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Original Research Paper

Innovative Design and Implementation of Portable and Rechargeable Air Purifier and Humidifier

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Abstract: This study presents the innovative design and successful implementation of a Portable and Rechargeable Air Purifier and Humidifier (PRAPH) aimed at addressing indoor air quality issues in Uganda. The device combines air purification and humidification functionalities into a compact, user-friendly, and energy-efficient unit. The design phase of the PRA-PH involved a thorough analysis of existing air purifiers and humidifiers, identifying key limitations such as limited portability, energy inefficiency, and complex maintenance requirements. The system incorporates high-efficiency particulate air (HEPA) filters, activated carbon filters, and ultrasonic humidification technology to effectively remove particulate matter, allergens, and airborne contaminants while simultaneously maintaining optimal humidity levels. A rechargeable lithium-ion battery was integrated to ensure portability, enabling users to use the PRA-PH without relying on a constant power source. Additionally, smart sensors and microcontroller-based control systems were employed to automate the device's operation, adjusting purification and humidification settings based on real-time air quality measurements. The PRA-PH was subjected to rigorous testing to evaluate its efficiency in purifying air and maintaining suitable humidity levels across various indoor environments. The results demonstrated significant improvements in air quality, showcasing the device's ability to effectively remove pollutants and maintain a comfortable humidity range. This study contributes to a portable and rechargeable air purifier and humidifier system that addresses the limitations of existing solutions. The PRA-PH's innovative design, efficient operation, and user-friendly interface make it a promising option for individuals seeking a convenient and effective way to improve indoor air quality and enhance the overall well-being of Ugandans.

Keywords: Air Purifier, Arduino Uno, Rechargeable Humidifier, Renewable Energy, SDG, Solar.

1. Introduction

In today's fast-paced and increasingly urbanized world, concerns regarding air quality and overall well-being have become paramount. The escalating levels of air pollution, coupled with the challenges posed by climate change, have necessitated innovative solutions to ensure a healthier living environment. In this context, the design and implementation of a portable and rechargeable air purifier and humidifier stand as a ground-breaking achievement, addressing the pressing need for clean, purified air and optimal humidity levels in indoor spaces [1][2].

This revolutionary device represents a fusion of cutting-edge technology, sustainable design, and user-centric functionality. By seamlessly integrating air purification and humidification capabilities into a single, portable unit, it offers unparalleled convenience and versatility. Unlike traditional air purifiers and humidifiers, which often rely on fixed power sources and lack portability, this solution empowers users to create a healthier atmosphere wherever they go, be it in their homes, offices, or even during travel [3].

The underlying design principles of this portable and rechargeable air purifier and humidifier prioritize efficiency, eco-friendliness, and ease of use. By employing advanced filtration systems, it effectively eliminates harmful pollutants, allergens, and airborne particles, ensuring the air remains clean and safe to breathe. Simultaneously, the integrated humidification technology maintains optimal moisture levels, preventing issues related to dry air, such as skin irritation and respiratory discomfort. Furthermore, its rechargeable feature aligns with the global shift towards sustainable energy usage, reducing the device's carbon footprint and contributing to a greener future [4][5]

2. Literature Review

Air purifiers are manufactured as either small stand-alone or larger units that can be affixed to an air handler unit (AHU) or an HVAC unit found in hospitals and industries. A variety of equipment, including packing-filled towers, spray towers, bubble columns, and wetted-wall towers, can be utilized as humidifiers [1].

The heterogeneity of the rooms in temperature and humidity is a significant factor that must be regulated in an industrial operation. Healthy air has three main components to it. It has to be fresh, clean and have the right moisture content. Human beings are prone to humidity because the human body uses evaporative cooking as the primary mechanism for getting rid of the system [3][2].

In [2], the researcher designed an automatic humidity controller prototype that can help control the level of humidity to lower a room’s humidity or to balance the temperature. The designed devices after detecting the room’s humidity will either humidify or dehumidify the room depending on the degree of the room's sanity. Figure 1 is the prototype of the Automatic Room Humidifier and Dehumidifier Controller using Arduino Uno.

Figure 1. Automatic Room Humidifier and Dehumidifier Controller using Arduino Uno [2]

Figure 1 depicts the system's authentic layout, featuring a DIY dehumidifier positioned on the left side. In this research study, silica gel, fans, and acrylic were utilized to encase the system. The central design displays the humidity value and the programmed sensing of room humidity. This study engineered a device employing humidity sensors (DHT), Arduino Uno, and an LCD to autonomously showcase humidity data. The developer created a system capable of regulating room humidity by activating devices such as dehumidifiers and humidifiers, thus normalizing the room's humidity level [5][6][7][8].

The scholar in [9], introduced a novel active humidification system designed specifically for individuals suffering from dry eyes. This innovative system comprises modules dedicated to sensing, mist generation, and a central control unit. Upon activation, the humidifier rapidly elevates the relative humidity within its confined space by an impressive 30% within just four minutes.

The current global landscape presents a pressing need for solutions to the escalating energy and water challenges, especially in sparsely populated regions lacking access to fresh water and electricity grids like Uganda [10][11][7][12]. Utilizing renewable energies, such as solar panels, wind turbines, and other emerging technologies, offers a viable and economically feasible option for desalination processes. These sustainable methods can effectively transform brackish, sea, and ocean water into affordable freshwater sources, simultaneously mitigating the environmental impact associated with traditional desalination methods [13]. Additionally, the implementation of the HDH system for decentralized water production offers distinct advantages, including simplified brine pre-treatment and disposal requirements, as well as streamlined operation and maintenance protocols, as mentioned in references [1][14].

Humidifiers and Air purifiers can be enhanced by incorporating renewable energy in the design to improve its durability and robustness. Solar as one of the renewable energy is highly used in the design of durable and portable humidifiers. Solar desalination technologies can be broadly categorized into two types: direct and indirect. In the direct type, solar radiation is directly absorbed by the input feed water of the desalination plant. Conversely, in the indirect type, solar energy is absorbed either by solar thermal collectors and then transferred to the saline water, or transformed into electricity and utilized to run the plant. In both cases, solar energy serves as a crucial power source, driving a heat engine. This highlights the potential of solar energy as an alternative source, ensuring constant room humidity and temperature [15].

