SMART AND AUTOMATED UMBRELLA SYSTEM

220403K - M.T.L. Munasinghe
220417G - Naveendya J.T.
220415A - Navanjana D.K.N.

1.Introduction

The advent of smart wearable technology is transforming the way humans interact with their surroundings. The difficulty that manually operated umbrellas cause is one concern that is frequently encountered in daily life. They usually require one hand for most of the time and must be carried separately. Additionally, people frequently forget their umbrellas because, in many public and professional contexts, they must be kept separately in buckets. This project addresses these constraints by introducing a **Smart and Automated Umbrella System**. This project suggests developing an Arduino-based smart umbrella system that is monitored by LabVIEW and integrated in a backpack. The invention is the direct integration of a motorized umbrella into a backpack, which makes it user-aware, hands-free, and automated. The umbrella uses environmental sensing, specifically rain detection, humidity levels, and user presence, to open and close without any manual effort.

Three sensors are integrated into the system, which is based on an Arduino Uno microcontroller: a humidity sensor, a PIR motion sensor to determine whether the user is physically present, and a custom-built rain sensor with analog signal conditioning. The umbrella folding mechanism is operated by a servo motor, and the user is alerted by a buzzer.

By fusing mechanical control, electronic sensing, and user feedback, this project not only automates an everyday tool but also adds intelligence and interaction. The entire system is simulated and monitored through LabVIEW, offering a real-time visualization and instrumentation interface. This makes it ideal not just for daily convenience, but also as a demonstrable project in the domain of instrumentation and smart wearable technology.

2. Background and Context

Explanation of the problem or opportunity being addressed:

Conventional umbrellas have several common drawbacks, despite being commonly used. They must be carried separately, operated manually, take up one hand when in use, and are frequently misplaced or forgotten when kept in public areas. When people are multitasking, such as carrying bags or using their phones, or when there are unexpected weather changes, these problems become particularly challenging. Integrating automation and smart sensing features into umbrella designs has emerged as a clear chance to improve their usefulness and functionality. In addition to enhancing convenience and reducing the possibility of losing or breaking the umbrella, a wearable, self-operating umbrella system would also improve user comfort.

Relevant literature review or prior research:

In the field of embedded and wearable automation, numerous studies and projects have shown promising directions for weather-reactive systems. Notable examples include

- **“Design of a Rain Sensing Automatic Wiper”** (International Journal of Engineering Research & Technology - IJERT, 2013) demonstrates how rain sensors can be used to automate common mechanical tasks such as windshield wiping, proving the viability of water-triggered automation.
- **“Smart Umbrella System using Arduino”** (IJSRP, Volume 11, Issue 6, June 2021) proposes a simple umbrella model that opens using a rain sensor and Arduino Uno. However, this model lacks context awareness, such as detecting whether a user is present or if environmental humidity is a factor.

These systems confirm that smart umbrellas are a feasible concept, but they fall short in environmental context detection, user feedback, manual override options, and real-time system visualization, all of which are critical for improving the user experience and safety in dynamic weather conditions.

Explanation of why this project is necessary or timely:

Wearable technology needs improvements to provide intelligent, responsive protection as climate unpredictability increases. Furthermore, the concept of Smart and Automated Umbrella System is especially crucial considering the growing need for smart and hands-free lifestyle items. The system integrates a PIR sensor to detect whether a person (user) is present nearby, specifically, whether someone is wearing or close to the backpack that contains the umbrella system. With the use of this feature, the system can eliminate weakness in prior researches, opening when no one is wearing it. The DHT11 Humidity Sensor confirms rain by measuring humidity (>70% RH as threshold). The system can avoid false triggers from non-rain moisture (e.g., dew), which is a unique feature of the system. By addressing current system gaps such as lack of user interaction, poor accuracy, and limited control, this project offers a modern, responsive, and educationally rich alternative to existing smart umbrellas.

3. Objectives

- Enhance rain detection accuracy by integrating humidity monitoring to reduce false triggers.
- Ensure energy-efficient operation by activating the system only when a user is present, using a PIR sensor.
- Provide user feedback and control through a buzzer and manual override button to enhance usability.

4. Project Scope and Boundaries

4.1Project Scope

The aim of this project is to design and develop a LabVIEW-monitored smart umbrella system that operates automatically based on environmental conditions. The system will have the following features when it functions as a wearable backpack:

- A custom-built rain sensor with signal conditioning to detect real-time rainfall using conductive electrodes and an LM358 op-amp.
- Atmospheric moisture was measured, and rainfall presence was confirmed by the DHT11 humidity sensor.
- A PIR motion sensor is used to detect the presence of a user, because the umbrella only activates if someone is nearby or wearing the backpack.
- A servo motor to unfold or fold the umbrella based on sensor input and logic.
- Before the umbrella activates, a buzzer will notify the user, enabling manual override button action.
- An Arduino Uno to control logic flow and interface with sensors and actuators.
- A LabVIEW interface that uses virtual instrumentation to simulate a Data Acquisition (DAQ) system and view data in real-time

This smart umbrella system is made to be both a useful tool that responds to the weather and a learning project to show how embedded systems and sensors work.

