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Development of Environmental Low-Cost Acid Precipitation Sampler IoT-Based (ELCAPSIoT)

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Abstract

The Malaysian Meteorological Department (MET Malaysia) participates in the Acid Deposition Monitoring Network in East Asia (EANET), utilizing Acid Precipitation Samplers (APS) to monitor wet and dry deposition across Malaysia. These instruments are critical in evaluating acid rain and its environmental impacts. This project aimed to develop a low-cost alternative to the existing APS control system, incorporating Internet of Things (IoT) features and the additive manufacturing to reduce OD (OD) at sites and operational expenses, for EANET and METMalaysia. The current system faced frequent breakdowns, inefficiently refurbished components and increasing maintenance costs. The ELCAPSIoT was developed using microcontroller programmed with Arduino IDE. A cost-effective enclosure and mechanical parts were fabricated using 3D printing. System improvements, based on end users' feedback, included RC filtering for actuator noise suppression, analog-based rain detection, and expanded sensor area. Deployment at selected sites showed a reduction in APS failure rate from 70% to 30%, while component cost was reduced by over 94%, with the new system costing RM 1,360 compared to RM 23,000 previously. Field tests are in compliance with WMO GAW and EANET standards. The ELCAPSIoT project successfully demonstrated the feasibility of a low- cost, IoT-integrated acid precipitation sampler, meeting international monitoring standards while enhancing maintainability, cost efficiency, and technological adaptability. Future developments will explore renewable energy integration and broader environmental applications.

Keywords: Acid deposition; Internet of Things; Environmental monitoring; Arduino; Low Cost Sensors

I.INTRODUCTION

EANET is an international initiative that the Malaysian Meteorological Department agreed upon, providing acid deposition data and analysis as a supportive country for Malaysia. This initiative consists of 13 East Asian countries, including Malaysia, Mongolia, Russia, China, the Republic of Korea, Japan, Myanmar, Thailand, Lao PDR, Vietnam, Cambodia, the Philippines, and Indonesia, all of which give their full support and participation to combat acid deposition and air pollution due to rapid industrialization. They did this by producing high-quality open data, providing knowledge-sharing, capacity building, and public awareness to government officials. [1]

The acid deposition data is significant and important because acid deposition could cause various effects on ecosystems via the acidification of soil and water, as well as damage to buildings and cultural heritage through the corrosion of metals, concrete, and stone. To monitor its dose-effect relationship, five monitoring parameters were identified: Wet Deposition (rainwater), Dry Deposition (air concentration), Soil & Vegetation (forest areas), Inland Aquatic Environment (lake & river water), and Catchment [2]. The chemical composition of rainwater, specifically its ionic content, plays a crucial role in identifying potential pollutants. It determines their sources of pollution whether it is natural or human-made. Plus, it is also to show an understanding how it is dispersed through the atmosphere. This information is essential for assessing their impacts on public health, wildlife, and both natural and urban environments at local and regional scales, as part of the broader deposition processes occurring in the troposphere [3]. Malaysia has an obligation to provide data for Wet Deposition and Dry Deposition, and the instrument responsible for collecting rain and air samples is called the Acid Precipitation Sampler (APS). Wet deposition is defined as the process by which gases and aerosols are incorporated into cloud droplets, either as forming cloud condensation nuclei, or being incorporated in cloud droplets or scavenged as the droplets fall to the ground [4]. Wet deposition is delivered to the earth's surface in the form of rain, snow and mist [5] . Dry deposition of gases and particles occurs by turbulent transfer and by gravitational settling on land and over water surfaces [6].

Figure 1: Acid Precipitation Sampler (APS).