To maintain a consistent power supply and enhance efficiency and durability, it is imperative to focus on fabrication and maximum power point tracking optimization [16][17][18]. Researchers in [19][20] have developed techniques to optimize solar Photovoltaic systems, enhancing power efficiency effectively. Moreover, recent advancements in solar panel fabrications have led to efficient power delivery without the need for extensive physical tracking. Innovative fabrication methods according to these researchers [21][22][23] utilize organic-inorganic processing techniques, particularly in the production of perovskite solar cells, contributing to the evolution of solar desalination technologies [24]

The major problems faced by humidifiers in Uganda include inadequate access to electricity, high energy consumption, and dependency on non-renewable energy sources. These challenges often lead to inconsistent operation and limited usability, especially in areas with unreliable power supply. Additionally, conventional humidifiers may contribute to environmental degradation due to their reliance on fossil fuels or grid electricity generated from non-renewable sources. The researcher recognized these challenges and sought to address them by developing a Renewable and Rechargeable-Powered Air Purifier and Humidifier that harnesses renewable energy sources, reduces energy consumption, ensures portability, and integrates air purification capabilities, providing users with a sustainable and efficient solution for maintaining optimal indoor air quality and humidity levels. This innovative solution aims to provide consistent and eco-friendly air purification and humidification in Uganda, addressing both health and environmental concerns.

3. Methodology

3.1. Materials

Designing a circuit for a renewable and rechargeable powered air purifier and humidifier involves integrating various components to ensure efficient operation while maximizing energy sustainability. Here are the components required in designing and implementing RAPH.

a. Components

All the electrical, electronic and mechanical components used in the design and implementation of the Rechargeable Air Purifier and Humidifier (RAPH) are shown in Table 1.

b. Software

The Software used for this research are:

- Proteus Professional: circuit design environment software
- IDE Arduino: programming environment software.
- Fusion 360: 3D objects design environment software.
- Cura: 3d objects to3d printer converter.

3.2. Methods

(i) Air Purification Process

The microcontroller should trigger the air purification system when air quality falls below a certain threshold. The air purification process involves a double filtration method. Initially, the polluted air is passed through a pre-filter, preventing bacteria from entering the subsequent filtering stages, as illustrated in Figure 2. The input air undergoes a continuous cycle of filtration until it emerges as clean and purified air, ready for use. This iterative process ensures the removal of contaminants, resulting in purified and humidified air. The fan and air filter were connected to the microcontroller. The microcontroller was programmed to activate the fan and adjust its speed based on the air quality data received from sensors.

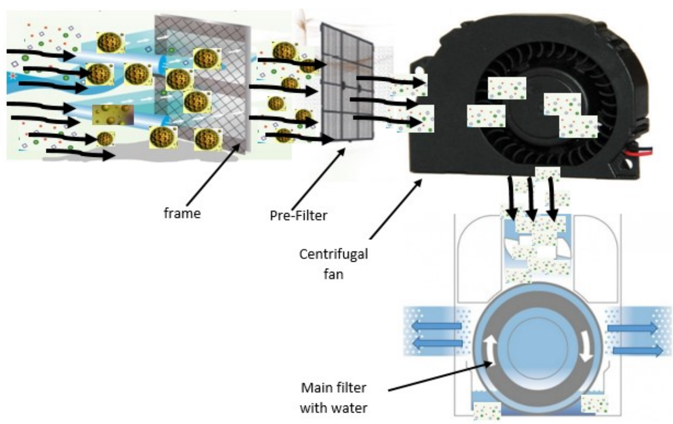


Figure 2. Air Purification Processes

The block diagram of the proposed system that shows the overview of the device is shown in Figure 3.

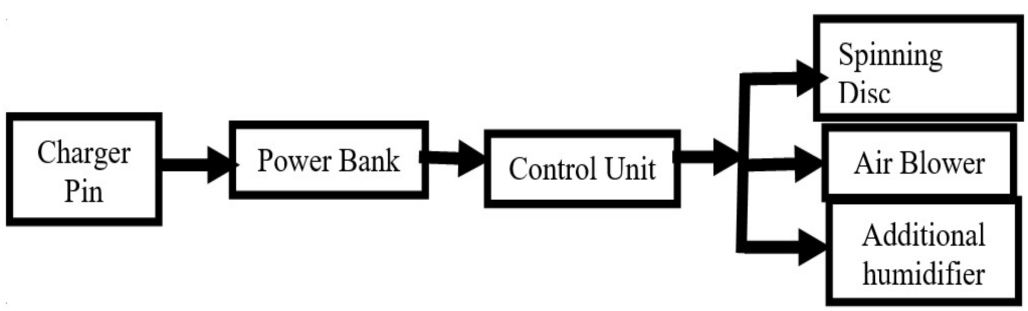


Figure 3. Block Diagram

Table 1. Components Used for the Design and Implementation of RAPH

S/N	Components	Description
1.	Circuit board	Single layer
2.	220 resistor, 1k, 1.5k resistor, 3k resistor, 4.7 resistor, 5k resistor 10k Resistors, 18k resistor, 56k resistor	Standard
3.	10v, 11v and 13v zener diode	Standard
4.	IRFZ44N transistor	Mosfet
5.	2N4401 transistor	Bjt
6.	5k potentiometer, 10k potentiometer,	Standard
7.	1N4007 diode	Standard
8.	2200u capacitor	Electrolyte
9.	12v relay	Standard
10.	Switch	Simple
11.	RG LED, Yellow LED, Blue LED, White LED (small)	Standard
12.	3.7v batteries	Lithium
13.	LM3914 microcontroller	Standard
14.	24vdc power regulator	Computer
15.	101 capacitor, 152 capacitor, 473 capacitor	Ceramic
16.	20u inductor	Coreless
17.	2.7MKHz piezo disc	Mist maker
18.	BU406 transistor	Mosfet
19.	Arduino Nano	Standard
20.	Push button	Standard
21.	L298 MOTOR DRIVER	Standard
22.	12vdc air blower	Medium
23.	12vdc motor	Medium
24.	Soldering wire	Standard
25.	1mm wires, 1.5mm wires	Copper/aluminium
26.	Heat sink	Single
27.	Plastic glue	Standard
28.	1.0mm female connectors, 2.5mm female connectors	Standard
29.	1.0mm male connectors, 2.5mm male connectors	Standard
30.	Plastic filament	PLA

