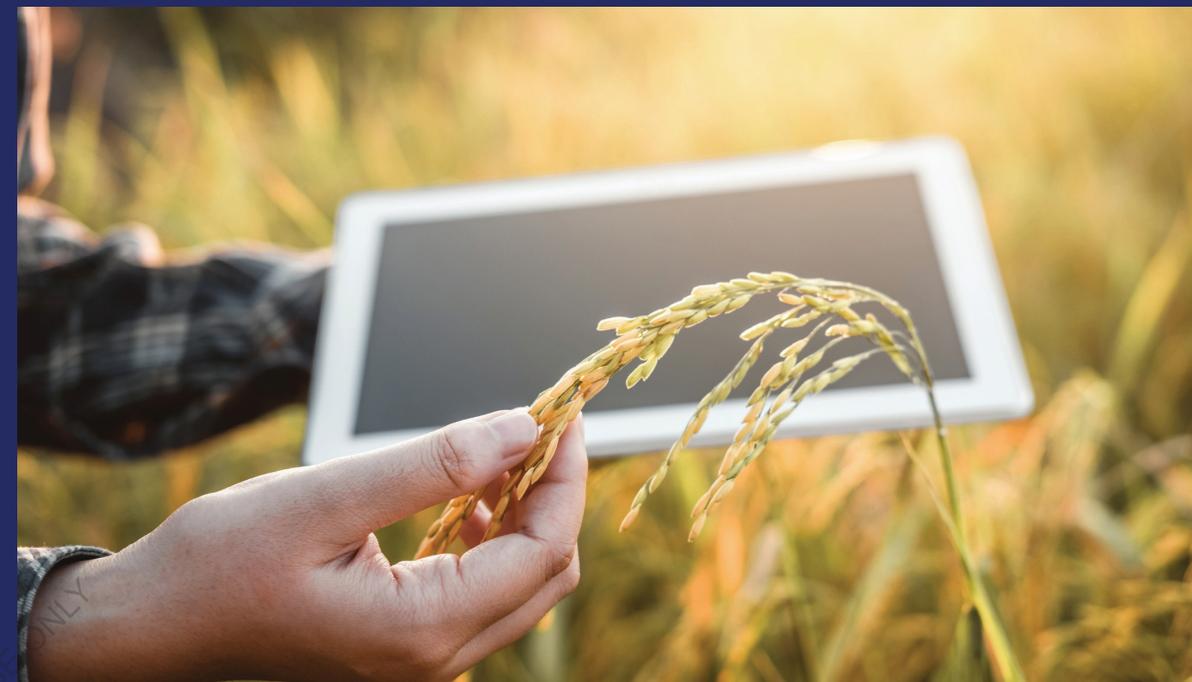


Indeed, Wireless Sensor Network (WSN), is emerging as powerful platform for distributed embedded computing and data management. It ensures the deployment of both embedded technology and computer based data management technology along with the involvement of wireless communication. The ubiquitous field, the WSN exhibit wide spectrum of applications. Emphasizing the themes of Site Specific Crop Management (SSCM), the principle of Precision Agriculture, the Wireless Sensor Network is designed and implemented to monitor the environmental parameters of the high-tech polyhouse. The WSN is designed for monitoring of the Humidity, Temperature and Intensity of Light in the real units. The systems comprises ten Wireless Sensor Nodes, routed through star networking protocol and are located at different places with the polyhouse environment, wherein the Gerbera, Carnesian, Ginger and Rose are growing. The values of parameters are collected at the Base Station, which is developed about computer. A smart GUI is developed to realize the deployment of information processing Technology to facilitate the demonstration of Site Specific data and data logging as well.



Aparna Pawar
Bhimarao Ladgaonakr
Suhas Patil



Dr. Aparna Madhukar Pawar is Assist. Professor in Department of Electronics, T. C. College, Baramati. Dist. Pune (India). His area of research is the Wirless Senosr Network and IoT design, Embedded System, Instrumentation designing. He presented more than 40 research papers in National/International conferences & 15 papers in International Journa

Wireless Sensor Network for Agricultural Application

Wireless Sensor Network, Precision Agriculture, Site Specific Crop Management, Embedded Technology, GUI



