PROCEEDING

# IEEE COMNETSAT 2012

## 2012 IEEE International Conference on Communication, Networks and Satellite


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*BALI, INDONESIA, 12-14 JULY 2012*

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# IEEE COMNETSAT 2012

## 2012 IEEE International Conference on Communication, Networks and Satellite

## 12-14 July 2012
## Bali, Indonesia

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# Foreword form General Chair

**Dr. Ford Lumban Gaol**

General Chair, Cyberneticscom 2012 and Comnetsat 2012

Ladies and gentlemen,

Warm Greetings and good morning to all on this auspicious day!

Welcome to Bali, Indonesia and The IEEE International Conference on Communication, Networks and Satellite (COMNETSAT 2012) and The IEEE International Conference on Computational Intelligence and Cybernetics (CYBERNETICSCOM 2012) .

I feel honoured as the General Chair of COMNETSAT 2012 & CYBERNETICSCOM 2012 to be here in the midst of the conference and thank the organizers, IEEE Indonesia Section, for having provided me the opportunity to welcome the honourable dignitaries today.

The 2012 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT 2012) targets to address current state of the technology and the outcome of the ongoing research in the area of Telecommunications, Networks and Satellite Systems.

The 2012 IEEE International Conference on Computational Intelligence and Cybernetics (CYBERNETICSCOM 2012) aims to address current state of the technology and the outcome of the ongoing research in the area of Computational Intelligence and Cybernetics.

This year, we have received about 161 submissions for these conferences from around the world. Topics range from Architecture, Protocols & Internet Computing, Cybernetics, Mobile & Wireless Broadband, Quality Security, Mobile & Wireless Broadband, Soft Computing, Network Planning and Policy, Data Mining & Software Development, Satellite & Aerospace, Machine Vision.

After a rigorous peer-review process, we have finally included 78 papers in the proceeding.

Ladies and Gentlemen,

It's a great honour to meet and greet our speakers in Comnetsat and Cyberneticscom.

We are very grateful to the keynote speakers,

Professor Michael Lightner.

Professor Michael is Fellow IEEE and IEEE President 2006. Michael Lightner is Professor and Chair of Electrical, Computer, and Energy Engineering at the University of Colorado, Boulder, USA,

Byeong Gi Lee

Prof Byeong Gi Lee is Fellow IEEE and President of IEEE Comsoc 2010. Byeong Gi Lee is Professor Electrical Engineering Seoul National University.

We are very grateful for gracing the occasion with their authoritative speech.

We also have opportunity to extend our grateful for Plenary speakers,

Prof. Mehmet Emin Yuksel.

Mehmet Emin Yuksel is Professor in Dept. of Electrical and Electronics Engineering, Erciyes University, Kayseri, Turkey and Senior Member of IEEE

Prof. Pramod K. Varshney.

Pramod K. Varshney is Distinguished Professor of Electrical Engineering and Computer Science and the Director of CASE: Centre for Advanced Systems and Engineering Syracuse University, USA and Fellow of IEEE.

We also express our thankful to all of participants that already spent their time and energy as well as their resources to finalized their research paper and submitted and revised to the conferences. We are really appreciate with your presence and presentation of your papers in the conferences.

Ladies and Gentlemen,

In this occasion, we would to give our sincere gratitude to our conference sponsor:

Wolfram Mathematica Nabenta Indonesia for their great support. It's very nice to meet and talk with Pak Ruben Garcia Berastegui as the representative of Mathematica in Indonesia.

Multikom Indonesia in this case to Bapak Satriyo and Ibu Agnes for their excellent support to Comnetsat and Cyberneticcom.

We would like to extend our gratitude for the support from University of Udayana, University of Indonesia, Telkom Institute of Technology, Bandung Institute of Technology, PT Telkom Tbk and Binus University for their support to succeed these conferences.

Here we would like to sincerely thank all organizing committee members, program committee members and reviewers for their hard work and valuable contribution. Without your help, this conference would not have been possible.

