is always available. This smart tissue dispenser system is a system that uses a network to support connections to sensors, to produce output at the maximum and minimum number of tissue levels. This is to alert the user to add new tissue when the available tissue is already at a minimum level. This system can also reduce the workload of cleaners to ensure that the toilet is always in good condition, both in terms of cleanliness and internal facilities.

The device should be able to help monitor and notify the user when the tissue reaches a minimum level via a web page. Users can detect these tissue shortages and refill as soon as the device notifies them. A proximity sensor will be placed in the tissue dispenser box to detect the tissue level along with a microcontroller and powered by a rechargeable battery.

This system will be a web-based service, where it provides a platform to allow various applications built on various programming languages to be able to communicate with each other. The advantages of web-based distributed databases are user-friendly maintenance and updating processes, reusability and modularity, distribution of data updates, and security.

2. Previous Works

Many researchers, inventors and project developers keep coming up with their new technologies and inventions [3]. Since in this decade, new technologies and innovations are widely used and their functions are maximized to something of very high quality, production costs are becoming more affordable, and the availability of technology is increasing.

There are several existing or similar systems regarding smart tissue dispensers that have been developed for smart monitoring and some of them use IoT to help make the system more efficient [4**?**].

IoT Garbage Monitoring System has an ultrasonic sensor (A.K.A distance sensor) as shown in Figure 1 placed on the inside of the hood, which faces the solid waste [5]. As the litter increases, the distance between the ultrasonic sensor and the litter decreases. This data will be sent directly to the microcontroller, which will then process the data and send it to the application through the help of Wi-Fi.

The Sensibo Sky is a rectangular dark gray plastic with an infrared sensor on top. It measures 3.2 x 2.2 x 0.8 inches

Figure 1. IoT Garbage Monitoring System

Figure 2. Sensibo Smart Air Conditionar

(HWD) and weighs 1.4 ounces. There is an S-shaped indicator light towards the top that turns blue when it is paired with certain devices. The back has a power jack and peel-off adhesive for easy wall mounting. By downloading and installing the Sensibo app on android and iOS, the temperature of the air conditioner can be effectively monitored. Sky-installed air conditioners allow users to monitor the temperature and humidity of the room from the main screen and identify the presence of occupants at home. Geotags allow location-based settings to be toggled, clock icons allow users to create schedules based on time, and gear icons take users to general settings.

The IoT Smart Valve (as shown in Figure 3) is a state-of-the-art Internet of things (IoT) controller and can compress the air present in the water stream as it flows past the consumer's water meter using a network [6]. In addition, with its ultra-low power consumption, the valve can operate on batteries for more than 10 years and is capable of extreme long-range coverage with exceptional penetration of obstacles, even inside buildings or urban areas. In addition, additional Digital and Analogue inputs connected to alarm contacts, pressure, or moisture sensors, for example, valves can be turned off on the main line stopping leaks before significant damage occurs and at the same time, sending an alarm to your Mobile or desktop platform through a gateway or Application Server. Results are sent via email and SMS and online portal iot.guys.com.

Figure 3. LoRa Wireless Smart Valves

Figure 4. Safedome SD Mini Bluetooth Tracker

The Safedome Mini SD Bluetooth Tracker is a top choice for a remote free key tracker because of its functionality and effectiveness. This system uses Bluetooth 5 technology [7] that creates a strong and stable link between the receiver and the user's phone device in addition to triggering an alarm when the range between the two becomes too large. This free companion mobile app can notify users of their last location if they accidentally leave their phone, bag or wallet behind. Additionally, sound alerts can also be triggered to the SD Mini, guiding users to the location of lost items. Made of the highest quality components and combined with a compact design and replaceable battery, the SD Mini smart tracking device can help users, especially teenagers to find lost items or even to record the perfect selfie. An easy-to-replace battery with a year of life, a "phone rings" receiver button that tracks the user's phone if it's misplaced, and customizable alerts with visual map tracking are also some great benefits that put this

tracker at the top of the heap. It works with Android and iOS.