Air pollution is originated from numerous sources and is eventually deposited into both natural and urban ecosystems. These pollutants can lead to ecological disruptions, including prolonged acidification of soils and surface waters, imbalances in soil nutrients that hinder plant development, and declines in biodiversity. Additionally, they pose significant risks to human health, contributing to conditions such as allergies, asthma, and lung cancer, with the severity of impact influenced by the pollutant type and duration of exposure [7]. Nevertheless, one of the reactive gases, from dry deposition monitoring, originated from sulphate and it is a known respiratory irritant and bronchoconstrictor, but its effects seem limited to patients with asthma and bronchitis, although sensitivity to exposure varies widely [8]. Acid did not only affect humans but historical buildings as well. Calcareous stones, such as marble and limestone, have been widely used in ancient architecture due to their durability, abundance, and ease of extraction and workability. However, their chemical nature renders them vulnerable to atmospheric pollutants. With industrialization and socio- economic growth, air pollution has severely impacted built heritage, including numerous historical buildings and monuments, particularly under changing climate and environmental conditions. Various forms of degradation, such as acid corrosion, mineral crystallization, and black crusts, are widespread and typically driven by atmospheric pollutants like sulfur dioxide (SO_2), nitrogen oxides (NO_X), ozone (O_3), and particulates (PM), which accelerate the deterioration of stone surfaces [9].

The APS (Figure 1) is designed to collect rain samples (wet bucket) and dry air samples (dry bucket) for acid rain and air quality monitoring. The collection of both samples were protected by the lid which was moved by a linear actuator. The instrument's mechanism operated such that when rainfall hit the rain sensor, the relay is energized, and the actuator moved the lid to the bucket that captured air concentration. At the same time, the rain sensor activated the heating element to remove any moisture present on the rain sensor. An electronic moisture sensor causes the lid to retract from the sample bucket, allowing a precipitation sample to be collected [10]. The sensor sensitivity needs to be monitored as it can differentiate different types of precipitation [11]. The APS components were divided into two major sections: the control module and the rain sensor. The control module consisted of relays that controlled the actuator, a 555 timer IC, and a 220VAC to 12VDC transformer. Meanwhile, the rain sensor contained a rain sensor, a thermostat, and a heating element. There were 24 APS units in Malaysia [12], it is placed at the main Meteorological Farm near the airport and other areas. This instrument was installed in 2001 and still operational. This instrument was manufactured in the US, and most of its components are not available in Malaysia.

Therefore, this project aims to develop an environmental low-cost APS IoT based system that integrated with additive manufacturing for EANET and MET Malaysia. In order to implement this new APS system, with the integration of IoT and the additive manufacturing, this project is submitted and presented to a committee within my department called Jawatankuasa Pembangunan Teknikal (JPT), where the chairperson for this meeting was MET Malaysia Director General. The committee had several functions, one of which is to discuss technical issues raised by every division in the department that required extensive discussion. The project, eventually, approved by the committee later in the meeting in support of innovation and sustainability.

II. PROBLEM STATEMENT

1. *Cost of components increased*

This project identified a few problems within the division and the instrument itself. Since 2017, the division has received a lower budget than in previous years, while maintenance costs exceeded the budget. This trend continued over the years. Additionally, the control module used by the instrument was not available locally and had to be ordered from the US, with its price increasing every year.

2. *Longer duration of instrument downtime*

All 24 instruments, regularly, experience operational failures simultaneously, halting monitoring activities. Downtime lasted at least two to three weeks to repair and diagnose the cause of failure. Year by year, the instruments experience breakdowns—approximately two to three times per station annually. The failure frequency of the APS is recorded to be above 70% per year in logbooks.

3. *Inefficient components and sensors*

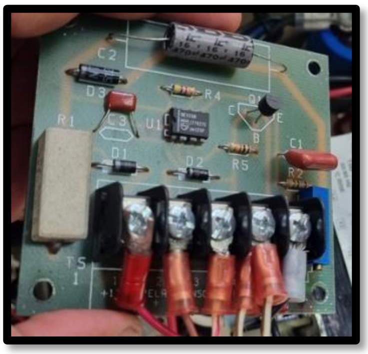

Figure 2: Overheated heating element burnt the circuit board.