Last but not the least, our sincere appreciation IEEE Indonesia Section. The officers outstanding and fantastic devotion to succeed this conference is really magnificent. It is a great experiences for us as the Committee to collaborate with.

Ladies and Gentlemen,

Bali is well known as the place for favourite vacation destination for many nationalities as well as the place for meeting. The island's rich cultural heritage is visible everywhere - in over 20,000 temples and palaces, in many colourful festivals and ceremonies, in drama, music, and dance.

To err is human. With this regard, kindly accept our sincere apology if you find any inconvenient during the conferences. We wish you have a great experiences during the conferences as well as fruitful and pleasant stay in Bali!

**Dr Ford Lumban Gaol**

General Chair, Comnetsat 2012 and Cyberneticscom 2012

# Foreword from Conference Chair

**Dr. Arifin Nugroho**

Conference Chair, COMNETSAT 2012

Dear IEEE fellows,

The IEEE has shown to be the most influential engineering organization in the globe. We have learnt how many of our standards play its roles in developing the communications networks. However, this institution does not mean anything without excellent supports coming from excellent laboratories, universities, workshops, schools, and people like you. It is amazing to see how IEEE members interact one another through emails, journals, and conferences. Yes, conferences do contribute a lots in streamlining the flow of thoughts and ideas, in broadening the cooperations among institutions, in enlarging the netwokings among engineers.

This Comnetsat 2012 is just one of those. However, there is some uniqueness in it. It is being held at Bali, the island of gamelans and goddies dancers. This may inspire engineers that the accomplishment of any job is a matter of art. As Webster's Dictionary puts it, the art is the rules or ideas that a person must know in order to follow a profession or craft. So Bali dancers and gamelaners validate us how importance ideas and rules would be for engineers like us, to conduct our professions, to express our crafts.

Please enjoy this cozy corner of Bali to express your ideas, to meet people, … and to experience this vivacious Bali.

With my warmest regards,

Arifin Nugroho

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# PROGRAM SCHEDULE
## Comnetsat 2012
2012 IEEE International Conference on Communications, Networks and Satellite
**Inna Grand Bali Beach Hotel, Bali, INDONESIA**

**Wednesday, July 11, 2012**

| | |
|---|---|
| 14.00 - 20.00 | Registration |

**Thursday, July 12, 2012**

| | |
|---|---|
| 09.00 - 09.15 | Opening Ceremony : Welcome addrress from Conference General Chair<br>Welcome addrress from IEEE Indonesia Section Chair |
| 09.15 - 09.30 | Welcome Traditional Dance |
| 09.30 - 10.30 | Keynote Speaker : (Session Chair : Arnold Ph. Djiwatampu)<br>Prof. Michael Lightner<br>Professor at the University of Colorado, Boulder, USA |
| 10.30 - 11.00 | **Coffee Break** |
| 11.00 - 12.00 | CyberneticsCom Keynote Speaker<br>Prof. Byeong Gi Lee<br>Seoul National University, South Korea |
| 12.00 - 13.30 | **Lunch Break** |
| 13.30 - 14.00 | CyberneticsCom Plenary Talk<br>Prof. Mehmet Emin Yuksel<br>Electrical and Electronics Engineering, Erciyes University, Kayseri, Turkey |
| 14.00 - 14.30 | **Coffee Break** |
| 16.00- 16.30 | **Forum Discussions** |
| 19.00 - 21.00 | **Welcome Dinner** |