4.2 Project Boundaries

The following boundaries are established for the project in order to ensure an intended and achievable result:

- The system is solely local and serially based on Arduino-LabVIEW; wireless connectivity (such as Wi-Fi or Bluetooth modules) is excluded.
- The system is not scaled for commercial or multi-user deployments; it is primarily intended for individual usage.
- Power optimization is not the main goal, and it is expected that the power source, a battery or adapter, is present.
- Advanced weather parameters like wind speed, UV index, and air quality are not taken into consideration by the project, which solely concentrates on rain and user presence.
- The scope does not automatically automate the hygienic maintenance of sensors, such as cleaning water-exposed components.
- The system is not designed for high-speed weather response, such as storm detection or industrial-grade rain sensing.

5. Methodology

The development of the **Smart and Automated Umbrella System** follows these stages:

5.1. Component Selection and Circuit Design

- Custom rain sensor designed with conductive strips, voltage divider, and LM358 op-amp for signal amplification.
- DHT11 for humidity sensing and HC-SR501 PIR sensor for motion/user detection.
- Servo motor (SG90) to unfold/fold the umbrella canopy
- buzzer to alert the user before opening the umbrella.

- Manual push button for override.

5.2. Arduino Programming

- Logical decision based on sensor data thresholds:
    - Rain voltage > 2V, Humidity > 70%, PIR = HIGH → Umbrella opens after warning.
    - No rain or user not detected → Umbrella stays idle or closed.
    - The button interrupts action if pressed within 5 seconds of buzzer trigger.

5.3. Simulation with LabVIEW

- Arduino sends analog/digital data to LabVIEW.
- The LabVIEW front panel displays sensor status, motor actions and allows override inputs.
- DAQ interface is used to log, visualize, and control real-time data.

5.4. Integration and Testing

- Backpack-mounted smart umbrella prototype assembled.
- The system is tested for:
    - Sensor accuracy and timing.
    - Reliable folding/unfolding.
    - Response to override input.
    - Power consumption.

6. Timeline

The project will be completed over 12 weeks, with the following milestones:

- Week 1-2: Project planning, component procurement, initial design.
- Week 3-4: Construction of the custom sensor (Rain sensor).
- Week 5-6: Implementing Arduino firmware.
- Week 7-8: Implementing LabVIEW.
- Week 9-10: Hardware assembly (umbrella, sensors, actuators).
- Week 11: Environmental testing, debugging, optimization.
- Week 12: Final demonstration and submission.

7. Conclusion

The automated rain-sensing umbrella system conveys an innovative and practical answer to a typical day-to-day problem. The project showcases a scalable, interactive, and efficient instrumentation system by introducing sensor integration, embedded control through Arduino, and real-time data acquisition with LabVIEW. The system's versatility and functionality are

further improved by the addition of a manually controlled override and a customized analog sensor.

In addition to providing convenience and protection from environmental conditions, this system demonstrates how instrumentation principles can be utilized in real-world scenarios. Future extension possibilities, such as wireless control, solar-powered operation, and interaction with smart city infrastructure, are rendered possible by the modular design. It functions as a practical wearable gadget as well as a teaching aid for contemporary automation and embedded systems.

References

Yudi Irawan Chandra,Marti Riastuti, Kosdiana,Edo Prasetiyo Nugroho,"Automatic Garden Umbrella Prototype with Light and Rain Sensor Based on Arduino uno Microcontroller", International Journal of Artificial Intelligence & Robotics Vol.No.2,2020,pp.42-51

Sakshi karande, Vaishnavi Shrikhande, Renuka Joshi, Prof. Halcherikar R.R, “Rain SensingAutomatic Car Wiper System”IJARIIE-ISSN(O),Vol-5 Issue-2 2019

Sarika Kanetkar, Ankit Rathore, Krati Maheshwari, Prasanna Dubey, Ankit Saxena,“Smart Helmet Wiper”2020 IEEE International Students’Conference on Electrical,Electronics and Computer science

Jawad Haider Gillani, Saud ul Saqlain, M Yousaf, Hamza Ahsan, “Fabrication of AutomatedSensor Controlled Umbrella”JUNE ,2018.

Alkali, A.H., Dada, E.G., Kida, A.M. and Ali, A.A.,. “Sunlight and Rainfall Activated Retractable Roof”, International Journal of Computer Engineering and Applications, 12(11), pp.1-12, 2018.