Furthermore, in the rain sensor, the heating element is responsible for removing moisture or raindrops from the sensor plate. At a certain temperature, the thermostat acted as a temperature controller to cut off the heating element circuit. However, the rain sensor experience issues where

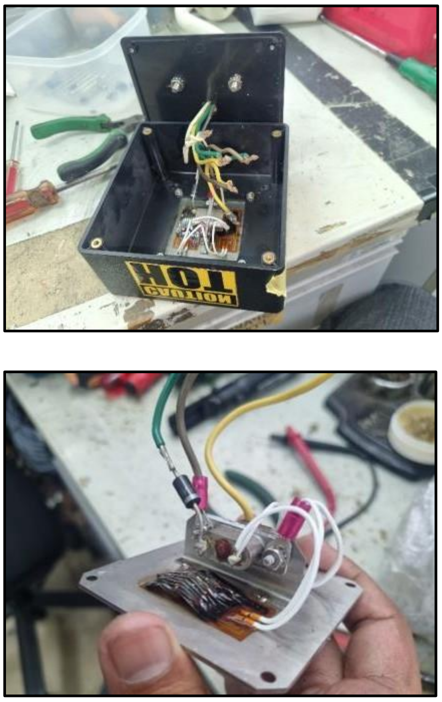

Figure 3: Overheated heating element on the rain sensor.

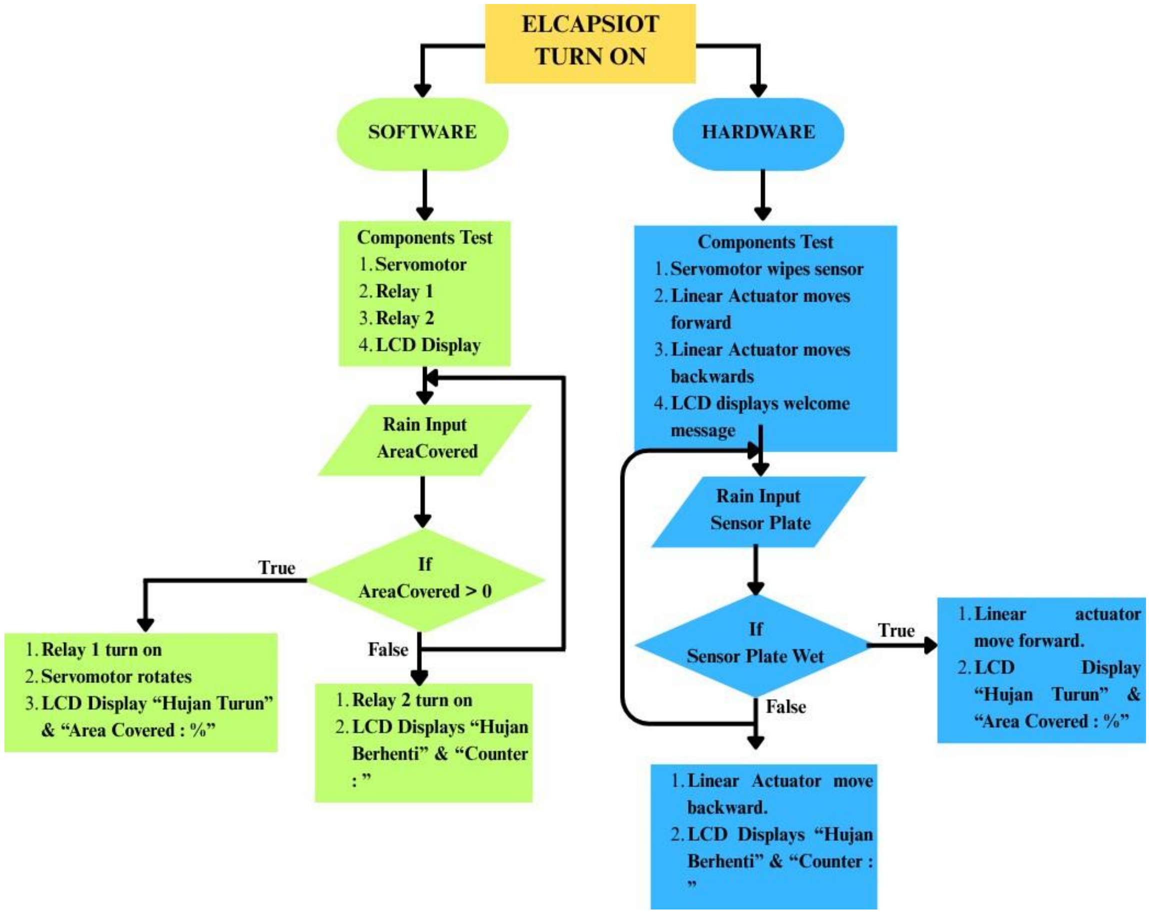

Figure 4: Mechanism Flowchart between software and hardware.

