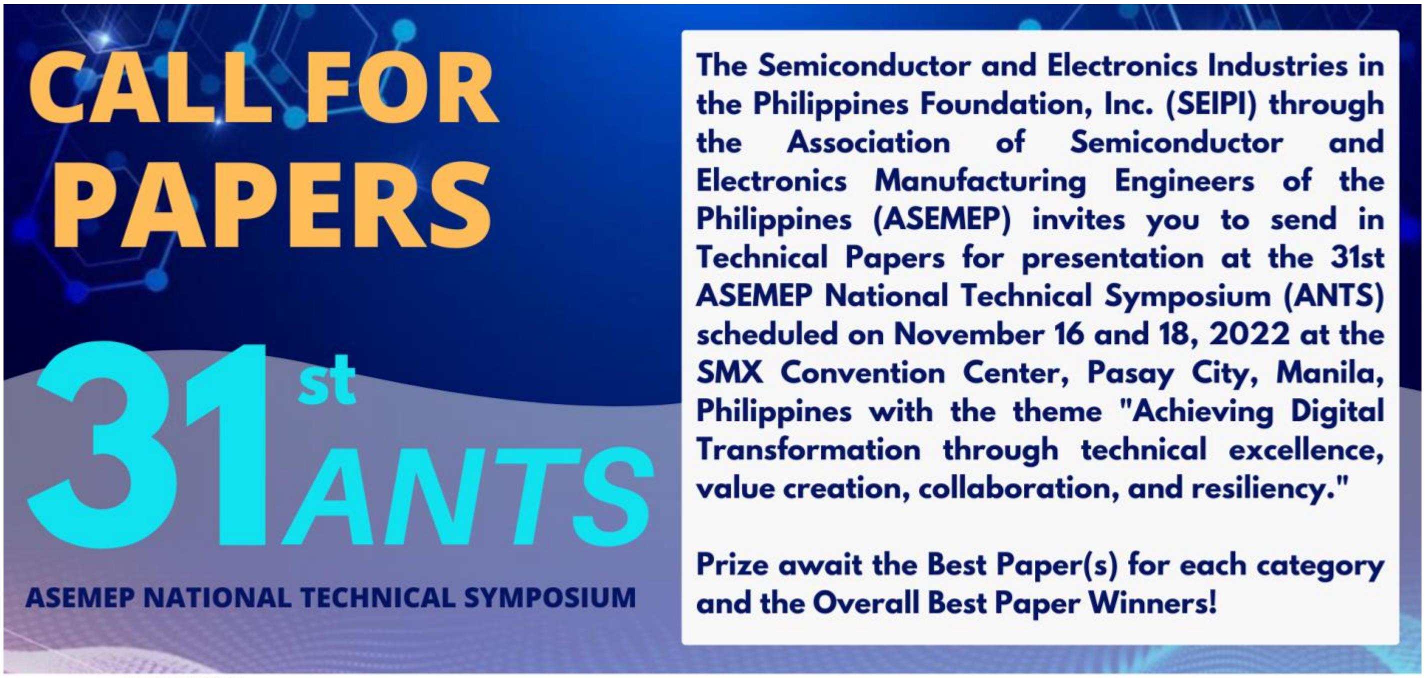

ORGANIZED BY

SEIPI'S ANNUAL BUSINESS PARTNERS

31st ANTS 2022 AUTHOR'S CHECKLIST

This checklist is intended to assist the author(s) in the preparation of technical papers for review by the ANTS 2022 Technical Screening Committee.

Technical Papers are due on **SEPTEMBER 16, 2022** and the requirements are:

- ❑ List all authors and their email addresses.
- ❑ Indicate the Category and Sub-category of the paper.
- ❑ Verify that the paper contains at most 7 pages and follows the NTS Technical Paper Template.
- ❑ Include all supporting data, figures, and information.
- ❑ Include author biography with picture (50 words or less).
- ❑ Send Paper(s) in PDF Adobe Acrobat only (virus-free) and send on or before the deadline of September 16, 2022.
- ❑ Obtain permission from Manager and/or Company to submit paper and present (if the paper is accepted).
- ❑ Include company contact information in the Technical Paper Entry & Endorsement Form.
- ❑ Submit scanned copies of Technical Paper Entry & Endorsement Form and Author Checklist to SEIPI through email at rose.duazo@seipi.org.ph.
- ❑ This Author Checklist should be checked and signed by you.

