Design and Implementation of an IOT-Enabled Smart Sampayan with Automated Moisture, Temperature, and Rain-Sensing

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***Abstract*— This research presents the design and implementation of an IoT-Enabled Smart Sampayan with Automated Moisture, Temperature, and Rain Sensing. The primary objective of this study was to design and implement a smart clothesline that is capable of either automatically retracting or deploying based on environmental values or performing functions that are manually operated by the user through a mobile app. The mechanism incorporates a series of interconnected chain linkages, allowing for deployment and retract motions, rain, humidity, and temperature sensors for environmental data gathering and a mobile application. This paper outlines the detailed design process, including the selection of suitable materials and components to ensure optimal performance and durability. Furthermore, comprehensive testing methodologies are employed to assess the mechanism capabilities. The results demonstrate promising outcomes in terms of IoT-Enabled technologies and home automation.**

Index Terms*— *automated clothesline, automated sensors, humidity sensors, IoT-Enabled, Information Technology, Smart mechanism, Smart sampayan, Rain sensors, Temperature sensors.

INTRODUCTION

The Philippines is a country located in Southeast Asia with a tropical climate with distinct rainy and dry seasons. The occurrence of sudden and intense rainfall during the dry season has become more frequent, and this phenomenon is often linked to the problem of climate change. For instance, the intensity of extreme daily rainfall is already being experienced in most parts of the country according to the article on Climate Change in the Philippines, from DOST Pagasa (2023). Because of the result of the recurring and sudden inclement weather, many Filipinos are having trouble drying their clothes, especially the majority of them still dry their clothes outdoors. It also becomes a huge problem for working individuals who don't have time or the capability to remove their clothes from the clothesline when it rains.

With the current state of Information technology, we can see clearly that IT can help with the aforementioned issue stated above. The proponent developed Smart Sampayan with the use of sensors by ways of integrating it to the clothesline, the system can detect when it starts to rain and automatically retracts the line to prevent clothes from getting wet, The proponent also developed a smartphone application to control the clothesline and developed it by integrating the clothesline to the internet to control it remotely making it a device that can be a part of smart homes which according to the study done by Amri & Setiawan (2018) that this kind of devices that utilizes Internet of things (IoT) is getting more tractions in recent years.

The Mechanism uses an Esp8266 microcontroller that also acts as its own Wi-Fi module, and according to the study done by Mesquita et. al. (2018) The ESP8266 module showed suitability for battery powered IoT applications that allow 2-4 days recharge cycles on a 1000mAh battery with seconds-scale transmission intervals. There is also the stepper motor that is the mechanism motor, stepper motor driver, rain, humidity, and temperature sensors that detects and is programmed to respond to the input from the environment and limit switches that limits the movements of the stepper motor. The mechanism is also paired with a mobile application interface.

LITERATURE REVIEW

The automatic clothesline is an innovative and convenient home appliance that simplifies the process of drying clothes. This literature review provides a comprehensive overview of the current state of

knowledge in this field and will be instrumental in shaping future research on automatic clotheslines.

