

DESIGN AND DEVELOPMENT OF A WIRELESS
SUGAR PALM VINEGAR PROPERTY
MONITORING SYSTEM

Design Project

CESAR IAN A. BALURAN
VENZ JOSEPH P. MELINDO

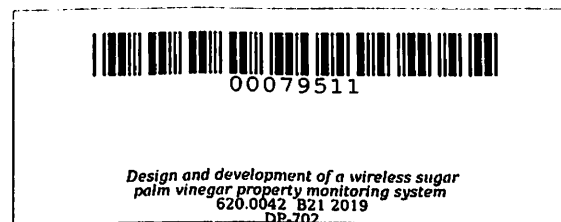
College of Engineering and Information Technology
CAVITE STATE UNIVERSITY
Indang, Cavite

October 2019

DESIGN AND DEVELOPMENT OF A WIRELESS SUGAR PALM VINEGAR PROPERTY MONITORING SYSTEM

Undergraduate Design Project
Submitted to the Faculty of the
College of Engineering and Information Technology
Cavite State University, Indang, Cavite

In partial fulfillment
of the requirements for the degree
Bachelor of Science in Electronics and Communications Engineering



**CESAR IAN A. BALURAN
VENZ JOSEPH P. MELINDO**

October 2019

ABSTRACT

BALURAN, CESAR IAN A. and MELINDO, VENZ JOSEPH P., Design and Development of a Wireless Sugar Palm Vinegar Property Monitoring System. Undergraduate Design Project. Bachelor of Science in Electronics and Communications Engineering. Cavite State University, Indang, Cavite. October 2019. Adviser: Engr. Nemilyn A. Fadchar.

The main objective of the study was to design and construct a wireless sugar palm vinegar property monitoring system. Specifically, it aimed to: 1. design and construct the circuit of the system; 2. develop a system software; 3. test and evaluate the system through the following parameters: sensitivity, response time, and accuracy; 4. conduct cost computation.

The system is composed of four (4) sensors turbidity sensor, pH sensor, waterproof temperature sensor, and ambient temperature sensor. These sensors were used to measure TSS, pH level, sap temperature and ambient temperature respectively. The data collected by the system was transmitted in a cloud server using a WI-FI module and displayed on a webpage through ThingSpeak™ platform. The data was also stored in a SD Card as backup in case internet connection was not available.

The results of the evaluation showed that the system is excellent in terms of its accuracy, response time and sensitivity. The readings from the system has a small percentage error and were comparable from the readings taken manually using handheld sensors.

The study was conducted from January 2019 to May 2019 at Gen. Trias, Cavite and Indang, Cavite. The total cost of the design project was ₱3, 370.00.

TABLE OF CONTENTS

	Page
BIOGRAPHICAL DATA	ii
ACKNOWLEDGMENT	iv
ABSTRACT	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	x
LIST OF FIGURES	xiii
LIST OF APPENDICES	xv
LIST OF APPENDIX TABLES	xvi
LIST OF APPENDIX FIGURES	xvii
INTRODUCTION	1
Objectives of the Study	4
Significance of the Study	4
Time and Place of the Study	5
Scope and Limitation of the Study	5
Definition of Terms	6
REVIEW OF RELATED LITERATURE	7
METHODOLOGY	22
Materials	22
Methods	25
Information Gathering	25

System Overview	25
Design and Construction of the monitoring system	30
Upload and Retrieval of Sensor Data	32
Hardware and Software Flowchart	34
Test and Evaluation	36
RESULTS AND DISCUSSION	38
SUMMARY, CONCLUSION, AND RECOMMENDATIONS	93
Summary	93
Conclusion	94
Recommendations	95
REFERENCES	97
APPENDICES	100

LIST OF TABLES

Table	Page
1 An example conversion of different refractive indices and brix	10
2 The Brix and Temperature Correction Table	14
3 Materials Specification	24
4 Comparison of TSS reading of Device 1 and its percentage error	49
5 T-test for sample 1 of digital refractometer and device 1.....	50
6 T-test for sample 2 of digital refractometer and device 1.....	51
7 Comparison of TSS reading of Device 2 and its percentage error	52
8 T-test for sample 1 of digital refractometer and device 2.....	53
9 T-test for sample 2 of digital refractometer and device 2	53
10 Comparison of TSS reading of Device 3 and its percentage error	54
11 T-test for sample 1 of digital refractometer and device 3.....	55
12 T-test for sample 2 of digital refractometer and device 3.....	56
13 Comparison of pH reading of Device 1 and its percentage error	56
14 T-test for sample 1 of pH meter and device 1.....	57
15 T-test for sample 2 of pH meter and device 1.....	58
16 Comparison of pH reading of Device 2 and its percentage error	59
17 T-test for sample 1 of pH meter and device 2	60
18 T-test for sample 2 of pH meter and device 2	60
19 Comparison of pH reading of Device 3 and its percentage error	61
20 T-test for sample 1 of pH meter and device 3	62