I verify that I checked all of the above-listed requirements.
Name of Author(s) & Signature(s): Shirley Azuma
John Rendell C. Padura
Joshua T. Prado
Manager's Name & Signature: Adonis S. Santos
Date: September 16, 2022
Name of Company Coordinator: Adonis S. Santos
Contact Number: 09177730324
Email: assantos@firstasia.edu.ph

DEADLINE FOR SUBMISSION IS ON SEPTEMBER 16, 2022!

TECHNICAL PAPER ENTRY & ENDORSEMENT FORM

COMPANY NAME: **FAITH Colleges**	
ADDRESS: **#2 Pres. JP Laurel Hi-way, Tanauan City, Batangas**	
TEL. NO. **(043) 778 0656**	FAX. NO.
PAPER TITLE: **SOLAR-POWERED GREENHOUSE SYSTEM FOR LETTUCE USING ARDUINO**	
What is the new idea presented in this technical paper? A greenhouse system is developed to monitor and control parameters including temperature and relative humidity to aid greenhouse farming in Tanauan City, Batangas in collaboration with Tanauan City Agriculture's Office Demo Farm.	
PAPER CATEGORY: **ACADEME TRACKS/PRODUCTS**	PAPER SUBCATEGORY: **OTHERS (New Trends, End-user Applications, New Product Development, R&D Outputs)**
NAME OF AUTHORS:	E-MAIL:
1 Shirley Azuma	shirleyazuma018@yahoo.com
2 John Rendell C. Padura	johnrendellpadura@gmail.com
3 Joshua T. Prado	joshuapra027@gmail.com
ENDORSED BY (name of endorsing Manager or Company representative, please sign over printed name): **ADONIS S. SANTOS**	POSITION: **ASST. PROFESSOR/CHAIR, ECE Department**

Category and Subcategory: Please check/mark one or more that is applicable:

__✓__ A) **ACADEME TRACKS**

_____ B) **ASSEMBLY MANUFACTURING**

(Semiconductor Manufacturing Services, Original Device Manufacturers, Electronics Manufacturing Services)

- o New Manufacturing Technologies / Automation
- o Process Improvement

_____ C) **TEST MANUFACTURING**

(Semiconductor Manufacturing Services, Original Device Manufacturers, Electronics Manufacturing Services)

- o New Manufacturing Technologies / Automation
- o New Test Processes and Technologies

__✓__ D) **PRODUCT** (Semiconductor Devices & Electronics Systems)

- o Product and Technology Holistic Strategy (PATHS)
  - Semiconductors/ Component/ Devices (Smart Sensors, Chips, IC Design)
  - Office Equipment (3D Printers)
  - Consumer Electronics (Smart Phone, Smart Home Devices)
  - Telecom (Gateways and Enabling Technologies, IoT Devices)
  - Electronic Data Processing (Big Data Storage Devices)
  - Control/ Instrument (Autonomous Vehicle, Autonomous Drone, Collaborative Robot)
  - Medical/ Industrial RxBox Laser for Cancer Detection, 3D Printer for Bone Implants)
  - Automotive Electronics (AV/SV/SDV Electronics, Lithium-Ion Batteries, Intelligent Battery Sensors)
  - Solar/ Renewable (High-Density Storage Batteries)
- ✓ Others
  - New Trends
  - End-user Applications
  - New Product Development
  - R&D Outputs

_____ E) **QUALITY**

- o Lean Manufacturing
- o Six Sigma Projects
- o TPM/TQM

_____ F) **FA / REL ENGINEERING**

- o Reliability Engineering
- o Product/Failure Analysis
- o ESD Control
- o Product Contamination Control

_____ G) **SUPPORT SYSTEMS**

- o IT/Software Development
- o Industrial Engineering Technologies
- o Training and Education
- o Facilities
- o Environment EMS

IMPORTANT: Kindly accomplish one (1) form for every completed PAPER entry to be submitted to SEIPI via email to rose.duazo@seipi.org.ph.