the heating element overheated, causing the circuit board to burn out and become inoperative, melting the rain sensor casing. The control module also had problems, such as relays with unstable high-frequency contacts, leading to spark deposition on the contact surfaces. This caused the actuator to fail in moving the lid.

III. METHODOLOGY

1. INNOVATIVE MEASURES

Before innovative measures were taken, several short-term fixes were taken to keep the instrument operational at a minimal level. First, increasing the frequency of routine preventive maintenance visits to each location twice a year. Next, refurbishment and maintainance all components regularly, using parts salvaged from previous instruments. Regularly refurbished components included the linear actuator, mechanical relays, and heating elements on sensors. After that, specific electrical and mechanical parts purchased in bulk that year using the so-called "Barang Guna Habis" budget. Spare parts were carefully distributed and used to ensure stock levels were not exceeded. Furthermore, several instruments at different stations were officially taken out of operation for significant durations depending on spare part availability. These non-operational instruments were used as spare part sources for the operational ones.Due to the frequent breakdown of the APS instrument, a long-term solution had to be taken into account. Therefore, this project is developing a new control module system using current Industrial Revolution 4.0 technologies such as the Internet of Things (IoT) and additive manufacturing (3D prototyping) without removing its usual mechanism.

1.1 Hardware Design

As for IoT, this project is using a microcontroller named Nodemcu ESP8266. The microcontroller is controlled using a programming language in Arduino Software. The existing APS used a 555 timer IC to control the mechanism, but by using this microcontroller, we, as users, could control the system according to our own ideas. In Figure 5, the Arduino Software is used to program the microcontroller board. By using the code, the APS operated the exact same mechanism as before. The reason this project uses Nodemcu, compared to other Arduino modules, is that the microcontroller board was equipped with an onboard WiFi module, and its processing speed was up to 80MHz, which is sufficient to operate the APS system.

The frame's position, in Figure 6, of the APS System is controlled based on the bucket's height. Thus, limit switches are used to cut off the circuit when the frame reached the top of the bucket. The limit switches functioned to control the frame's position. Otherwise, the actuator would be continuously moving, potentially breaking and cracking the frame.

Figure 5: (Top) The Microcontroller use is Nodemcu. (Bottom) Arduino IDE is the software to upload programming to microcontroller.

Figure 6: The limit switch position(orange) and the frame(red).

The additive manufacturing process is applied to minimize the cost of buying spare parts that can be 3D printed. There are several options of materials for 3D printing. Different material constitute different pricing range and durability, however, the higher the quality of material, the longer time taken to print one design.

Now there are bigger differences in price for each individual set of holders. This will in turn be economical for our division to save the budget for the next 5 to 10 years to allocate the budget for other usages. Plus, due to the high yield strength value of the material, we will be able to use it longer than it should be.

Table 1: Price for different materials.

Properties	PTFE	PETG	ASA
Price	RM 500.00	RM 20.00	RM 30.00

Table 2: Printers with its time of printing of the same design.

Printers	Bambu Lab P1P	Ender 3 S1 Pro	Ender 3
Time Taken	25 minutes	1 hour	1.5 hours

The need to have a 3D printer such as Bambu Lab, Ender 3, Prusa and others, we would be able to print this holder or other parts anyhow, for such a affordable price. The startup cost maybe high but it is just a one-time purchase that last longer than expected. The current technology used in 3D printer products allows the additive manufacturing to be done in such short amount of time. Below is in comparison of time taken to print 4 units of holder with different brands of 3D printer.