**Friday, July 13, 2012**

| | |
|---|---|
| | **Room A** |
| 09.00 - 10.30 | Architecture, Protocols & Internet Computing<br>CT1.1 |
| 10.30 - 10.45 | **Coffee Break** |

| | | | |
|---|---|---|---|
| | **Room A** | **Room B** | |
| 10.45 - 12.00 | Quality, Security, and Management CT3.1 | Mobile & Wireless Broadband CT2.1 | |
| 12.00 - 13.30 | | **Lunch** | |
| | **Room A** | **Room B** | |
| 13.30 - 15.00 | Network Planning and Policy CT4.1 | Mobile & Wireless Broadband CT2.2 | |
| 15.00 - 15.30 | | **Coffee Break** | |
| | **Room A** | **Room B** | **Room C** |
| 15.30 - 17.00 | Mobile & Wireless Broadband CT2.4 | Architecture & Protocols CT1.2 | System & Applications CT5.1 |

**Saturday, July 14, 2012**

| | | | |
|---|---|---|---|
| | Plenary Talk : (Session Chair : Dr. Wahidin Wahab) | | |
| 09.00 - 09.30 | Prof. Pramod K. Varshney<br>Center for Advanced Systems and Engineering Syracuse University | | |
| 09.30 - 09.45 | | **Coffee Break** | |
| | **Room A** | **Room B** | |
| 10.45 - 11.00 | Mobile & Wireless Broadband CT2.5 | Satellite & Aerospace CT6.1 | |

# TECHNICAL PROGRAM

July 12, 2012

**KEYNOTE SPEECH**
**Convergence of Communications towards Smart Era**
Prof. Byeong Gi Lee

July 14, 2012

**PLENARY SPEECH**
**Cognitive Radio Networks: Design Issues and Security Threats**
Prof. Pramod K. Varshney

## Room A

**July 13, 2012**
**09.00 - 10.30**

**CT1.1: Internet Computing**

**CT1.1.1 Auction-based vs. Incentive-based Multiple-Cloud Orchestration Mechanisms**
Ganesh Neelakanta Iyer, Ramkumar Chandrasekaran, Bharadwaj Veeravalli
*National University of Singapore*

**CT1.1.2 Efficient Normal Peers Group Recovery in Hierarchical Peer-To-Peer**
Sri Wahjuni, Kalamullah Ramli, Anak Agung Putri Ratna
*University of Indonesia*

## Room B

**July 13, 2012**
**10:45 - 12:00**

**CT2.1: Mobile & Wireless Broadband**

**CT2.1.1 Sum Rate Maximization for Spectrum Sharing Multiuser MIMO Network under Rayleigh Fading**
Jie Tang, Georgia Bournaka, Sangarapillai Lambotharan
*Loughborough University*

**CT2.1.2 Mitigating Sybil Attacks in Vanets**
Khaled Mohamed Rabieh, Marianne Azer, Mahmoud Allam
*Nile University*

**CT2.1.3 Blind Spectrum Sensing for Cognitive Radio**
Kris Sujatmoko, Gunawan Wibisono, Dadang Gunawan
*University of Indonesia*

**CT2.1.4 A Taxonomy for Congestion Control Algorithms in Vehicular Ad Hoc Networks**
Mohammad Reza Jabbarpour Sattari, Rafidah Md Noor, Hassan Keshavarz
*University of Malaya*

**CT2.1.5 Adaptive Beamforming Schemes for SC-FDMA Systems with Insufficient Cyclic Prefix**
Shiuan-Wei Huang, Kuo-Ching Fu, Yung-Fang Chen
*Department of Communication Engineering, National Central University*

**CT2.1.6 The Development of 3D Curve Dynamic Path Planning Simulation in Cluttered Environment**
T B Adji, Hendri H Triharminto, N A Setiawan, A S Prabuwono
*Gadjah Mada University*

## Room A

**July 13, 2012**
**10:45 - 12:00**

**CT3.1: Quality, Security, and Management**

**CT3.1.1 End User Based Measurement System For Cellular Packet Data Network Performance**
Zahir Zainuddin, Ady Wahyudi Paundu
*Hasanuddin University*

**CT3.1.2 Offline Delegation Protocol for Mobile RFID**
Jia-Ning Luo, Ming-Hour Yang, Ming-Chien Yang, Ming-Chi Tseng
*Ming Chuan University*