The component of the proposed system that shows the overview of the device as follow:

- Charger Pin: This accounts for charging the device's internal batteries with a constant 12-voltage supply.
- Power Bank: Set of batteries connected in series /parallel to store electric energy with an output capacity of 12v when fully charged.
- Control unit: This unit is in charge of controlling many circuits such as turning ON/OFF different operations in the system such as:
  - Power ON/OFF button
  - Power bank-level indicator LED
  - Charge ON/OFF RG LED
  - Main purification & humidification ON/OFF button
  - Main purification & humidification ON/OFF LED
  - Additional humidifier ON/OFF button
  - Additional humidifier ON/OFF LED
- Air blower: In this research a centrifugal fan is used to draw the polluted air inside the room to the purification system and outputs clean air to the room it is powered on.
- Spinning disc: This supplies a DC motor with a regulated voltage which regulates the rotation speed of the bleed inside water which continuously washes the air coming from the blower fan and dispenses clean air into the room.
- Additional humidifier: This system provides humidity by atomizing water dropped on it into the form of mist.

(ii) Circuit Designs and Simulations

- Charging Circuit

Solar was used as a source of energy to power the system as shown in figure 4. The solar charging circuit was integrated by varying its voltage as we simulated the circuit at input voltage ranges of 11v-13v DC. This helps to avoid overvoltage in the system, D1 and D2 manage the operation with the combination of Q4, Q5 and RL1. Once the battery is fully charged the current flow across terminal Q1 acts as an isolator (no current flow to Drain-Source), this action results in the opening of RL2 contact. The Red LED indicator powers ON when the battery is charging and green when the battery is fully charged.

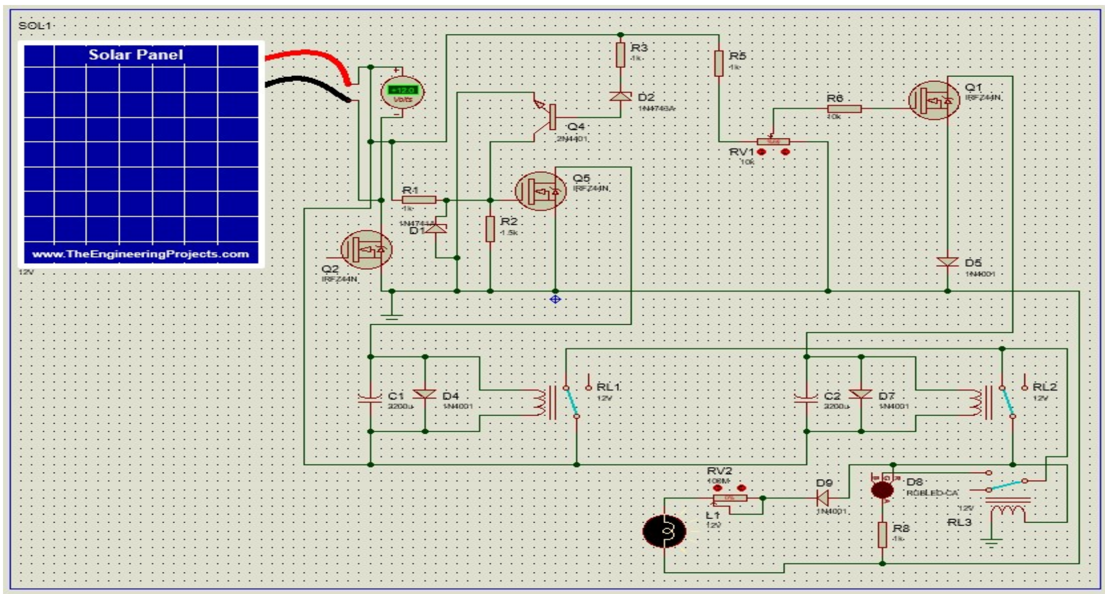


Figure 4. Charging Circuit

- Power Bank Circuit

This research makes use of nine lithium batteries of 15.5WAH (3.7V/4200mah) capacity each connected in series/parallel as shown in Figure 5.

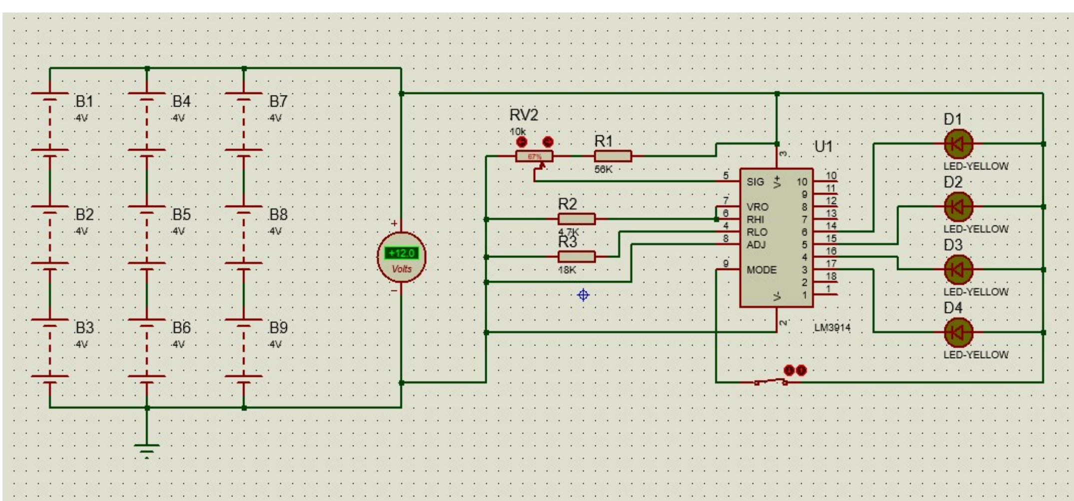


Figure 5. Power Bank Circuit

- ✓ Total Capacity of the Design= 9 batteries × 15.5 WAH/battery=139.5 WAH.
- ✓ The total voltage of the system in a series/parallel configuration would be the voltage rating of a single battery = 3.7V×3 (series)=11.1V.
- ✓ The total ampere-hour (Ah) rating of the system = 4200mAh×9 batteries=12.6Ah.
- ✓ Therefore, when fully charged, the power bank terminals can deliver up to 12.6V without any interruption.
- ✓ A voltage level indicator circuit is embedded into the design to show power decreases with the help of four LEDs (D1, D2, D3 and D4).