21	T-test for sample 2 of pH meter and device 3	62
22	Sap Temperature reading of Device 1 and its percentage error.....	63
23	T-test for sample 1 of digital thermometer and device 1.....	64
24	T-test for sample 2 of thermometer and device 1	65
25	Sap Temperature reading of Device 2 and its percentage error	65
26	T-test for sample 1 of digital thermometer and device 2	66
27	T-test for sample 2 of thermometer and device 2	67
28	Sap Temperature reading of Device 3 and its percentage error	68
29	T-test for sample 1 of digital thermometer and device 3	69
30	T-test for sample 2 of thermometer and device 3	69
31	Ambient Temperature reading of Device 1 and its percentage error.....	70
32	T-test for sample 1 of digital thermometer and device 1	71
33	T-test for sample 2 of thermometer and device 1	72
34	Ambient Temperature reading of Device 2 and its percentage error.....	72
35	T-test for sample 1 of digital thermometer and device 2	73
36	T-test for sample 2 of thermometer and device 2	74
37	Ambient Temperature reading of Device 3 and its percentage error.....	74
38	T-test for sample 1 of digital thermometer and device 3	75
39	T-test for sample 2 of thermometer and device 3	76
40	Percent Error Comparison Between Calibration and Final Evaluation...	84
41	Response Time Test Result of Turbidity Sensor.....	85
42	Response Time Test Result of pH Sensor.....	86
43	Response Time Test Result of DS18B20 Sensor.....	87

44	Response Time Test Result of DHT22 Sensor.	87
45	Cost Computation of the Device.	92

LIST OF FIGURES

Figure	Page
1 Analog refractometer and example scale.....	11
2 Hand held refractometer – working principle	12
3 Digital refractometer	13
4 pH changes during fermentation.....	16
5 Total soluble solids changes during the fermentation	17
6 The TSS-NTU Relationship.....	19
7 Conceptual Framework of the System.....	26
8 The System Block Diagram	27
9 Traditional Method of Sugar Palm Sap Collection	28
10 A Freshly Collected Sugar Palm Sap from SPRINT	28
11 Sugar Palm Sap collected inside small containers	29
12 Fermentation of Sugar Palm Sap at CvSU-SPRINT	29
13 Sugar palm sap easily attracted insects causing contamination.....	30
14 Schematic diagram of the monitoring system.....	31
15 Webpage UI Displaying Sensor Data Gathered by The System	33
16 The Hardware Flowchart of the System	35
17 The Software Flowchart of the System	35
18 The Software Flowchart of the Cloud Server	36
19 Sugar palm vinegar property monitoring device	39
20 Plastic floater holding the sensors	39

21	Dimensions of the device.....	40
22	Physical connection of the control circuit	41
23	Schematic diagram of the device.....	42
24	Sensor data visualization on the web with ThingSpeak	43
25	Sensors Channel viewed on the web with ThingSpeak.....	44
26	TSS-Turbidity Relationship for Sugar Palm Sap	46
27	Digital Brix Refractometer and pH meter.....	47
28	The proponents setting up the jar	48
29	Device calibration with the first sugar palm sap sample	48
30	Device calibration with the second sugar palm sap sample.....	49

LIST OF APPENDICES

Appendix	Page
1 Tables	100
2 Figures	111
3 Specification Sheets	116
4 Program Codes	143
5 Computation	155

LIST OF APPENDIX TABLES

Table		Page
1	TSS readings of the system to manual reading of Device No. 1.....	102
2	TSS readings of the system to manual reading of Device No. 2.....	102
3	TSS readings of the system to manual reading of Device No. 3.....	103
4	ph level readings of the system to manual reading of the Device No. 1...	104
5	ph level readings of the system to manual reading of the Device No. 2...	105
6	ph level readings of the system to manual reading of the Device No. 3...	105
7	Sap temperature readings of the system to manual reading of the Device No. 1.....	106
8	Sap temperature readings of the system to manual reading of the Device No. 2.....	107
9	Sap temperature readings of the system to manual reading of the Device No. 3.....	108
10	Ambient temperature readings of the system to manual reading of Device No. 1.....	108
11	Ambient temperature readings of the system to manual reading of the Device No. 2.....	109
12	Ambient temperature readings of the system to manual reading of the Device No. 3.....	110

LIST OF APPENDIX FIGURES

Figure		Page
1	Wireless Monitoring Circuit 1.....	112
2	Wireless Monitoring Circuit 2.....	112
3	Wireless Monitoring Circuit with Chassis	113
4	Floater and Sensors	113
5	Calibration and testing of the Wireless Monitoring Device	114
6	Evaluation Area	114
7	The jar used for evaluation	115
8	Testing of floater and sensors.....	115

Design and Development of a Wireless Sugar Palm Vinegar Property Monitoring System

**Cesar Ian A. Baluran
Venz Joseph P. Melindo**

An undergraduate design project submitted to the faculty of the Department of Computer and Electronics Engineering, College of Engineering and Information Technology, Cavite State University, Indang, Cavite, in partial fulfilment of the requirements for the degree of Bachelor of Science in Electronics and Communication Engineering (BSEcE) with Contribution No. CEIT 2019-20-1-002 . Prepared under the supervision of Engr. Nemilyn A. Fadchar.

INTRODUCTION

Sugar palm is popularly known as *Kaong* (*Arenga pinnata*). Although considered as a minor forest species, it provides two important food products: the sweet *Kaong* gel and vinegar, according to DENR. These products have great potentials for export. *Kaong* gel is a very popular ingredient for salad and can be eaten alone as dessert, while *Kaong* vinegar is processed from the sweet sap. *Kaong* vinegar became a popular product of Indang. In fact, it became the town's entry in One Town, One Product program of previous Gov. Ayong Maliksi.

Additionally, the *Arenga Pinnata* is also known to produce the healthiest alternative sugar made from the sap of palm tree (B. Okpala, 2015). In 1409, the *Arenga* syrup and sugar were exported from Indonesia to China for the Chinese Emperor to be used as a diabetic food enhancer (Retrieved from www.hankerfoods.com).