This will allow us to manufacture the parts or any parts on that matter, on our own without having to buy the parts. Just a tiny bit knowledge of CAD drawing will have the user print whatever design they desired. This will in turn increase the efficiency of our division in being economical and adaptation to current use of technology.

1.2 Software Development

The way Arduino code worked was that the commands ran line by line. However, the requirement was that when the rain hit the sensor, the relay was turned on, and simultaneously, the LCD displayed "The rain is starting." The servo motor was also activated to act as the wiper for the sensor. The timer function acted as a stopwatch, ensuring tasks were executed according to the setup timer. The newly made control module was able to control a servo motor (wiper), rain sensor detection, two units of a 12VDC relay module, and the LCD.

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1.3 System Integration

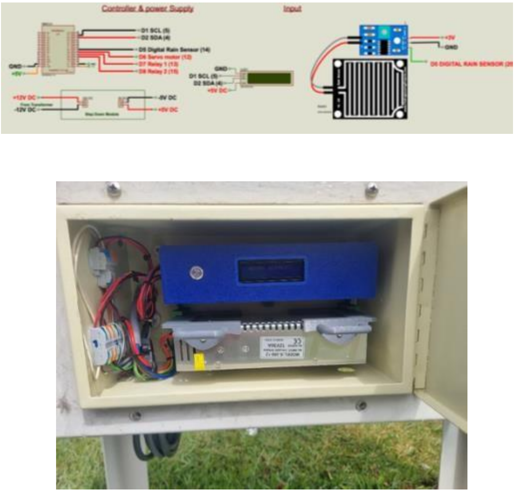

Figure 7: (Top) Microcontroller with respective pins according to software. (Below) The 3D prototyping desing intergrating with circuit boards and power supply unit.

Figure 7 shows the integration of the hardware and the software design. The software development shown where the microcontroller is designated to its respective pins to carry out specific function according to the program uploaded. The 3D design is seen in figure 7 (below) where the circuit board is designed and attached to 3D Printed creative and innovative design and the power supply are given a holder to avoid any electric shock to the users.

Figure 8: 6 Sites where ELCAPSIoT were deployed and installed.

IV. RESULTS & DISCUSSIONS

1. DEPLOYMENTS & INSTALLATIONS

The installation and deployment of 6 sites are done as early as of May 2025 and after the permission of JPT. All of the maintenance trip is done to fulfill the needs to ensure that the acid precipitation sampler operates accordingly, based on WMO GAW No. 160 [13], QA/QC Guidebook for Acid Deposition Monitoring Network in East Asia 2016 [14], and Technical Manual for Wet Deposition Monitoring in East Asia 2010 [15].

This project should be deployed at specific locations. The reason was the project had to be tested based on 3D printed materials for its durability to extreme weather and high humidity and to test the electronics component's durability towards salt water. The table 3 showed a simplified version of locations that are higher risk of failure.

Table 3: Selected locations that might have issues with environment.

Bil.	Station	Reason
1.	Cameron Highlands Station, Pahang	High Humidity between 70% to 90% [16] that might affect electronics and sensors due to condensation.
2.	Sitiawan Station, Perak	Near the coastal area of Selat Melaka and electronics and sensors effects, in terms of rusting rate and other factors that might fail, when South West Monsoon and inter monsoon season.
3.	Mersing Station, Johor	Near the coastal area of South China Sea and electronics and sensors effects, in terms of rusting rate and other factors that might fail, when North East Monsoon and inter monsoon season.
4.	Bayan Lepas Station, Penang	Effects on urban area of Penang.
5.	Kuala Terengganu Station, Terengganu	Near the coastal area of South China Sea and electronics and sensors effects, in terms of rusting rate and other factors that might fail, when North East Monsoon and inter monsoon season.
6.	Chuping Station, Perlis	It's one of the hottest place ever recorded in Malaysia [17]. We want to check the durability of 3D printed designs and electronics due to extreme weather.

Table 4: Comparison of events of OD at different sites in 6 months period.