- Air washing system

For this main operation to take place we came up with a four-step system that consists of starting the air blower and the spinning disc by the first press, and for the second press the air blower and the spinning disc switch OFF as shown in Figure 6.

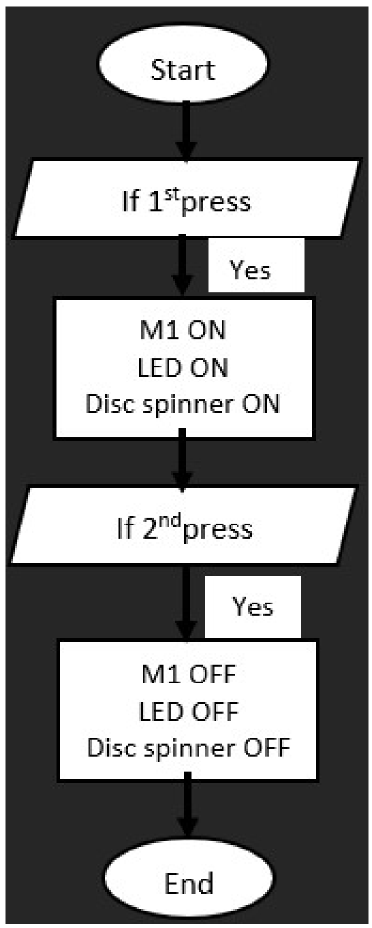


Figure 6. Flowchart of Air Washing

- Air washing Circuit

Two motors are linked to an L298 motor driver and are regulated using pulse-width modulation (PWM) signals from a microcontroller on the Arduino Nano board. When a push button is pressed, the system reads the input data and executes the corresponding code on the preceding page to perform the required operation. Figure 7 represents a standard air washing circuit within the Renewable and Rechargeable Powered Air Purifier and Humidifier.

Air washing Code:

```
int Button = 2;
int button, speeder;
int Motorap =4;
int Motoran = 5;
int Ena =3;
int Motorbp= 6;
int Motorbn =7;
int Enb = 8;
int led = 9;
void setup() {
  // put your setup code here, to run once:
pinMode(Button,INPUT);
pinMode(Motorap,OUTPUT);
pinMode(Motoran,OUTPUT);
pinMode(Ena,OUTPUT);
pinMode(Motorbp,OUTPUT);
pinMode(Motorbn,OUTPUT);
pinMode(Enb,OUTPUT);
pinMode(led,OUTPUT);
}
void loop() {
  //Put your main code here, to run repeatedly:
 button = digitalRead(Button);
if (button ==1){
  speeder ++;
  digitalWrite(Motorbp,HIGH);
  digitalWrite(Motorbn,LOW);
  digitalWrite(Motorap,HIGH);
digitalWrite(Motoran,LOW);
analogWrite(Ena,150);
digitalWrite(led,HIGH);
delay (300);
if (speeder == 4){
  speeder = 0;
}
if (speeder == 1){
  analogWrite(Enb,130);
}
else if (speeder == 2){
  analogWrite(Enb,180);
}
 else if (speeder == 3){
  analogWrite(Enb,255);
}
 else  {
  speeder = 0;
  analogWrite(Enb,0);
  digitalWrite(Motorbp,LOW);
  digitalWrite(Motorbn,LOW);
  analogWrite(Ena,0);
  digitalWrite(Motorap,LOW);
  digitalWrite(Motoran,LOW);
  digitalWrite(led,LOW);
 }
}
}
```

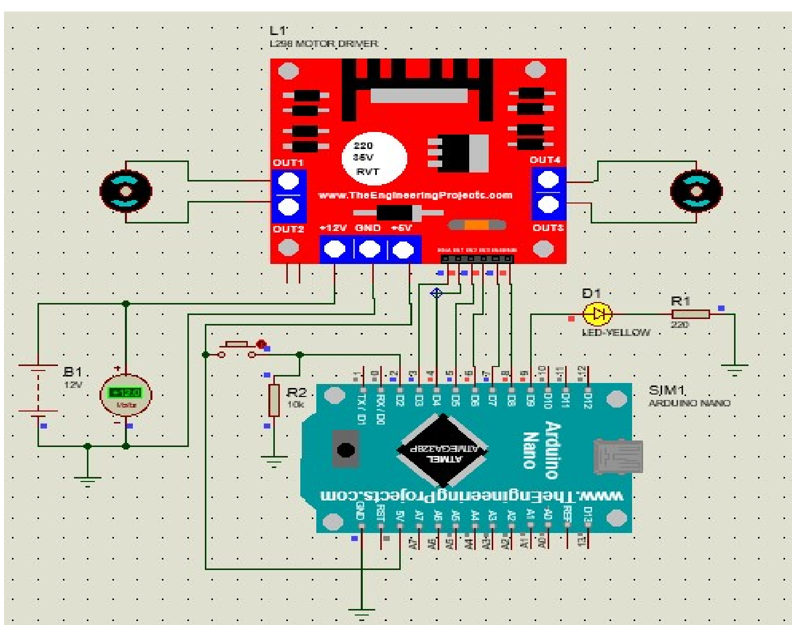


Figure 7. Air Washing Circuit

- Additional Humidifier system

This circuit operates on a 24V power supply to generate a precise electrical signal directed towards the piezo disc, denoted as LS1 in Figure 8. This specialized piezo disc, when stimulated by the electrical signal, induces ultrasonic vibrations at a frequency of 1.70 MHz. These vibrations play a key role in atomizing the liquid, typically water placed atop the disc. As a fascinating consequence of this process, the water is transformed into a fine mist, creating fog. Beyond its primary purpose of generating fog, this operation serves a secondary function: humidification. The fine mist produced by the ultrasonic vibrations not only creates a visually captivating fog effect but also increases the humidity levels in the surrounding environment. This dual functionality makes the circuit invaluable for applications where controlled humidification and atmospheric enhancement are essential. The synergy of precise electrical signals, ultrasonic vibrations, and liquid atomization showcases the innovative capabilities of this circuit, making it a versatile solution for various practical and creative endeavors.