Typical IoT application still facing difficulties with performance issues i.e., range of coverage, speed of the connection as well as the battery lifetime. To date, the security model for IoT application model is not being standardized [8]. To response to that, the Cloud model is being modified and integrated by introducing emerging computing paradigms like FOG computing, EDGE computing, Mobile Cloud computing [9]. The monitoring of heart pulse of patient is implemented using sensor connected to ESP8266 (NodeMCU) wifi module [10]. The work by [11] focus on the dispensing of ingredients using a distance sensor called as VL53LOX and Piezoelectric Polymer Sensor. The VL53LOX sensor shows the level of the ingredients present while Piezoelectric polymer gasket sensor provides the change in resistance value as the quantity varies in the container.

Based on the system mentioned above, the Smart Tissue Dispenser has many beneficial features for users. It can send data to an online system that allows the user to view tissue quantities. It can also register new devices and users to facilitate control management using the system in addition to its main function of knowing the location of toilets that require tissue refills.

3. System Analysis & Design

3.1 Use Case Diagram

Based on the Figure 5 below, there are two actors that represent the roles played by system users, namely Administrators and Supervisors.

Figure 5. Use Case diagram of Smart Tissue Dispenser System

The main process of this system is to manage user profiles, manage broadcasts, manage device information, and generate reports. In short, supervisors and administrators have the right to add, update, delete and retrieve profile information from the database. This process also includes registering to the system, logging in, updating information, and deleting accounts, including verifying accounts and passwords. Additionally, this use case also describes how users and administrators can register devices into the system, update information, or delete device information from the database. Another key process is explaining how administrators can post notifications into the system for users, update the notification status and delete notifications from the database. In addition, this case also explains how administrators can manage reports using temperature and location data. Through this process, the admin can produce a report for the user to analyze the tissue level, whether it needs to be refilled or not.

3.2 System Requirement

To develop the Smart Tissue Dispenser, the operating system used is Microsoft Windows 8 and above. The system can be accessed through Google Chrome, Internet Explorer and Mozilla Firefox. The platform used to develop this software is NetBeans 8.2, while Apache Tomcat is used as a web server that will support the functionality of the module. MySQL software is used to manage the system database including creating, retrieving, updating and deleting data in the system. The programming languages used to develop this system are Hypertext Markup Language (HTML5), JavaScript, Cascading Style Sheets (CSS), Java and MySQL in the database.

3.3 System Architecture

In its development process, this project uses a three-level architecture consisting of the presentation level, the business or data access level and the data level [12].

The Presentation layer or can also be known as the client layer includes the UI or application interface part. This layer is used for designing purposes where input can be taken from the user or presented to them in the form of a graph showing the timeline of sensor readings from the microcontroller [13].

The business layer is dedicated to the documentation of all business logic such as data validation, calculations, data insertion etc. It acts as an interface between the Client layer and the Data Access Layer. This layer, also called the intermediary layer, can help speed up communication between the client and the data layer.

At this Data layer, a database is used to manipulate the raw information collected from the sensors each time. It is connected to the database to perform insert, update, delete, retrieve data from the database based on the input data. The architecture of this device is mainly based on the IoT approach. Figure 6 describes the IoT approach used in this system [14].

3.3.1 Sensor

The VL53L0X distance sensor (Time of Flight) is used to measure the distance from the sensor to the surface of the toilet paper roll and send a signal to the microcontroller [15].

3.3.2 Gateway

It acts as a gateway to the internet for all things/devices that require interaction. It is the carrier between the sensor node's internal network and the local server and collects data from the sensor node, then sends it to the server infrastructure [16].

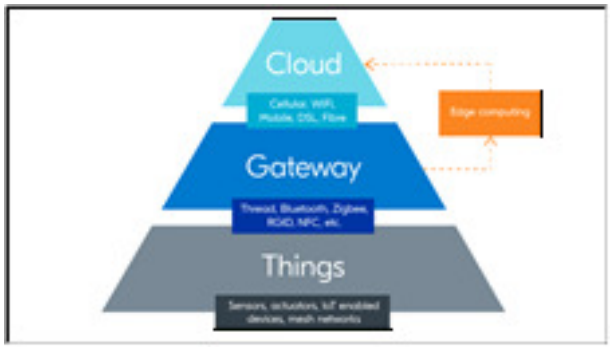

Figure 6. IoT Architecture

3.3.3 Cloud

The data that has been sent through the gateway will be stored & processed securely in the cloud server and the next process will convert the data into valuable information and then perform intelligent actions that make all devices "Smart Devices".