DEADLINE FOR SUBMISSION IS ON SEPTEMBER 16, 2022.

SOLAR-POWERED GREENHOUSE SYSTEM FOR LETTUCE USING ARDUINO

Shirley Azuma
John Rendell C. Padura
Joshua T. Prado

College of Engineering
First Asia Institute of Technology and Humanities, Tanauan City, Batangas
shirleyazuma018@yahoo.com, johnrendellpadura@gmail.com, joshuapra027@gmail.com

ABSTRACT

Temperature and relative humidity are greenhouse parameters necessary to nurture a sustainable living environment. Various crops, particularly lettuces, require optimum temperature and humidity conditions inside the greenhouse for best possible yield. In this regard, a greenhouse system for lettuce can provide the required conditions and ensure that temperature and humidity are distributed equally through the greenhouse. This study focuses in creating a system that can control and monitor the greenhouse environment through Arduino, temperature and humidity sensor, cooling system, lighting, water pump and fertilizer pump with sprinkler, display, and solar panel. The control system for temperature and humidity is done through a cooling system and lighting, moreover misting process will be done with the use of water pump and a sprinkler. On the other hand, monitoring process is done by a display, it will show the actual temperature and humidity reading as well as if the area needs fertilizer. More so, the system includes a semi-automatic liquid fertilizer pump as utilization of fertilizers likewise impact the development of greenhouse crops. Controlling the functions of embedded systems is the Arduino and the overall system is powered by a solar panel

1. 0 INTRODUCTION

Hajdu (2021) defines greenhouse farming as a unique farm practice of growing crops within sheltered structures covered by a transparent or partially transparent material. It stabilizes the growing environment for plants to cultivate as its main purpose is to provide favorable growing conditions and to protect crops from unfavorable weather and various pests. In greenhouse farming, it is scientifically verified that moisture, warmth, and light are needed in order for plants to grow[1].

Temperature determines the rate of crop development and consequently affects growth period of the crops. Growth starts at some minimum temperature (4-5°C) and as the temperature increases, rate of plant growth increases until an optimum temperature is reached. According to the Magazine Greenhouse Management, some common greenhouse problems are temperature swings and crops drying out due to dehydration. Hence, neglecting to control the temperature and humidity in the greenhouse can negatively affect the crops.

Ideal humidity level ranges between 50% to 70% for vegetative growth and 50% to 60% for flowering plants while the ideal temperature for the vegetative plants is at 25°C and flowering plants are 28°C. Under low humidity condition, rate of transpiration increases and plants may wilt. When humidity levels drop too low, the plants transpire at a rate much quicker than that of nutrient uptake. The utilization of fertilizers likewise impacts plant development.

According to Mr. Sherwin Rimas, an agriculturist on Tanauan City Demo Farm, the greenhouse is in need of a system that can control the environment for the crop to maximize its full potential. The high-value crops in the farm are broccoli, bell pepper, and lettuce; however, lettuces are the most grown crops in the greenhouse. Encouraged by the existing problems, the researchers would like to design and implement a solar-powered system that can control and monitor the greenhouse's environment. On the other hand, the difference of the project from existing studies is the semi-automatic liquid fertilizer pump. The system is powered by a solar panel. The system to be designed and implemented is significant to greenhouse farming; more so, will solve various problems being encountered by greenhouse farmers and growers.

1.1 Objective of the Study

The study aims to design and implement a solar-powered greenhouse system using microcontroller that can control temperature and humidity, and have a semi-automatic fertilization process.