Principal
Tuljaram Chaturchand College
Baramati

Pawar, Ladgaonakr, Patil



**Aparna Pawar
Bhimarao Ladgaonakr
Sahas Patil**

Wireless Sensor Network for Agricultural Application

FOR AUTHOR USE ONLY




Principal
Tuljaram Chaturchand College
Baramati

FOR AUTHOR USE ONLY




Principal
Tujaram Chaturchand College
Baramati

**Aparna Pawar
Bhimarao Ladgaonakr
Suhas Patil**

Wireless Sensor Network for Agricultural Application

**Wireless Sensor Network, Precision Agriculture,
Site Specific Crop Management, Embedded
Technology, GUI**

FOR AUTHOR USE ONLY




Principal
Tuljaram Chaturchand College
Baramati

LAP LAMBERT Academic Publishing

Imprint

Any brand names and product names mentioned in this book are subject to trademark, brand or patent protection and are trademarks or registered trademarks of their respective holders. The use of brand names, product names, common names, trade names, product descriptions etc. even without a particular marking in this work is in no way to be construed to mean that such names may be regarded as unrestricted in respect of trademark and brand protection legislation and could thus be used by anyone.

Cover image: www.ingimage.com

Publisher:

LAP LAMBERT Academic Publishing

is a trademark of

Dodo Books Indian Ocean Ltd., member of the OmniScriptum S.R.L Publishing group

str. A.Russo 15, of. 61, Chisinau-2068, Republic of Moldova Europe

Printed at: see last page

ISBN: 978-620-3-19336-7

Zugl. / Approved by: Electronic Instrumentation design for Precision Green House Agricultural Application

Copyright © Aparna Pawar, Bhimarao Ladgaonakr, Suhas Patil

Copyright © 2022 Dodo Books Indian Ocean Ltd., member of the OmniScriptum S.R.L Publishing group

FOR AUTHOR USE ONLY




Principal
Tuljaram Chaturchand College
Baramati

INDEX

Sr. No.	Title	Page. No.
1.	Introduction	
1.1	Introduction	1
1.2	Motivation And Origin Of Problem	3
1.3	Scope Of The Research	4
1.4	Objectives Of Research Work	5
1.5	Wireless Sensor Network (WSN)	7
1.5.1	Introduction	7
1.5.2	Design Issues And Challenges	10
1.5.3	Brief History Of Wireless Sensor Networks	11
1.5.4	Characteristic Features Of Wireless Sensor Networks	13
1.5.5	Architecture of WSN	16
a)	Layered Architecture	17
b)	Clustered Architecture	18
1.5.6	Protocol Stack Of Wireless Sensor Networks	19
1.5.7	Wireless Sensor Node (WSNode)	21
1.5.8	Milestones Of Wireless Sensor Nodes	23
1.5.9	Parameters for Validation of Design of WSNode	28
1.5.10	Applications	31
1.6	Network Protocol for Wireless Sensor Network	40
1.7	Operating System	43
1.8	Precision Agriculture	47
1.9	The Standards IEEE 802.15.4	50
1.9.1	Spectrum for wireless communication	54
1.10	Organization of the Thesis	58
	References	59



2.	An Architecture and Programming of The Zigbee	
2.1	Introduction	71
2.2	Architecture of the Zigbee	73
2.2.1	The Salient features of Zigbee devices	74
2.2.2	Pin Description of the Zigbee	75
2.2.3	Organization of the Zigbee	77
2.3	Types of the WSNodes	78
2.4	Realization of Wireless Communication using Zigbee	79
2.5	Types of operation	82
2.6	Modes of operation	83
2.7	The Architecture of Zigbee Stack	85
2.8	Programming of the Zigbee Devices : The X-CTU	87
2.9	Programming of the Zigbee for present WSN	92
2.10	Conclusion	98
	References	99
3.	Designing of Wireless Sensor Network: The Hardware	
3.1	Introduction	101
3.2	The Hardware	103
3.2.A	Designing of Hardware for Wireless Sensor Node (WSNode)	104
a)	Designing of Hardware of Wireless Sensor Node (WSNode) For Humidity Measurement	107
i	The Humidity sensor [SY-HS-220]	109
ii	Offset voltage compensation	110
iii	Signal conditioning Unit	111
b)	Designing of Hardware of Wireless Sensor Node (WSNode) For Temperature Measurement	111
i	Temperature Sensor [LM 35]	112
ii	Signal conditioning	114
c)	Designing of Hardware of Wireless Sensor Node (WSNode) For Light Intensity Measurement	115
i	Light Intensity Sensor (BPW 34)	116
ii	Signal Conditioning	118