3.4 Interface Design

3.4.1 Home Interface

Figure 7 shows the homepage Smart Tissue Dispenser. This homepage shows the description of the company, Scanpap. User can log in to the system by choosing the login site on the homepage.

Figure 7. Homepage of Smart Tissue Dispenser

3.4.2 Dashboard Interface

Figure 8 shows the dashboard Smart Tissue Dispenser. This dashboard shows the graph of tissue data.

3.4.3 List of Devices Interface

Figure 9 shows the list of devices Smart Tissue Dispenser. This site shows data gather by each device and at this site user can add new device.

3.4.4 List of User Interface

Figure 10 shows the list of users of Smart Tissues Dispense. This page is where admin can monitor list of users who used the system and here admin can add new user.

Figure 8. Dashboard of Smart Tissue Dispenser

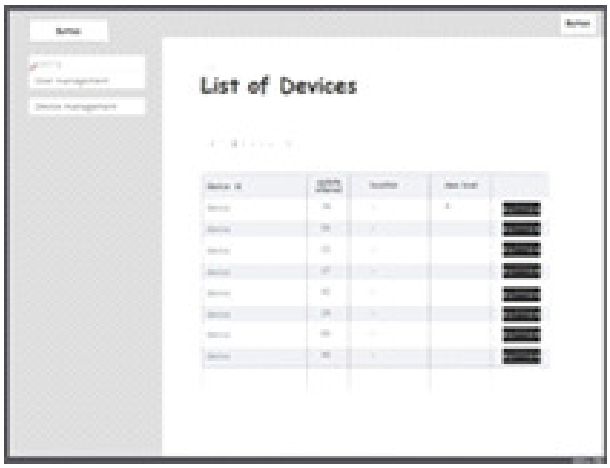

Figure 9. List of Devices of Smart Tissue Dispenser

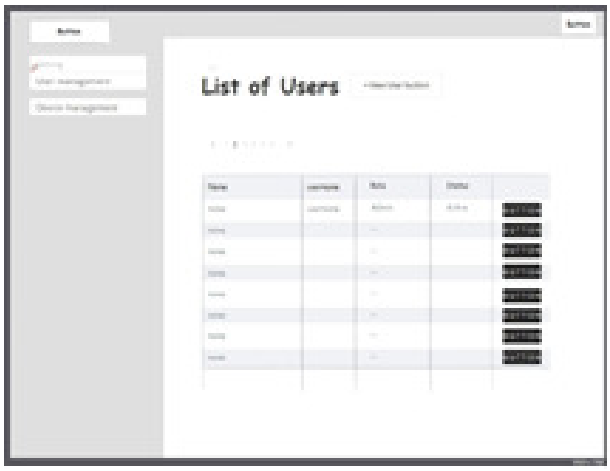

Figure 10. List of Devices of Smart Tissue Dispenser

3.4.5 Hardware Design

There are various types of hardware or sensors that will be used as a device function that will make it easier for users to monitor and analyze tissue quantities. There is also a prototype device casing to protect the hardware and sensors inside the device. The hardware design not only works to collect and transmit data but also necessary to ensure the hardware

is protected and durable. Here are the hardware and sensors used in this project:

Table 1. Hardware used in Smart Tissue Dispenser

Hardware	Description
NodeMCU (ESP8266) module 	ESP8266 or also popularly known as NodeMCU is a microcontroller which the most efficient way to transmit data over internet as it uses normal Wi-Fi connection to transfer data. By utilizing 2.4 GHz network band, it is almost compatible with any common modern and legacy router or any compatible access point.
VL53L0X Distance sensor 	VL53L0X is an accurate distance sensor that measure distance up to maximum two meter. By using time of flight for light to reflect after beamed from the sensor between the surface of object that to be measured, the sensor can output much accurate distance without being compromised from the external factor such as air humidity or temperature which is much more convenient compared to ultrasonic range sensor. The most important factor of this sensor is not only of its small size but also very low power consumption which make it perfect for IoT application
3.3V DC step up voltage 	To achieve higher voltages, battery power systems often arrange cells in series. Even so, an adequate array of cells is not possible in many high voltage applications due to lack of space. Boost converters can increase the voltage and decrease the number of cells. This is necessary to ensure that a constant voltage of 3.3 volts is supplied to the ESP-12F chip and sensors even when the battery voltage has dropped to lower than the initial voltage when the battery capacity is full.
Device Housing 	The housing of the device was designed using Autodesk Fusion 360 and the housing was formed by printing it on a 3D printer. The diagram shown is also in 3D form.