In countries located in Southeast Asia, according to the article on silk weaving in the Asean region, from visit southeast asia.travel (2023), traditional clothing is often crafted by hand and inherited from ancestors. This makes the clothes delicate and more susceptible to damage. As a result, the clothesline serves as both a practical drying method and a celebration of the long-standing customs of the area. That is why even with the rise of technology, people are still using clotheslines to dry their clothes. In the Philippines in which its weather is split into rainy and dry seasons. It has been a custom for Filipinos to dry their clothes outdoors. This method of drying clothes is the most popular so far for Filipinos. But according to the study of Abd et al (2021), stated due to the increase in frequency and intensity of sudden, unexpected rains due to climate change. The sudden weather changes are challenging the traditional methods of drying clothes, making solutions like automatic clotheslines more relevant and necessary. The benefits of automatic clotheslines and how they are made to enhance user experience. The simplicity of use is the main benefit of automatic clotheslines. Automatic clotheslines, in contrast to traditional clotheslines, need no effort to remove clothing from sudden outbursts of rain. According to the study by Putri et. al. (2017), Yusoff, et. al. (2018), This is done through the help of electric motors and pulleys that are controlled by a remote control, control panel, or an application. The user only needs to hang the clothes on the line and turn on the motor; after that, the line will raise and lower itself on its own. Automatic clotheslines also have the advantage of being energy efficient. Automatic clotheslines rely on the sun's natural rays and the wind to dry clothes, as opposed to electric dryers, which use a lot of electricity. According to the study of Berahim et. al. (2021), stated that automatic clothesline is an innovation whereby the user's clothesline is retrieved and pulled out when the system detects the change in surrounding weather that shows that some models additionally have weather sensors that, in the event of bad weather, will cause the line to automatically retract, safeguarding the clothing from harm. The usage of automatic clotheslines is another design element that has grown in popularity in recent years. According to the studies of Kumar et. al. (2017), Ton Mohamad (2008), Ishak et. al. (2020), automatic clotheslines automatically retrieve clothes when it is sunny and oppositely retrieve-in clothes when it is a rainy day. When not in use, some of these versions are simply retracted and affixed to a wall or post, saving space, and maintaining the aesthetic appeal of the outside space. Finally, automatic clotheslines are made to last, with many types composed of materials that can tolerate exposure to the outdoors over time. For people who live in locations with severe weather, such as high winds or a lot of rain, this is especially crucial.

METHODOLOGY

For this project, the proponent has used the Mobile Development Life Cycle for the development of the mobile application and Agile Methodology for the mechanism.

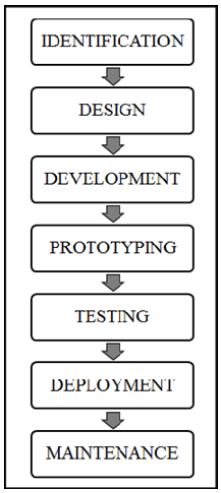

Fig 1. Mobile application development life cycle by Raus, M. I et al (2016)

Identification phase

The mobile application development life cycle commenced with the identification stage, where the proponent pinpoints a frequent problem in the Philippines that can be resolved with the aid of existing technology. Following the problem identification, the proponent has established the project's objectives and requirements, which will include specifying the hardware components and software's that will be utilized.

Design phase

In the design phase, the overall architecture of the system was created, including the hardware, and mobile application interface. In this project, the proponent used Godot Engine to create the mobile app.

Development phase

The development phase involved writing the code for the system, including the mobile application. In this project, the proponent used G-script programming language and Godot Engine as the development tool.

Prototyping phase

The prototyping phase involved designing and testing various user interfaces and features to ensure the app meets the desired functionality and usability.

Testing phase

The testing phase followed, where the system was tested to ensure it meets the project's requirements and objectives. This involve both hardware and software testing, including functionality and usability testing.

Deployment phase

Once the testing phase was completed, the deployment phase began, where the application was installed and made available for use by the end users.

Maintenance phase

The final phase of the mobile application development life cycle is the maintenance phase, where the app will be maintained and updated to ensure that it continues to meet the needs of the end users.

Methodology for the Mechanism

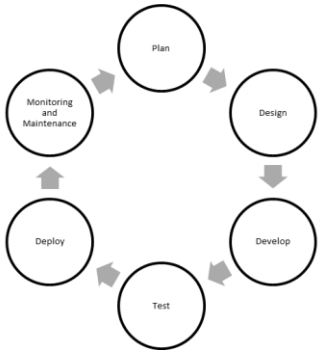

Fig 2. Agile Methodology

Planning phase

The proponent in this phase gathered requirements, identified the features of the Smart Sampayan mechanism, and established a project timeline.

Design phase

The design phase is where the proponent began to design the mechanism. During this phase, the proponent defines the architecture, data model, and the design of the mechanism using OnShape as the tool for the 3d model. The proponent also creates prototypes of the mechanism to ensure that the design is working properly.

Development phase

During this phase, the proponent started to build the mechanism. The proponent wrote the code in Arduino, tests it, and integrates it into the overall system.

Testing phase

The testing stage is where the proponent tested the Smart Sampayan mechanism to ensure that it works as intended. During this stage, the proponent performs unit tests, integration tests, and acceptance tests to verify the system's functionality and fixes any bugs or issues that arise during testing.