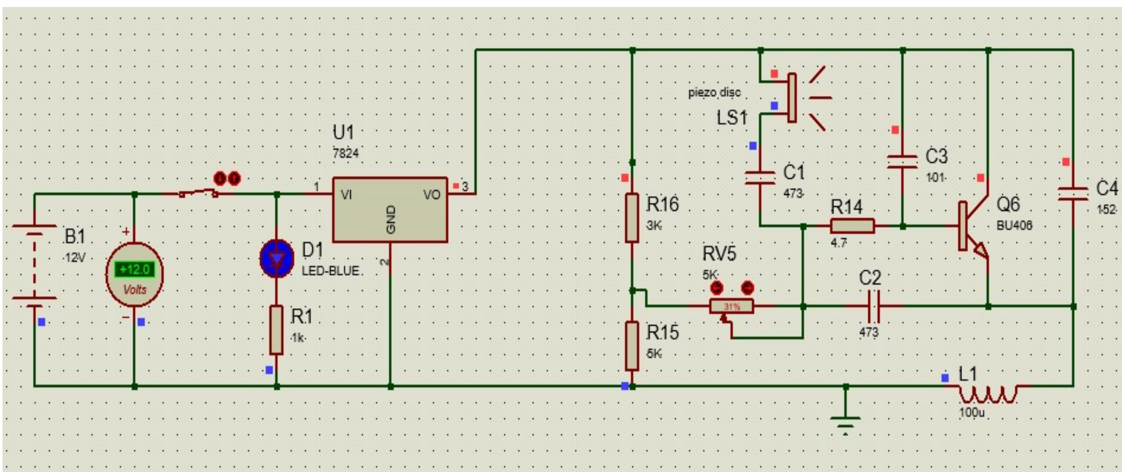


Figure 8. Additional Humidifier Circuit

- General system

The general system combines all the circuits used in the system (charging circuit, power bank circuit, air washing circuit and additional humidifier circuit) as shown in Figure 9.

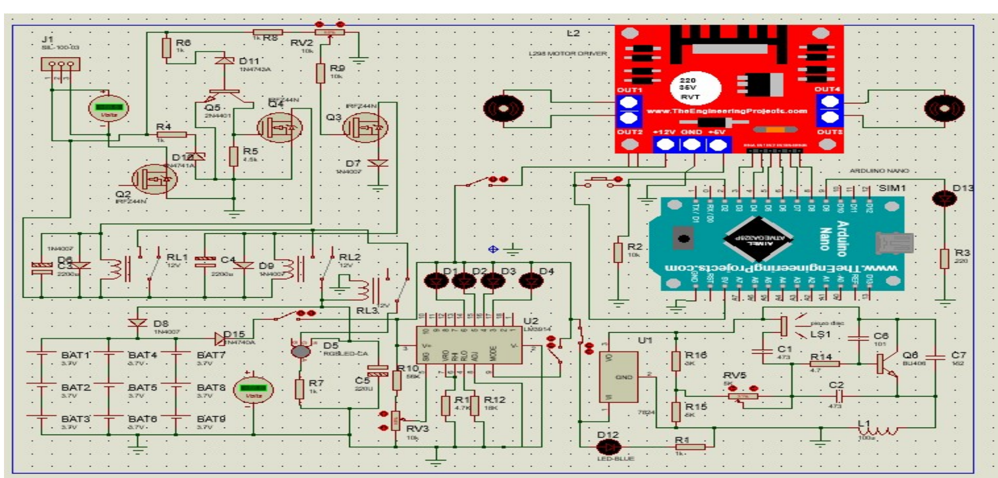
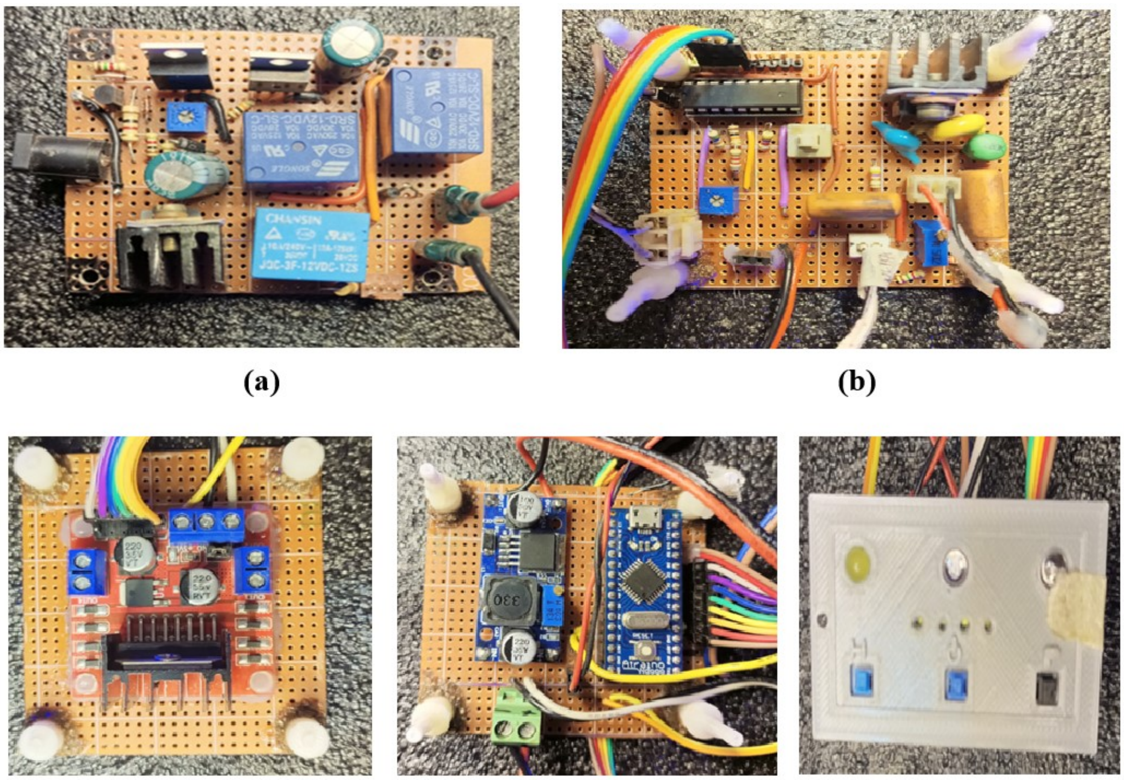