Stations	Operational Disruption Before ELCAPSIoT (events / 6 months)	Operational Disruption After ELCAPSIoT (events / 6 months)
Chuping, Perlis	5	2
Bayan Lepas, Pulau Pinang	7	3
Sitiawan, Perak	8	3
Cameron Highlands, Pahang	15	1
Mersing, Johor	9	2
Kuala Terengganu, Terengganu	8	2

The performance of ELCAPSIoT across the six highlighted stations demonstrates clear improvements in reliability under different environmental stressors. At Cameron Highlands, which is characterized by persistent high humidity levels between 70–90%, operational disruptions were the highest before system deployment with 15 recorded events in six months.

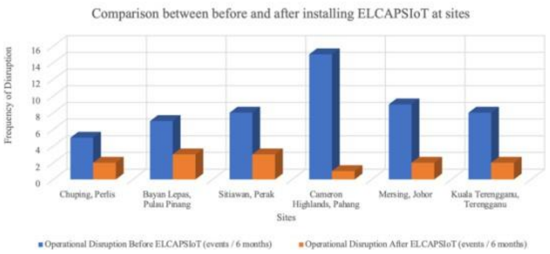

Figure 9: Comparison of events of OD before and after installing ELCAPSIoT at sites.

After ELCAPSIoT was introduced, disruptions dropped dramatically to just a single event, highlighting the system's strong resistance to moisture-related failures. In Sitiawan**,** a coastal station exposed to the South West Monsoon and prone to corrosion, disruptions were reduced from 8 to 3, showing significant improvement though moderate vulnerability remained. Similarly, Mersing and Kuala Terengganu, both located along the South China Sea and affected by saltwater exposure and monsoon seasons, recorded substantial reductions, from 9 to 2 and 8 to 2 events respectively, confirming the system's resilience in coastal environments. In the urban setting of Bayan Lepas, disruptions declined from 7 to 3, indicating that the system effectively addressed failures influenced by urban pollution and localized weather conditions. Finally, in Chuping**,** one of Malaysia's hottest regions, operational failures decreased from 5 to 2, demonstrating the durability of 3D-printed components and electronics under extreme heat. Collectively, these results show that ELCAPSIoT reduces operational disruptions by 60–90% across diverse environments, with the most dramatic improvement seen in Cameron Highlands, thereby validating its scalability and reliability for long-term environmental monitoring. The event that occurred are generally considered minor, such as linear actuator not operating, power supply malfunction, disconnected wires, sensor not detecting rain events. Those malfunctions are easily resolved with guidance and reduce downtime duration and reduce OD. Thus, with those reductions at sites, with minor error, it is an acceptable value that comply with standards and guidelines.

The ELCAPSIoT demonstrates a high level of adaptability across different environmental settings in Malaysia. Its modular design and reliance on readily available components allow deployment in diverse climates, including highland areas with extreme humidity, coastal stations exposed to saltwater corrosion, and urban stations with heavy pollution. This adaptability ensures that the system remains relevant for long-term acid deposition monitoring and can be modified for specific site conditions without extensive redesign.

Despite its advantages, several limitations remain. Long-term durability of 3D-printed components under continuous exposure to harsh weather requires further validation, especially beyond a one-year operational cycle. Reliance on WiFi connectivity may restrict deployment in remote stations with limited infrastructure, and the system still requires consistent maintenance to prevent failures in actuators, power supplies, and sensors. These limitations highlight areas for further improvement in material selection, network connectivity, and maintenance strategies.

Looking forward, the ELCAPSIoT has the potential to evolve into a comprehensive environmental monitoring platform. Integration with renewable energy sources such as solar and wind would enable off-grid operation and support Malaysia's National Energy Transformation Roadmap (NETR). In addition, cloud-based data integration and artificial intelligence could transform the system from a reactive sampler into a predictive decision-support tool capable of forecasting acid deposition events. Beyond acid rain, the modular architecture can be adapted to monitor additional parameters such as particulate matter, greenhouse gases, or water quality, thereby expanding its role in environmental protection.

At the international level, the ELCAPSIoT could serve as a low-cost model for other countries participating in EANET. By demonstrating cost savings, reduced downtime, and compliance with global standards, the system positions Malaysia as a regional leader in innovative and sustainable environmental monitoring. These forward-looking perspectives show that the ELCAPSIoT not only addresses current challenges but also has the potential to significantly contribute to long-term environmental sustainability and global monitoring efforts.