3.5 Hardware Design

All the hardware and sensor will be connected with each other to form a full functional device. The sketch for the connection is shown in Figure 11.

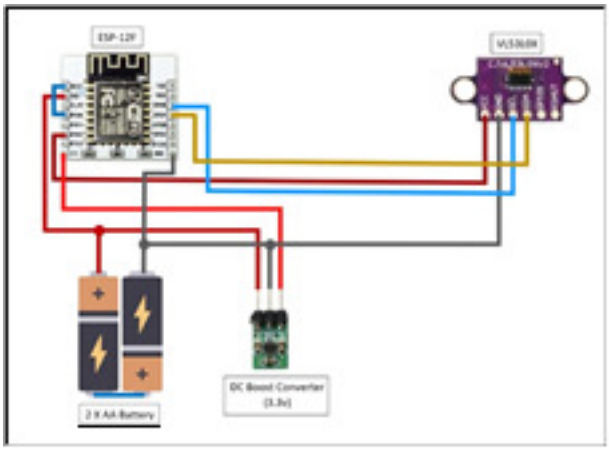

Figure 11. Hardware Connection for Smart Tissue Dispenser Device

In order to make microcontroller execute task as intended, it needed to be flash with proper code. The coding is done in the Arduino IDE and the code is uploaded via USB through serial connection. A programmer is needed for this purpose in order to mount the bare ESP-12F chip. Figures below will show the part of coding used to operate the ESP8266 module.

3.5.1 Library

```
#include <MySQL_Connection.h>
#include <MySQL_Cursor.h>
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <DNSServer.h>
#include <ESP8266WebServer.h>
#include <WiFiManager.h>
#include "Adafruit_VL53L0X.h"
```

Figure 12. Library required

3.5.2 Initialization of Global Variable

Figure 13. Global Variable Initialization

Figure 14. Setup Code

3.5.3 Setup Block

3.5.4 Loop Block-Retrieve Configuration from Database

Figure 15. Retrieve Configuration Code

3.5.5 Initialize and Read Sensor

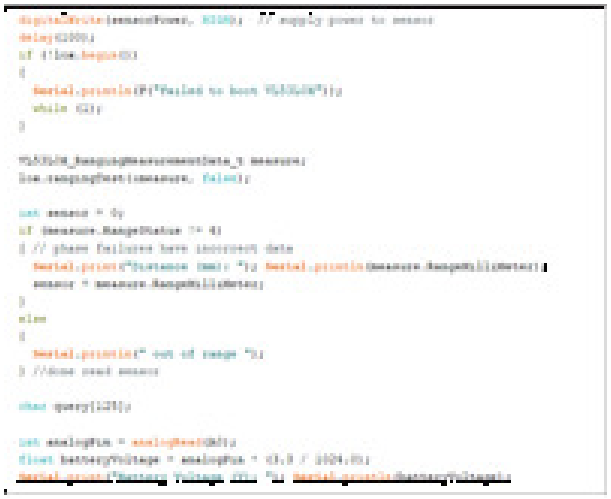

Figure 16. Initialise and Read Sensor Code

3.5.6 Execute Query and Upload Data

Figure 17. Upload to Database Code

4. System Implementation

4.1 System Hierarchical Menu

Through the system menu hierarchy, the process flow inherent in the Smart Tissue Dispenser System can be shown based on the categories of users. Through this system, there are several main modules in user view.

