

Advanced Surveillance Technology Multicast Using Optical Wireless Transceiver in Smart Environment

**Israel Oluwagbejamija FAKUNLE
LCU/PG/002520**

Being a MSc Post-Field Presentation Submitted to the Department of Computer Science, Faculty of Natural and Applied Sciences, Lead City University, Ibadan, Oyo State, Nigeria

In Partial Fulfillment of the Requirements for the Award of Master/Degree (MSc) in Computer and Information Science

2023

Certification

This is to certify that Israel Oluwagbejamija FAKUNLE with matriculation number LCU/PG/002520 carried out this research work titled “Advance Optical Wireless Surveillance Technology Decentralization For Smart Cities” in the Department of Computer Science, Faculty of Natural and Applied Sciences, Lead City University, Ibadan, Oyo state, for the award of Master Degree (MSc) in Computer and Information Science and that this has not been previously submitted.

Dr. Wilson Sakpere
(Supervisor)

Date

Dr. Wilson Sakpere
(Head of Department)

Date

Dedication

This research work is dedicated to God Almighty, my parents, and siblings.

Do Not Copy, Lead City University, Nigeria

Acknowledgement

I want to thank the prestigious institution Lead City University for the opportunity to learn and complete my Master's Program and to the University Library for provision of adequate materials needed.

I am grateful to the Department of Computer Science for giving me the privileged and opportunity to study and to learn, my appreciation goes to my supervisor Dr. W. Sakpere, I also like to acknowledge my lecturers, Dr. A Waheed, Dr. R. Badru, Dr. W. Ajayi for their supports and always ensuring that things are done rightly.

My appreciation goes to my family and friends who has always supported and sponsored me through this program.

“Even though the above-mentioned institutions and persons have assisted in the process of this research work, I alone stand responsible for the errors, if any, found in the work.”

Abstract

Security practice is crucial peaceful living. In the old times, before the advancement of technology, security was a major concern due to invasions, robbery, and wars. According to history, security personnel in those days known as vigilante also served as police. The security responsibilities then require 100% human effort, having to go over an assigned geographical area, restlessly and sleeplessly, to secure lives and properties. But today with technological advancements, people are able to live in security without the need for protection. The advancement in technology has relieved humans a whole lot of security threats and stress. This study aims to develop a real-time surveillance system that utilizes multicast technology to prevent and detect crime in an enclosed geographical location. The objective is to empower residents to work together and contribute to the security of their environment, lives, and properties. Real-time surveillance multicast is faced with numerous challenges, such as; lags / interruption in transmission, due to error from the framework or internet connections, high internet data consumption, due to enormous data transmission and limited number of users allowed. A Closed-Circuit Television system will be designed using an analogue camera and digital video recorder with a hard drive for data capturing and storage allowing decentralization of the system using a wireless video transceiver through integration. Overall, this study aims to develop a surveillance system that empowers residents to work together and contribute to the security of their community. The system will leverage advanced technologies such as wireless video transceivers and multicast technology to improve the efficiency and effectiveness of surveillance.

Keywords: Technological Advancement, Security Threats, need for protection, real-time surveillance, multicast, lags in transmission, empower residents.

Word Count: 260

Table of Contents

Content	Page
Title Page	i
Certification	ii
Dedication	iii
Acknowledgement	iv
Abstract	v
Table of Contents	vi
List of Tables	x
List of Figures	xi
List of Acronyms	xiii
Chapter One: Introduction	1
1.1 Background of the Study	1
1.2 Statement of the Problem	2
1.3 Aim and Objectives of the Study	2
1.4 Motivation of the Study	3
1.5 Significance of the Study	4
1.6 Scope of the Study	5
1.7 Limitation of the Study	5
1.8 Operational Definition of Terms	5
Endnotes	12
Chapter Two: Literature Review	14
2.1 Conceptual Review	14
2.1.1 Surveillance Retail intelligence	18
2.1.2 Surveillance Security Behavior	20

2.1.2.1 Types of Security Measures	22
2.1.3 Video Surveillance Applications	24
2.1.3.1 Crime Management	24
2.1.3.2 Disaster Management	26
2.1.3.3 City and Community Street Monitoring	28
2.1.3.4 Medical Monitoring and Diagnosis	29
2.2 Methodological Frameworks	31
2.3 Review of Related Works	34
2.3.1 Surveillance Technology	37
2.3.2 Decentralization / Multicast	38
2.3.3 Optical Wireless Communication	38
2.4 Summary of Gaps in Literature Reviewed	40
Endnotes	43
Chapter Three: Methodology	46
3.1 Research Approach	46
3.2 System Design	47
3.2.1 Surveillance Technology	47
3.2.1.1 Basic CCTV Architectural Diagram	50
3.2.1.2 CCTV Cameras Implementation	51
3.2.1.3 Video Recorder	52
3.2.2 CCTV Integration System	53
3.2.3 Wireless Video Transceiver	53
3.2.4 System Architecture	55
3.3 Requirements Specification	58
3.3.1 System Development Life Cycle	58