2. COST REDUCTION

The project's target was to compare the cost between APS TISCH and ELCAPSIOT, ELCAPSIOT definitely shown far lower cost than in APS TISCH. The percentage of cost reduction using ELCAPSIoT is 94.1% and it is a significant value to be reliable and sustainable. This is due to the implementation of new components that cost less than previous components.

Table 5: Cost reduction between existing APS and ELCAPSIOT

Bil.	Acid Precipitation Sampler (APS) TISCH	Harga (RM)
1	APS Control Module Box Complete	16,900.00
2	APS Sensor Assembly Complete	6,100.00
	Jumlah (RM)	23,000.00

Bil.	ITEM BAGI ELCAPSIOT	Harga (RM)
1	ESP32 - 38P - TYPEC Development Board WiFi+Bluetooth Ultra-Low Power Consumption	30.00
2	AC to DC 12V 30A 360W Switching Power Supply 220V to 12V 30A	70.00
3	12V 2-Channel Relay Module Active High/Low Switchable 12v Optocoupler Isolator Isolated Trigger Switch for Arduino	15.00
4	Step Down Module LM2596 DC/DC 4.0~40V to 1.25-37V Adjustable Voltage Regulator With LED Voltmeter	10.00
5	1602 Blue I2C LCD Screen Liquid Crystal Display Module for DIY Arduino Project (Basic / with IIC I2C Module)	35.00
6	Chrome 4 Pin 12mm Led Light Metal Push Button Momentary Switch Waterproof 12v	20.00
7	MG996R-270 Degree Towerpro Digital High Torque Metal Gear Servo	40.00
8	Rain Sensor Module For Arduino, Robotics, IoT	10.00
9	10 x 22cm DOT PCB, Veroboard, Printed Circuit Board, Project Board, Prototyping Board, Donut Board, Single-Sided	10.00
10	PETG Filament 1.75mm 1KG for 3D Printer	100.00
11	Silicone Wiper	20.00
12	Wire, wire jacket, connector, screw and nuts, soldering jobs, drilling jobs and miscellaneous finishing jobs	1,000.00
	Jumlah (RM)	1,360.00

Plus, the components needed a circuit board and enclosure to store the control module properly and looking compact. Thus, the enclosure uses 3D printing device to fabricate the enclosure without having to make it by using heavy machineries and sheet metal. Initially, buying the 3D printer is expensive and it is one time purchase only but it is a long-term investment.

Once the ELCAPSIoT is deployed at the chosen stations, the chief station was brief and asked to give feedback and reporting if there are any abnormalities happen to the ELCAPSIoT. Notabaly, since the old APS started working, majority of the 24 stations that has APS, do not have any recorded logbook to report any failure or maintenance work on the existing APS. Most of the reporting of failure, will be informed via official Whatsapp Group called Ranger Alam Sekitar. This group discusses on sampling matter and any failure of any instruments.

Therefore, for this ELCAPSIoT, this project has prepared a digitalized platform of logbook, that was Google Form, and it is automatically updated on the excel form we prepared. Easier for us to track any record of failures that happened, digitally and in support of current government's policy on digitalization.

3. COUNTERMEASUREMENTS

3.1 *FALSE TRIGGERING FROM THE LINEAR ACTUATOR*

First is the False triggering problem and managed to replicate the problem. Although sensor was not attached to circuit board, it still gave off false trigger. It was found that the motor was giving off the false trigger. The linear actuator could have a number of higher electrical noises. Based on the theoretical findings using Step Response and Bode Plot, it was discovered that by adding capacitor, the noise seems to be reduced.

3.2 *USE ANALOG VALUE THAN DIGITAL VALUE FOR RAIN SENSOR*

As for this matter, before this project used the rain sensor to give out digital value but the range is lower than analog value. Analog value gives the sensor a wider range of values, since rain sensor gave out resistance values.
Arduino gives off analog values from 0 to 1024 and gives us a broad range of values to further improve rain detection.