**CT3.1.3 A Searchable Encryption Scheme for Outsourcing Cloud Storage**
Jyun-Yao Huang, I-En Liao
*Department of Computer Science and Engineering at National Chung Hsing University*

## Room B

**July 13, 2012**
**13:30 - 15:00**

**CT2.2: Mobile & Wireless Broadband**

**CT2.2.1 Performance Analysis of Open and Closed Loop Spatial Multiplexing in LTE Downlink Physical Layer**
Pooja S Suratia, Satish K Shah
*Department of Electrical Engineering, The Maharaja Sayajirao University of Baroda*

**CT2.2.2 Capacity Analysis of Device-to-Device Resource Reusing Modes for Cellular Networks**
Rui Chen, Xuewen Liao, Shihua Zhu, Zhonghua Liang
*Xi'an Jiaotong University*

**CT2.2.3 Mobile Geotagged Data Gathering for Disaster Remediation**
Sally Elizabeth Goldin, Kurt T Rudahl
*King Mongkut's University of Technology Thonburi*

**CT2.2.4 Time-Oriented Care-of Address for Mobile IPv6 Networks**
Yu-Hsin Cheng, Shang-Juh Kao, Fu-Min Chang
*Department of Information Networking and System Administration, Ling Tung University*

**CT2.2.5 An Efficient FemtoCell Deployment Scheme for Mitigating Interference in Two-tier Networks**
Hsiu-Lang Wang, Shang-Juh Kao
*Department of Computer Science and Engineering, National Chung-Hsing University*

## Room A

**July 13, 2012**
**13:30 - 15:00**

**CT4.1: Quality, Security, and Management**

**CT4.1.1 Detecting Policy Misconfigurations in Temporal Domain Using Object Priority**
Madhu Sankeerth Dammati, Samrat Mondal
*Indian Institute of Technology Patna*

**CT4.1.2 Performance Evaluation of Available Bandwidth Estimation Tools in FTTH Networks**
Mun Leong Chan, Su Wei Tan, Ahmad Tajuddin Samsudin, Ahmad Fuad Mohamed Bandi
*Multimedia University*

**CT4.1.3 Analysis Against Secret Redundancy Mechanism for RFID Authentication Protocol**
N.W. Lo, Kuo-Hui Yeh, Hsuan-Yu Chen
*Department of Information Management, National Taiwan University of Science and Technology*

## Room B

**July 13, 2012**
**15:30 - 17:00**

**CT1.2: Architecture & Protocols**

**CT1.2.1 FPGA Implementation of ANN for Reactive Routing Protocols in MANET**
Satish K Shah, Dharmistha Doodhnath Vishwakarma
*M.S.University of Baroda*

**CT1.2.2 Credit-based Low Latency Packet Scheduling Algorithm for Real-time Applications**
Lyu-Han Chen, Hsiao-Kuang Wu, Ming-I Hsieh, Jorng-Tzong Horng, Gen-Huey Chen
*National Central University*

**CT1.2.3 Fault Notification Extension in Support of BSS 2G Siemens**
Linawati
*Udayana University*

**CT1.2.4 A Fast and Seamless Route Repairing Algorithm for Ad-hoc Networks**
Shih-Chang Huang
*National Formosa University*

## Room A

**July 13, 2012**
**15:30 - 17:00**

**CT2.4: Mobile & Wireless Broadband**

**CT2.4.1 High Isolation Compact WLAN/WiMAX Antenna**
Bing Yu, Junxiang Ge
*Nanjing University of Information Science & Technology*

**CT2.4.2 Differential BPSK Modulation for Cooperative Communication Systems in Time-Selective Rayleigh Fading Channels**
Chi-Hsiao Yih
*Tamkang University*

**CT2.4.3 An Efficient Cost-based Location Service Protocol for Vehicular Ad Hoc Networks**
Chih-Shun Hsu, Shen-Wen Wu
*Department of Information Management, Shih Hsin University*