2. 0 REVIEW OF RELATED WORK

2.1 FPGA-Based Battery Energy Storage System Using Solar Cells

In this study, Sujae (2014) stated that interfacing the monocrystalline 100 watts and 12 volts solar panel with field programmable gate array needs the output of the solar panel be sensed and turned to the dividing circuit to suit the range of FPGA kit. Moreover, the reduced voltage and current are given as the input of the microcontroller. The values presented are taken to be an input for the ADC conversion. The converted digital values are then implemented in MPPT algorithm, in which the duty cycle of the switch is changed to the calculated power. So, the constant output is achieved from the converter[2].

2.2 Arduino Based Digital Temperature Sensor

The project is a temperature sensor by an Arduino Uno, LM35 sensor, and other components. According to Bhalaaji (2017), the primary objective of the project is to identify the temperature of the surroundings and display it on an LCD monitor. To summarize, the project begins with the utilization of LM35 sensor which senses the change in temperature of the surrounding. The temperature difference is used to produce a voltage signal which is processed by the Arduino. It then gives a digital output showing the temperature of the given surrounding[3].

2.3 Automatic Solar Powered Fan for Regulation of Temperatures in a Green House

According to Tarus (2017), the Greenhouse has the most important role when it comes to agriculture to properly support crops and avoid environmental conditions such as high and low temperature, humidity, light etc. Rising and falling temperatures in crops greatly affect growth and controlling the temperature is expensive in electricity but because of the Automatic Solar Powered Fan can be controlled the temperature. When the temperature exceeds 30 ° Celsius the fan will turn on and run and when it drops to 13 ° Celsius the fan will still be on because there is still warm air inserted in the pebbles that can circulate inside the greenhouse. The Automatic Solar Powered Fan will maintain the temperature inside the greenhouse what is the required temperature range of a crop and moreover reduce the cost of using electricity because it uses polycrystalline 100 watts and 12 volts solar panel. [4].

3.0 METHODOLOGY

3.1 Design Specifications

This section presents the basis of the design concept including the list of components or material used to create the system, the detailed operation and functionalities of the greenhouse system that will help in the efficiency of the proposed work, the actual and 3D setup, and the conditions set in to the system.

Table 1. List of components that will be used in the Solar-Powered Greenhouse System

Electronic Board	Arduino Mega
Temperature and Humidity Sensor	DHT22
Lighting	LED Light Bulb (12V, 1.5W)
Cooling System	Oscillating Fan (12V, 25W)
Solar Panel	Monocrystalline (12V, 100W)
Display	LCD (16x2)
Battey	Lead-acid (12V, 45A)
Water Pump	Submersible (12V, 4.2W)
Fertilizer	Liquid Fertilizer

Table 2. Working Characteristics of the System

Characteristics	**System**
Operating Voltage	12V
Operating Current	12.87A
Maximum Power Consumption	154.4W
Temperature Range	-40-80°C with a ± 0.5° Accuracy
Humidity Range	0-100% RH with a ±2-5% Accuracy
Sampling Rate	0.5Hz (once every 2 seconds)
Greenhouse Dimensions	2.9m x 3.2m x 2m
Greenhouse Style and Design	Shade Clothed Tunnel Greenhouse

Fig. 1. 3D Model

Fig. 2. Actual Setup

3.1 Block Diagram

The control system of the proposed solar powered greenhouse system for lettuce is presented to provide an overview of the input and output ports, system components, principal process participants, and working relations.