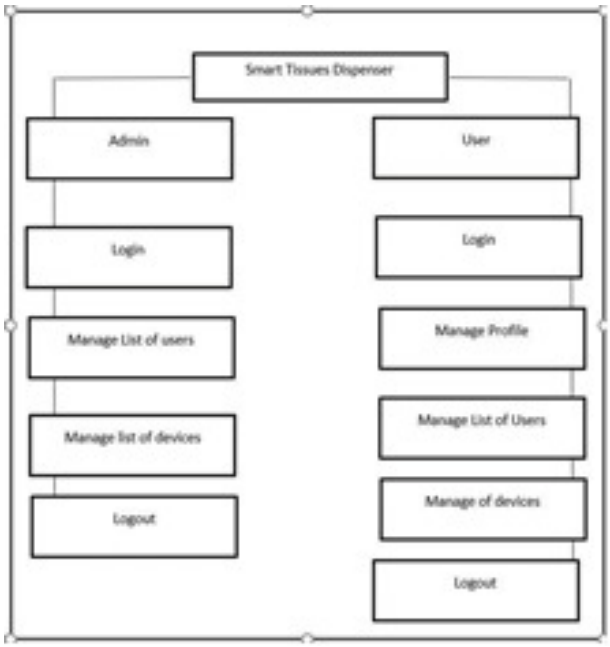

Figure 18. Hierarchy Diagram of Smart Tissue Dispenser

4.2 System Development

4.2.1 Home

Figure 19 shows the homepage Smart Tissue Dispenser. This homepage shows the description of the company, Scanpap. User can log in to the system by choose the login site on the homepage.

4.2.2 Dashboard

Figure 20 shows the dashboard Smart Tissue Dispenser. This dashboard shows the graph of tissue data.

4.2.3 List of device

Figure 21 shows the list of devices Smart Tissue Dispenser. This site shows data gather by each device and at this site user can add new device.

Figure 19. Homepage of Smart Tissue Dispenser

Figure 20. Dashboard of Smart Tissue Dispenser

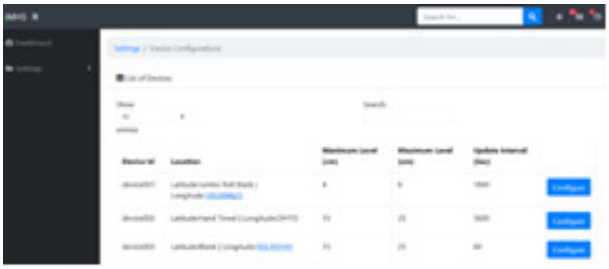

Figure 21. List of Devices of Smart Tissue Dispenser

4.2.4 List of Users

Figure 22 shows the list of users of Smart Tissue Dispenser. This page is where admin can monitor list of users who used the system and here admin can add new user.

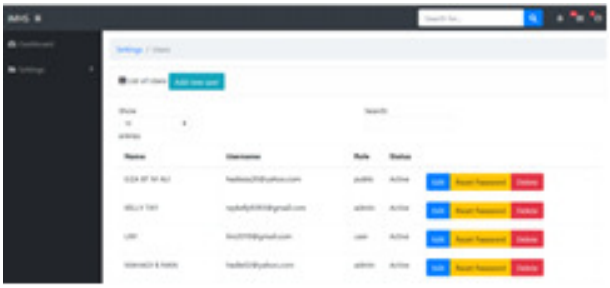

Figure 22. List of Users of Smart Tissue Dispenser

The device needs an internet connection in order to transmit data to the internet, so the device will need Wi-Fi with internet access.

5. Conclusion

Advanced technology is growing rapidly as the times change. Likewise with the rapid development of information technology. Indirectly, the Smart Tissue Dispenser will be developed in a wider context while giving users access anywhere through an internet connection. The system developed for the Scanpap Company works to automatically monitor their toilets to ensure timely refills of tissues by cleaners. Through this system, they don't need to check the toilet directly every time they want to refill tissues because they can check the quantity of tissues in the system. This helps them save time and avoid wasting time refilling tissues. In addition, this system also has high security and efficiency because users other than the administrator cannot log in unless they get registration confirmation from the administrator. This system has some restrictions involving devices in each toilet that require internet access to access the system for monitoring and data transmission to the database. Next, the device is not waterproof, so the probability of the sensor or controller board being damaged and not working properly is high. Furthermore, the most challenging issue is device battery consumption as efficiency is the most important aspect of IoT-based systems. However, the system remained as planned and did not experience any major disruptions. To improve this Smart Tissue Dispenser System, it should use a humidity or water sensor to save the amount of tissue used. By using this sensor, it can launch the right amount of tissue paper for wet hands. Next, the system can also increase the tissue capacity to hold two tissue papers at once. If there is capacity to hold the tissue, the user can get ready to change it.

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