Figure 9. Designed Circuit for Portable and Rechargeable Air Purifier and Humidifier

- Circuit Implementation

Figure 10a-e is the Designed Portable and Rechargeable Air Purifier and Humidifier which involves intricate circuit implementations for both the Additional Humidifier Circuit and the Purifier Circuit. The Additional Humidifier Circuit is responsible for maintaining the optimal humidity level in the air, while the Purifier Circuit ensures the air is clean and free from pollutants.



(a) **(b)** **(c)** **(d)** **(e)**

Figure 10a. Charging Circuit
Figure 10b. Power Bank Circuit & Add. humidifier Circuit I
Figure 10c. Purifier Circuit II
Figure 10d. Add. Humidifier Circuit I & Purifier Circuit II
Figure 10e. Control Unit

For the Additional Humidifier Circuit, a sensor measures the current humidity level. When the humidity falls below a certain threshold, the circuit activates a water pump, drawing water from a reservoir. This water is then atomized using ultrasonic or misting technology, adding moisture to the air. To prevent over-humidification, the circuit includes a feedback loop, monitoring the humidity constantly and adjusting the water atomization rate accordingly.

In the Purifier Circuit, air passes through multiple stages of filtration. First, a pre-filter traps large particles like dust and hair. Then, an activated carbon filter absorbs odours, gases, and volatile organic compounds. After that, a HEPA (High-Efficiency Particulate Air) filter captures tiny particles, including allergens and microorganisms. UV-C lamps or other disinfection methods can be employed to kill bacteria and viruses. An intelligent sensor monitors air quality and adjusts the fan speed and purification methods accordingly.

Both circuits are powered by a rechargeable battery and include a charging circuit that enables easy recharging. The portable nature of the device allows users to place it in various locations, ensuring clean and humidified air wherever needed.

- Assembling Procedures

Figure 11 is the diagram showing the names of the parts and the assembling procedures of all the electrical and mechanical parts of the system.

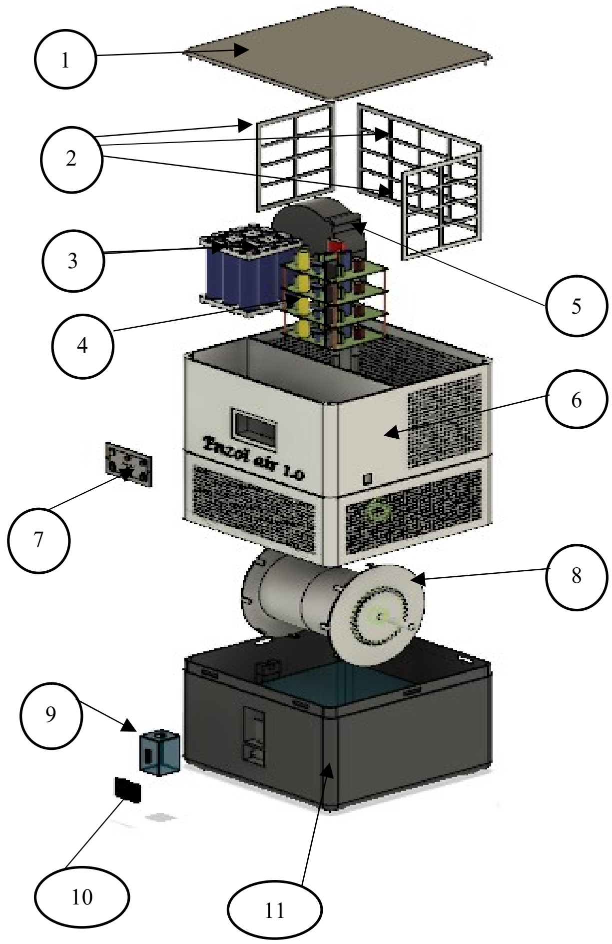


Figure 11. Assembling procedures of Portable and Rechargeable Purifier and Humidifier

The name and functions of each part of the Portable and Rechargeable Purifier and Humidifier as shown in the figure:

1. Cover (The top cover covers the up part of the device allowing easy opening and closing. This part enables the maintenance of the pre-filer, fan and different circuits)
2. Pre-filters (The pre-filter supports illustrated in figure16, are supported on which smooth filters are attached to)
3. Battery bank and the mount (The battery mount helps to secure batteries and enable proper connections between the cells. The nine battery cells used in this design were mounted using the battery mount to hold them firmly)
4. Circuit boards (where the components were mounted for easy connection)
5. Fan (for air distribution and cooling)
6. Top frame (This structure carries out most of the components used in the device. It is made in such a way that it draws in polluted air from the upper air inlet and sprays clean air from the lower air outlet)
7. Control unit (The control unit shown in figure17, is mounted with electronic components to control the device)
8. Spinning disk with an attached gear (This disc is attached with a filter and while rotating it moves the filter inside water as this one releases the dust captured in the polluted air out of the

fan into the water and the gear transmits the low torque high speed (16 teeth) from the auxiliary motor to high torque low speed (32 teeth) spinning disc)

9. Oil container (This is a small container for oil or water to be atomization for humidification)
10. Oil diffuser (This oil diffuser is a small part that lets atomized oil or water spray)
11. Base frame (The base structure is mainly a water container in which the disc rotates at a constant speed. It also carries out oil container and oil diffuser locations)

4. Finding and Discussion

The findings are about power consumption in different modes, full charging time, water degradation over time, the device performance in different room sizes and comparison with other devices on the market.