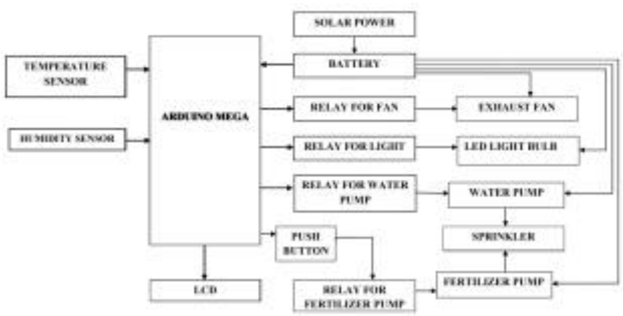

Fig. 3. Block Diagram

3.2 Flow Chart

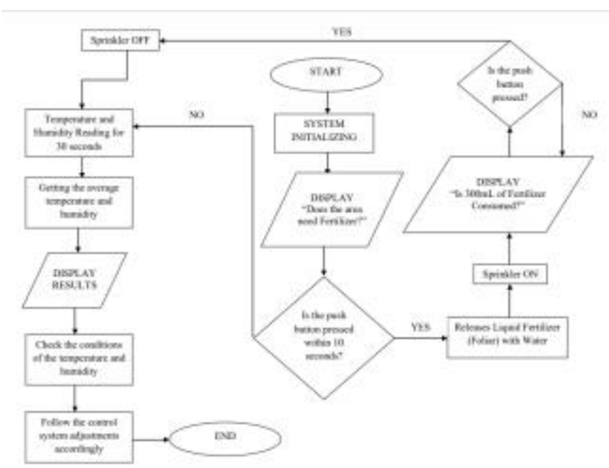

Fig. 4. Flow chart

Once the system is on, the LCD will display "Does the area needs fertilizer?" This question is for the farm worker to press the push button within 10 seconds. If the farm workers would be able to press the push button, the fertilizer pump will start releasing the liquid fertilizer and the sprinkler will automatically spray the area. While putting fertilizer, the system will ask again the operator if the fertilizer is totally consumed. If YES, the operator should press again the push button to stop fertilization, and proceed to temperature and humidity reading (30 seconds). If NO, the question will be continuously displayed, until the push button is pressed. However, when the push button is not pressed within 10 seconds after initialization, the system will automatically go to temperature and humidity reading (30 seconds); then compute its average reading; and will show the actual reading through the LCD. The system will check if temperature and humidity are on its ideal ranges. If YES, the peripherals (exhaust fan, light and water pump) will be on a standby mode. Then if NO, it will move along the other temperature and humidity control system listed below.

Table 3. Condition Set in the System

Conditions		Control System
Temperature	**Humidity**	
Ideal[a]	Ideal[d]	Peripherals Standby
Ideal[a]	High[e]	Turn on Fan
Ideal[a]	Low[f]	Turn on Misting
High[b]	Ideal[d]	Turn on Fan
High[b]	High[e]	Turn on Fan
High[b]	Low[f]	Turn on Misting and Fan
Low[c]	Ideal[d]	Turn on Light
Low[c]	High[e]	Turn on Light
Low[c]	Low[f]	Turn on Light and Misting

[a] Ideal in Temperature's Row means temperature is in 21°C to 32°C,
[b] High in Temperature's Row means temperature is greater than 32°C,
[C] Low in Temperature's Row means temperature is less than 21°C.
[d] Ideal in Humidity's row means relative humidity is in 50% to 70%,
[e] High in Humidity's row means relative humidity is greater than 70%,
[e] Low in Humidity's row means relative humidity is less than 50%.

The following adjustments in the control system might cause non ideal changes in temperature and humidity while in operation; thus, the system will continue asking if the parameters are on its ideal range. After meeting the desired temperature and humidity range, the peripherals will be automatically slept and the operation stops.

4.0 RESULTS AND DISCUSSION

4.1 Solar Powered Greenhouse System Test Results

Table 3. Test Results

Measured Conditions		Control System	Test Function Result
Temperature	Humidity		
29.20°C	69.30%	Standby peripherals	Successful
35.90°C	59.60%	Turn on Fan	Successful
30.40°C	75.10%	Turn on Fan	Successful
20.80°C	68.70%	Turn on Light	Successful
30.10°C	48.50%	Turn on misting	Successful
33.40°C	78.80%	Turn on Fan	Successful
20.60°C	47.90%	Turn on Misting & Light	Successful
32.80°C	48.60%	Turn on Misting & Fan	Successful
20.30°C	76.90%	Turn on Light	Successful

With the reference to Table 3, conditions set on the system, Table 4 is the test result of the experiment. Each condition has been tested and examined to check the quality, performance, and reliability of the solar- powered greenhouse system for lettuce to the particular circumstances due to temperature and relative humidity fluctuations. The figures below are the proof that the system is working.