3.3.2	Implementation and Evaluation Model	60
3.3.3	Use Case	61
3.4	Research Methods	62
3.4.1	CCTV System Development	62
3.4.2	Decentralization / Multicast	67
	Endnotes	72
	Chapter Four: Implementation and Evaluation	74
4.1	Implementation	74
4.1.1	Background Information	75
4.1.2	Integration of the Hard Disk	75
4.1.3	Integration of the CCTV Camera	81
4.1.4	Design of a Decentralisation System	84
4.2	Evaluation	95
4.2.1	System Evaluation	96
4.2.1.1	Camera Quality	96
4.2.1.2	DVR Functionality	96
4.2.1.3	Wireless Video Transceiver Performance	97
4.2.2	Performance Evaluation	98
4.2.2.1	Motion Detection Evaluation	101
4.2.3	Population under Surveillance	102
4.2.3.1	Public Privacy Importance	102
4.2.4	Period of Data collection	102
	Endnotes	106
	Chapter Five: Conclusion	107
5.1	Summary of Results	107

5.1.1	Conclusion	108
5.1.2	Recommendation	108
5.2	Contribution to Knowledge	109
5.3	Suggestion for Further Studies	111
	Bibliography	113
	Appendix	121
	Bio-data	140
	The University Compliance Certification	143

Do Not Copy, Lead City University, Nigeria

List of Tables

Table	Title	Page
2.1	Frequency & Wavelength Range Analysis	23
2.2	Wi-Fi protocol Summary	24
3.1	The Experiment Methodology and Techniques Applied	47
3.2	Wireless Video Transceiver Specifications	54
3.3	Frequency Range Analysis	67
3.4	IEEE 802.11 Wi-Fi Protocol Summary	68
3.5	Wireless Video Transceiver Module Specification	69
4.1	Performance Indices	86

Do Not Copy, Lead City University, Nigeria

List of Figures

Figure	Title	Page
2.1	PACMAD UE Framework	33
3.1	Proposed Surveillance System Multicast Conceptual Diagram	48
3.2	A typical Surveillance System Cycle	49
3.3	Basic CCTV surveillance system architecture	50
3.4	Typical DVR & NVR diagram	52
3.5	System Architecture	56
3.6	PACMAD UE Framework	57
3.7	Agile SDLC model	59
3.8	Quality Implementation and Evaluation model	60
3.9	Donabedian Structure-Process-Outcome framework	61
3.10	UML use case	62
3.11	Analogue Indoor Dome Camera	63
3.12	Analogue Outdoor Bullet Camera	64
3.13	RG59 Coaxial Cable	65
3.14	BNC Connectors	65
3.15	Digital Video Recorder	66
3:16	Wireless Transceiver Module Architecture	69
3:17	Wireless Video Transceiver Data Transmission Sequence	70
3.18	Research Display Result	71
4.1	Digital Video Recorder	76
4.2	Display Result for the DVR without Hard-drive	77
4.3	Internal Hardware of DVR	78
4.4	Hard Drive	79

4.5	Internal Hardware after the Hard drive integration	80
4.6	Display Result after HDD's integration	81
4.7	Analogue Indoor Dome Camera	82
4.8	RG59 with BNC Connector Coaxial Cable	83
4.9	Display result of first objective	84
4.10	Wireless Video Transmitter Module	87
4.11	Wireless Video Receiver Module	88
4.12	USB Power source display result	89
4.13	12V Power Supply Box	91
4.14	Alternative Power Supply Integration	92
4.15	Final Internal Hardware integration Diagram	93
4.16	Final of the implementation Research Result	94
4.17	Tool for performance evaluation	99
4.18	Background Area Selection	101
4.19	General Flowchart for Moving Object Detection	102

List of Acronyms

Abbreviation	Meaning
RF	Radio Frequency
OWC	Optics Wireless Communication
IoT	Internet of Things
ISP	Internet Service provider
SS	Surveillance System
UX	User Experience
M2M	Machine-to-Machine
nLos	Non-Line-of-Sight
DVR	Digital Video Recorder
NVR	Network Video Recorder
IP	Internet Protocol
CCTV	Closed Circuit Television
VMS	Video Management Software
HDD	Hard-drive
PoE	Power over Ethernet
PCB	Printed Circuit Board
EM	Electromagnetic
APP	Application
MAC	Media Access Control
PHY	Physical
VLC	Visible Light Communication
OCC	Optical Camera communication
IR	Infrared

WLAN	Wireless Local Area Networks
LAN	Local Area Networks
FSO	Free-space Optical Communications
WBAN	Wireless Body Area Network
WPAN	Wireless Personal Area Network
CWSNs	Cooperative Wireless a Sensor Networks
REMP	Reliable Efficient Multicast Protocol
DHS	Department of Homeland Security
SAVER	System Assessment and Validation for Emergency Responders
M2M	Machine-to-Machine
DHS	Department of Homeland Security
EPROM	Erasable Programmable Read-only Memory
CMOS	Complementary Metal Oxide Semiconductor)
CCD	Charged Coupled Device
QIE	Quality Implementation and Evaluation
BWVC	Body Worn Video Camera
GDT	Gun Detection Technology
UML	Unified Model Language
GT	Grand Truth
AR	Algorithm Result
VGA	Video Graphic Adapter
VCA	Video Content Analysis

Do Not Copy, Lead City University, Nigeria