Figure 12. Implemented Portable and Rechargeable Air Purifier and Humidifier

The power consumption takes place in three different ways as explored in Figure 13, Figure 14, Figure 15 and Figure 16.

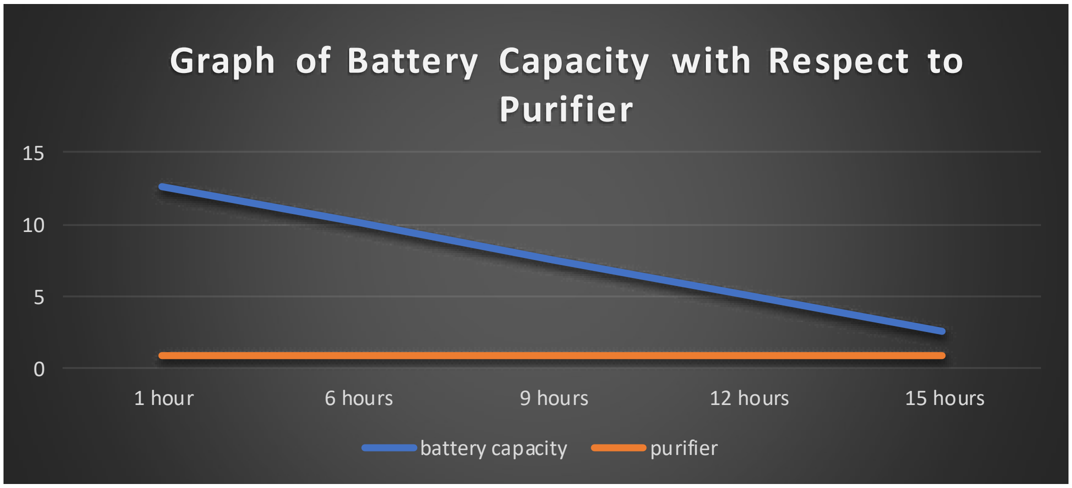


Figure 13. Graph of battery Capacity against Purifier

The data in Figure 13, clearly illustrates the energy consumption pattern of the Renewable and Rechargeable Powered Air Purifier and Humidifier. The graph demonstrates that the battery takes approximately 15 hours to fully drain when subjected to a constant purifier load of 0.84 amps. This finding highlights the efficiency and longevity of the device's power supply, shedding light on its practical usability in various settings. It signifies a step forward in sustainable energy solutions, showcasing the potential of harnessing renewable sources to power essential appliances like air purifiers and humidifiers. This breakthrough not only contributes to energy conservation but also promotes eco-friendly practices, aligning with our global efforts to combat climate change.

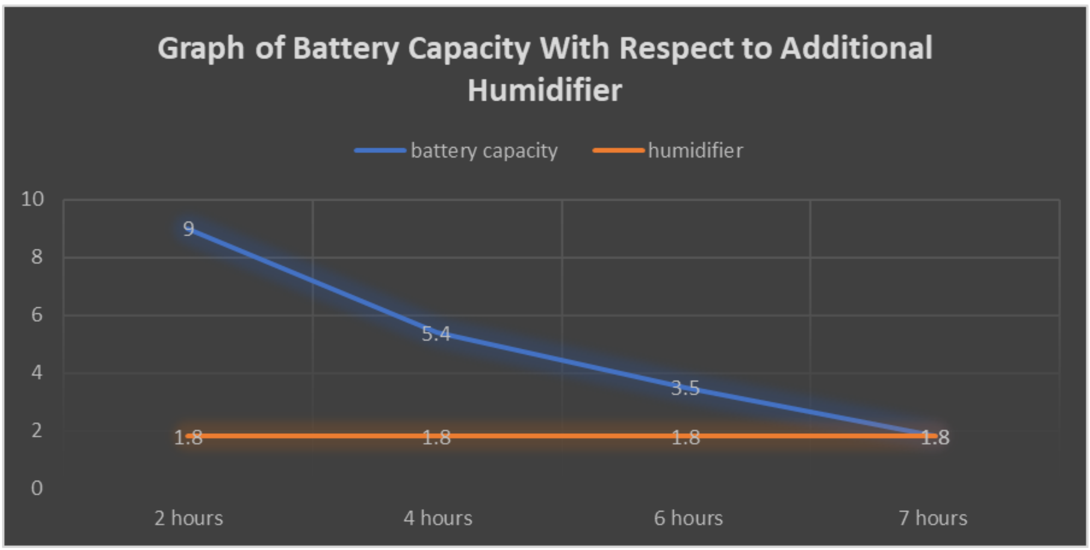


Figure 14. Graph of Battery Capacity with Respect to Additional Humidifier

Figure 14, provides valuable insights into the gradual reduction of battery energy over approximately 7 hours, specifically highlighting its ability to power an additional 1.8 Amps humidifier. This data is particularly pertinent in the context of Renewable and Rechargeable Powered Air purifiers and Humidifiers, offering a clear depiction of the device's operational sustainability. By delving into the intricacies of Figure 15, we gain a comprehensive understanding of the system's efficiency and its reliance on renewable and rechargeable energy sources. Over 7 hours, Figure 14 illustrates the gradual depletion of battery energy, showcasing the intricate balance required to sustainably power the 1.8 Amps additional humidifier. This nuanced analysis underscores the importance of leveraging renewable energy solutions in the realm of air purification and humidification technologies. In essence, it serves as a visual testament to the integration of eco-friendly practices within modern appliances. It not only highlights the device's reliance on renewable energy but also emphasizes the significance of rechargeable power sources in mitigating environmental impact. By demonstrating the device's ability to function seamlessly with these energy-efficient mechanisms, this advocates for a greener approach to air purification and humidification.

The chart depicted in Figure 15 illustrates the significant impact of utilizing both the purifier and humidifier in combination, drawing 264 Amps. This combination substantially reduces the system's operational duration to a mere 5 hours.

The chart in Figure 16, illustrates the charging time of our innovative Renewable and Rechargeable Powered Air Purifier and Humidifier. It showcases the duration required for the device to reach full charge when a constant current of 4 amperes is supplied to the charging pin. Our cutting-edge technology ensures efficient and rapid charging, allowing users to enjoy the benefits of clean and moisturized air without extended downtime.