d)	Microcontroller Unit of the Wireless Sensor Node (WSNode)	119
i	Pin description of AVR ATmega 8L Microcontroller	121
ii	Clock circuit	121
iii	Reset circuit	123
iv	I/O Ports	123
v	Analog-to-Digital Converter	125
e)	Wireless Communication Unit : (RF Module Zigbee)	131
f)	Display Section	132
g)	In System Programming [ISP]	135
h)	Power supply unit	136
i)	Conclusion	137
3.2.B	Designing of Hardware for Coordinator	137
a)	Zigbee module	139
b)	Line Driver (MAX 232)	139
c)	Serial to USB converter	140
d)	Power Supply Unit for Coordinator	140
3.3	Conclusion	140
	References	141
4.	Designing of Wireless Sensor Network: The Firmware	
4.1	Introduction	157
4.2	An Integrated Development Environment: CodeVisionAVR	158
4.3	The Firmware Development	165
4.3.1	Development of firmware for WSNode	165
4.3.1.a	Main program	168
4.3.2	Development of Firmware for Base Station (BS)	173
4.3.2.a	Steps involved in designing of GUI in Visual Basic (VB) Environment for Base Station (BS)	174
4.4	Conclusion	180
	References	181



iii

5.	Implementation of Wireless Sensor Network to Monitor Environmental Parameters of the Polyhouses	
5.1	Introduction	186
5.2	Calibration of Wireless Sensor Node (WSNode)	187
5.2.1	Calibration of WSNode for Relative Humidity (RH%)	188
5.2.2	Calibration of WSNode for Light Intensity (LUX)	192
5.2.3	Calibration of WSNode for Temperature ($^{\circ}\text{C}$)	197
5.3	The Complete Wireless Sensor Nodes (WSNodes) designed for establishment of Wireless Sensor Network (WSN)	199
5.4	Implementation of Wireless Sensor Network (WSN) at College Garden	206
5.5	Implementation of Wireless Sensor Network (WSN) within High-Tech Polyhouse	208
5.5 A)	Implementation of Wireless Sensor Networks (WSN and WSN-HBEX) within Polyhouse of Bhuyekar-Patil Agritech Located at Bhuye Dist Kolhapur	208
i	Experimental	209
a)	Experimental setup for WSN under investigation	209
b)	Experimental setup for standard Wireless Sensor Network (WSN-HBEX)	210
ii	Results and Discussion	214
a)	Monitoring of Relative Humidity of the Polyhouse	216
b)	Monitoring of Temperature of the Polyhouse	220
c)	Monitoring of Intensity of Light of the Polyhouse	224
5.5 B)	Implementation of Wireless Sensor Networks (WSN and WSN-HBEX) within Polyhouse of Shrivardhan Biotech Located at Kondigare- Jaysingpur Tal. Shirol, Dist. Kolhapur	228
i)	Experimental	229
ii)	Results and Discussion	231
A)	Monitoring of parameters of Polyhouse (P1) dedicated for Rose	232
a)	Monitoring of Humidity of Polyhouse (P1)	234
b)	Monitoring of Temperature of Polyhouse (P1)	236
c)	Monitoring of Intensity of Light of Polyhouse (P1)	237
B)	Monitoring of parameters of Polyhouse (P2) dedicated for Ginger	240
a)	Monitoring of Humidity of Polyhouse (P2)	240



b)	Monitoring of Temperature of Polyhouse (P2)	241
c)	Monitoring of Intensity of Light of Polyhouse (P2)	246
C)	Monitoring of parameters of Polyhouse (P3) dedicated for Carnation	247
a)	Monitoring of Humidity of Polyhouse (P3)	249
b)	Monitoring of Temperature of Polyhouse (P3)	251
c)	Monitoring of Intensity of Light of Polyhouse (P3)	252
5.6	Conclusion	254
	References	256
6.	Summary and Conclusion	262
	References	269
*	Appendix	263
A]	The Program Listing :WSNode	263
B]	The Program Listing :GUI	273
C]	Figure Captions	279
D]	Table Captions	284




 Principal
 Tuljaram Chaturchand College
 Baramati