3.3 *INCREASE SENSOR AREA*

The sensor area was limited to flat small plate that has an area of **2160** mm^2. Thus, by increasing the area and placing 2 plates at once, increases the area to 4320 mm^2.

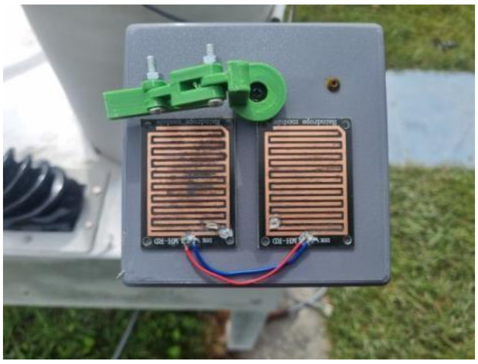

Figure 10: Sensor area is increased by adding another sensor plate.

4. FUTURE ENDEAVOURS

4.1 INTERNATIONAL INTRODUCTION

This project had the opportunity to be presented and introduced as ELCAPSIoT to the EANET Awareness Workshop 2024. This project also acknowledged the Coordinator of the Secretariat for the EANET about the development of the ELCAPSIoT. The possible collaboration with EANET in the future for increasing acid deposition network across EANET participating countries, are very high and sustainable.

4.2 RENEWABLE ENERGY

The ELCAPSIoT system ran on purely 12VDC and it allows ELCAPSIoT to discover the potential of using Renewable energy, to powering up the system. This was to ensure that this project is on par with current government's policy, National Energy Transformation Roadmap (NETR) on applying renewable energy in a system. ELCAPSIoT might be able to utilize solar energy, wind energy (Vertical Axis Wind Turbine or VAWT), and water turbine.

4.3 LEADERSHIP OPPORTUNITIES AND CAPACITY BUILDING

The ELCAPSIoT project is one of milestones project that enabled individual to show any leadership skills and engineering skills. The usage of Arduino opened up opportunities, to learn and enhance knowledge in coding and programming for other applications. Prior to this project, every individual involved in this project are given basic class on Arduino programming. This project helped the project utilized the AI platform such as ChatGPT to assist in finding corrections. As for 3D prints, this project has shown the software of printing the materials using various types of printers. This project also taught about the software used to slice the 3D design and the functionality of each button. The slicer software was called Bambu Studio.

4.4 ADDITIONAL SENSORS AND MODULES

The usage of a microcontroller enables countless possibilities for future measurements and monitoring by integrating additional sensors and modules. Beyond acid deposition, sensors such as relative humidity, temperature, and atmospheric pressure can provide a more comprehensive understanding of environmental conditions influencing acid rain formation. Infrared (IR) sensors can be applied to enhance precipitation detection and differentiate between rainfall intensity levels. Likewise, modular components such as real-time clock (RTC) modules allow precise timestamping of collected samples, GSM modules enable remote data transmission from stations without WiFi connectivity, and relay modules expand control capabilities for actuators and auxiliary devices. These enhancements can be seamlessly programmed into the existing Arduino-based framework, ensuring flexibility and adaptability without major redesign. This approach not only supports scalability within Malaysia's 24 monitoring stations but also strengthens the system's potential for international adoption under EANET.

V. CONCLUSION

In conclusion, the project was successfully deployed at sites and managed to reduce cost of the system and reduce operational failure of the system in comparison with the existing APS. By taking into account engineering problem solving techniques, it has lifted the project to another level and benefitted other parties as well. In order to fulfill this project, thorough and detailed discussion and ideas with the team, but required team effort. The objectives of this project were reducing cost, usage of current technology and reduced downtime of the sampler, definitely meet the target of the EANET Standards and WMO GAW No. 160 Standards. The usage of current technology opens wider possibility of new knowledge and engineering practices, such as 3D Prototyping Machine and Programming Microcontroller. Nevertheless, low-cost sensors enable this project to use renewable energy such as solar energy, wind energy and water turbine. For future planning purposes, the ELCAPSIoT will venture another usage besides utilizing as precipitation sampler.

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