At the intersection of sustainability and convenience, our Renewable and Rechargeable Powered Air Purifier and Humidifier not only enhances indoor air quality but also harnesses the power of renewable energy sources. This eco-friendly device aligns with our commitment to environmental responsibility, offering users a seamless experience while minimizing their carbon footprint.

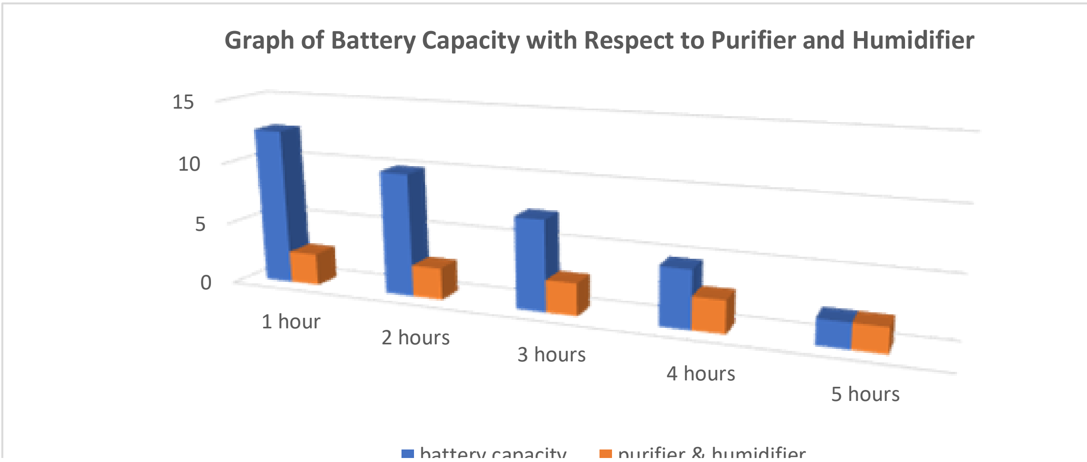


Figure 15. Graph of Battery Capacity with Respect to Purifier and Humidifier

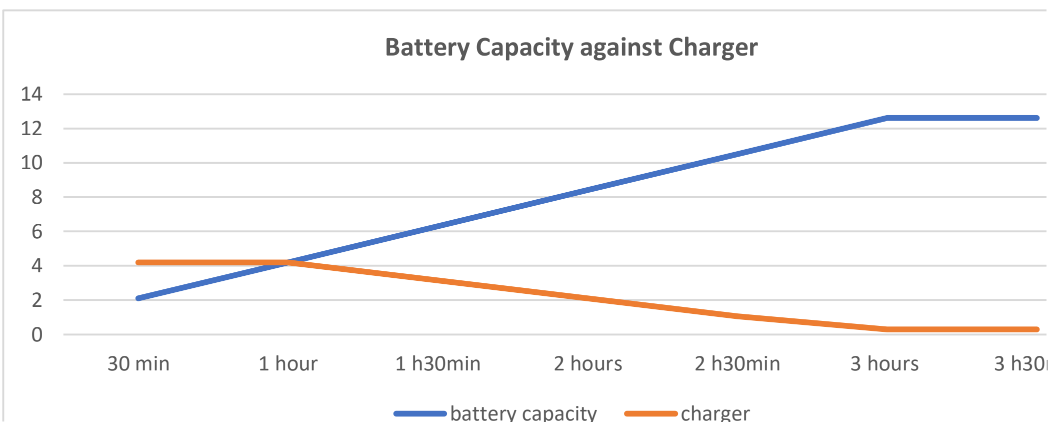


Figure 16. Battery Capacity against Fully Charging Time

Table 2 is a validation and comparison table that shows the different specifications of the implemented Air purifier and humidifier and conventional pure morning humidifier.

5. Conclusion

The design and implementation of a portable and rechargeable air purifier and humidifier represent a significant stride towards creating healthier and more comfortable living environments. This innovative solution addresses the pressing concerns of air quality and humidity control, ensuring that individuals have access to clean and moisturized air wherever they go. Through meticulous planning, cutting-edge technology, and a deep understanding of user needs, this device has been crafted to enhance the quality of life for people across diverse settings. Its portability empowers users to breathe fresh air and maintain optimal humidity levels in their homes, offices, and on the go. The integration of rechargeable features not only promotes sustainability by reducing disposable waste but also offers unparalleled convenience, eliminating the need for constant replacements or external power sources. Furthermore, this device represents a harmonious fusion of form and function, blending sleek design with high-performance capabilities. Its user-friendly interface and low maintenance requirements ensure that users can effortlessly enjoy the benefits of cleaner and more humidified air without complications in Uganda. The developed portable and rechargeable air purifier and humidifier serve as a beacon of innovation, paving the way for a future where clean air and optimal humidity are accessible to all the Ugandans.

Table 2. Comparison between this device and others

Device/Specifications	**Air Purifier and Humidifier**	**Pure Morning Humidifier**
Model	Enzoi Air 1.0	APH230C
Working area	Indoor use	Up to 315 sq. ft. (30m²)
Filter Structure	• Pre-Filter • Main filter water	• Pre-Filter • True HEPA Filter • Activated Carbon Filter also contains: - Nano Mineral - Cold Catalyst - Photo Catalyst Molecular Sieve
Filter Lifespan	As long as there is water	- 6 months
Noise level • Purification mode • Humidification mode • Hybrid mode	 • — dB • — dB • — dB	Sleep Mode <24dB Low Speed <30dB Middle Speed <40dBHigh Speed <49 dB
Rated power per mode: • Purification mode • Humidification mode • Hybrid mode	 • 10.08 W • 21.6 W • 31.68 W	60W
Power Supply	12VDC	AC120V, 60Hz (18AWG 70-inch cord)
Power Bank capacity	139.86 Wah • ≈ 15h in Purification mode • ≈ 7h in Humidification mode • ≈ 4.7h in Hybrid mode	< 2W
Operating TEMP	• -15⁰C ~ 60⁰C	-10°C ~ 55°C
Dimension	30*20*20cm	50*33*18.5cm
Weight	Portable	10lbs (4.5kg)
CADR		230m3/h (135CFM)

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