4.1.1 Condition: Temperature is Ideal; Humidity is Ideal

Fig. 4. Temperature: 21°C to 32°C; Relative Humidity: 50%-70%

Fig. 4. Standby Peripherals

4.1.2 Condition: Temperature is High; Humidity is Ideal

Fig. 5. Temperature: T>32°C; Relative Humidity: 50%-70%

Fig. 6. Turn on Fan

4.1.3 Condition: Temperature is Ideal; Humidity is Low

Fig. 7. Temperature: 21°C to 32°C; Relative Humidity: RH>70%)

Fig. 8. Turn on Fan

4.1.4 Condition: Temperature is Low; Humidity is Ideal

Fig. 9. Temperature: T>21°C; Relative Humidity: 50%-70%

Fig. 10. Turn on Light

4.1.5 Condition: Temperature is Ideal; Humidity is Low

Fig. 11. Temperature: 21°C to 32°C; Relative Humidity: RH <50%

Fig. 12. Turn on Misting

4.1.6 Condition: Temperature is High; Humidity is High

Fig. 13. Temperature: T>32°C; Relative Humidity: RH>70%

Fig. 14. Turn on Fan

4.1.7 Condition: Temperature is Low; Humidity is Low

Fig. 15. Temperature: T<21°C; Relative Humidity RH <50%

Fig. 16. Turn on Misting and Light

4.1.8 Condition: Temperature is High; Humidity is Low

Fig. 17. Temperature: T>32°C; Relative Humidity: RH<50%

Fig. 18. Turn on Misting and Fan

4.1.9 Condition: Temperature is Low; Humidity is High

Fig. 19. Temperature: T<21°C; Relative Humidity: RH>70%

Fig. 20. Turn on Light

5.0 CONCLUSION

The proponents were able to develop a solar-powered greenhouse system for growing lettuce that can control temperature and relative humidity and embedded a automate misting process through the use of Arduino. The system was also able to display the temperature and humidity of the area.

6.0 RECOMMENDATIONS

The solar-powered greenhouse system for lettuce can also be utilized in different kinds of crop or plant that and can be installed in different agricultural areas or houses especially places with extreme and/or very low temperature and/or relative humidity. Lastly, to be able to utilize the system in a more efficient manner, closed setups for greenhouse are more advisable.

7.0 ACKNOWLEDGMENT

An appreciation to the following people whom we are indebted for guidance, support, and inspiration to make this project plan possible:

To Bianca Joseph M. Pagba, a co-author of this study for her valuable contribution on its completion;

To Engr. Christopher B. Escarez and Engr. Jay Nickson T. Tabing, thesis advisers, for forfeiting their own time and for giving their insights noteworthy in the formation of the study;

To Engr. Adonis S. Santos, research instructor, for his significant suggestions to better this study;

To Tanauan City Demo Farm, greenhouse setting, for allowing us to implement our system in one of its greenhouses; and

To Engr. John Paul S. Endaya and Mr. Arjay M. Mangubat, companions, for helping us with the topic proposal and in setting up our system, respectively.

8.0 REFERENCES

1. Hajdu I., **Greenhouse Farming Exceeds Weather Limitations**, **2021**.
2. Sujae R., **FPGA Based Battery Energy Storage System Using Solar Cells**, **2014**.
3. Bhalaaji A., **Arduino Based Digital Temperature Sensor**, 2**017**
4. Harrison K. Tarus, **Automatic Solar Powered Fan for Regulation of Temperatures in a Green House**, International Journal of Advanced Engineering Research and Science (IJAERS), **2017**, Vol-4, Issue-3

9.0 ABOUT THE AUTHORS

Shirley C. Azuma is a graduate of Bachelor of Science in Computer Engineer at First Asia Institute of Technology and Humanities. She was a member of ICpEP4A.

John Rendell C. Padura is a graduate of Bachelor of Science in Electronics Engineer at First Asia Institute of Technology and Humanities. He was a member of IECEP Batangas Student Chapter.

Joshua T. Prado is a graduate of Bachelor of Science in Electronics Engineering at First Asia Institute of Technology and Humanities. He was a member of IECEP Batangas Student Chapter.