Deployment phase

The deployment stage is where the proponent releases the Smart Sampayan mechanism to end-users.

Monitoring and Maintenance phase

The monitoring and maintenance stage is where the proponent monitors the Smart Sampayan mechanism for issues and performs maintenance as needed.

TECHNOLOGY USED

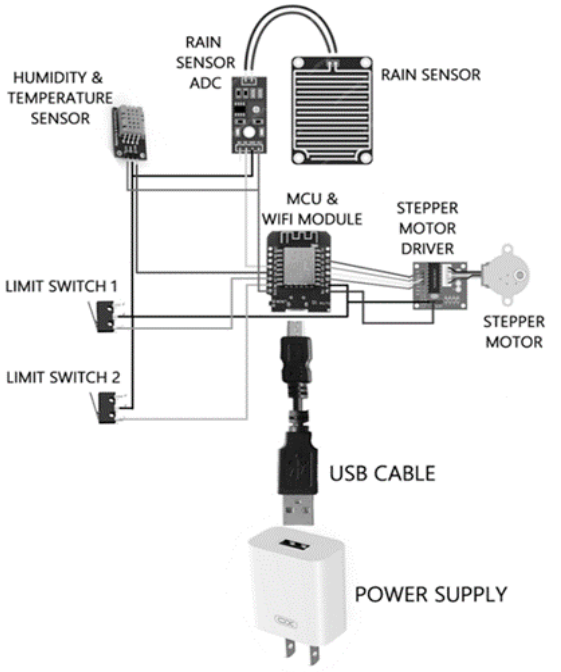

Fig 3. Mechanism Components

The power supply provides power to the entire circuitry, supplying 5 volts with a maximum current output of 2A. Assuming the average current consumption of the circuit is around 500mA, the power supply provides enough current. The USB cable

is used to connect the entire system and provide power. It is also used to program the MCU. The MCU/WIFI module serves as the brain of the system, responsible for decision making and accessing information on the web. It executes commands received from the app, recognizes signals from limit switches and sensors, and provides the appropriate step signals for the stepper driver to move the stepper motor.

The stepper motor driver provides the stepper motor with the necessary voltage, current, and signals to enable its movement. Limit switches are sensors that detect the limits of the movements of the chain linkage contraption. The humidity and temperature sensor measures the humidity and temperature of the surrounding environment and sends the information to the MCU.

Fig 4. Smart Sampayan

The results of this study highlight the effectiveness and usability of the project in aiding and improving the task of drying clothes. The mobile application played a crucial role in the project's adoption and acceptance. The intuitive navigation and clear labeling enabled users to quickly understand and utilize the mechanism functionalities without requiring extensive training or technical expertise. The mechanism's functionality demonstrates its efficiency in automating manual processes, allowing users to redirect their time and energy towards more critical tasks. The Sensor's accuracy exhibits the remarkable performance of sensors underscores their significance in modern technology and highlights their reliability in capturing valuable data for analysis, control, and optimization purposes. The incorporation of weather forecast in the mobile application proved to be a valuable resource, allowing users to optimize their laundry schedules.

This study showcased how the Internet of Things (IoT) has the potential to revolutionize everyday tasks, enhancing convenience and efficiency for humanity. By harnessing the power of technology, the project illustrated how IoT devices can transform mundane activities into streamlined and automated processes. It exemplified how interconnected devices can communicate, collect data, and make intelligent decisions, ultimately simplifying and optimizing various aspects of life. The project underscored the profound impact of IoT in improving the way we live, work, and interact with our surroundings.

CONCLUSIONS

It is hoped that the conduct of this study, the Smart Sampayan will stand out from existing products in the market and research studies because it can not only gather data from its sensors, but it can also retrieve information from the internet regarding weather forecasts and display all the data in the mechanism to the mobile app. Additionally, another unique feature is that it will be capable to be manually controlled through a mobile application, which is absent in the references cited. Furthermore, the mechanism will be designed for easy installation without the need for cutting a hole in the roof, which is a requirement in previous designs.

While the challenges encountered during the implementation are the following, the clothesline's chain linkage sags when clothes are hung on it, and although the clothesline material is flexible, it lacks durability to effectively eliminate the sagging.

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