**CT2.4.4 A Modified Low PAPR Space-Frequency Block Coding Scheme for SC-FDMA**
Chih-Yao Huang, Wei-Jay Chang, Li-Chung Chang
*National Taiwan University of Science and Technology*

**CT2.4.5 Ultra Low Profile Antenna for 2.45 GHz Wireless Communication**
Erfan Rohadi, Mitsuo Taguchi
*Nagasaki University and State Polytechnic of Malang*

**CT2.4.6 SINR Balancing Techniques for a Cognitive Radio Relay Network with Multiple Peer-to-peer Users**
Georgia Bournaka, Sangarapillai Lambotharan, Fotis Lazarakis
*Loughborough University*

## Room C

**July 13, 2012**
**15:30 - 17:00**

**CT5.1: System & Applications**

**CT5.1.1 Flu Incident Reporting on Mobile Phone**
Nichapa Panyasoponlert, Pawat Piboonudompornkul, Kurt T. Rudahl, Sally E. Goldin
*King Mongkut's University of Technology Thonburi (KMUTT)*

**CT5.1.2 Medical Image Watermarking with Tamper Detection and Recovery Using Reversible Watermarking with LSB Modification and Run Length Encoding (RLE) Compression**
Tjokorda Agung Budi Wirayuda, Adiwijaya, Febri Puguh Permana
*Institut Teknologi Telkom*

**CT5.1.3 Facial Expression Based Computer Cursor Control System for Assisting Physically Disabled Persons**
Vasanthan Maruthapillai, M. Murugappan, R. Nagarajan, Bukhari Ilias, Letchumikanth
*University Malaysia Perlis*

**CT5.1.4 Cloud Adaboost Feedback Training Machine for Outside Available Parking Spaces Query Service**
Jie-Qi Huang, Ming-Shi Wang
*National Cheng Kung University Department of Engineering Science*

## Room A

**July 14, 2012**
**10:45 - 12:00**

**CT2.5: Mobile & Wireless Broadband**

**CT2.5.1 An Overheard-Based Relay-Assisted MAC Protocol Using Symbol Level Network Coding**
Yuh-Shyan Chen, Chih-Shun Hsu, Jhao-Yen Wei
*Department of Computer Science and Information Engineering, National Taipei University*

**CT2.5.2 Joint Network/Channel Coding for Wireless Networks**
Zid Youssef, Sonia Ammar, Ridha Bouallègue
*NEST*

**CT2.5.3 A Delay-Bounded Routing Protocol for Vehicular Ad Hoc Networks with Traffic Lights**
Yuh-Shyan Chen, Chih-Shun Hsu, Yi-Ting Jiang
*Department of Computer Science and Information Engineering, National Taipei University*

**CT2.5.4 A Comparision of Frequency/AmplitudeModulation Scheme in Cognitive Radio Envoirnment**
Freeha Azmat, Junaid Imtiaz, Muhammad Hashim, Ithisham-ul-Haq, Malik Rizwan
*Bahria University*

## Room B

**July 14, 2012**
**10:45 - 12:00**

**CT6.1: Satellite & Aerospace**

# AUTHOR INDEX

# Medical Image Watermarking with Tamper Detection and Recovery Using Reversible Watermarking with LSB Modification and Run Length Encoding (RLE) Compression

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***Abstract*—Medical images have been used as one of the objects to diagnose the patient. A digitally formatted medical image is easier to be stored and distributed but also easier to be modified for illegal purposes. Digital image watermarking offers a solution to protect digital medical images. By embedding fragile authentication watermark, the watermarking system can detect and localize the tampered area of medical images. Moreover, by embedding the feature extraction in the form of average intensities of the image, an original image can be recovered from the tampered image. This paper will study and test a watermarking scheme using LSB Modification to perform tamper detection and recovery in the ROI. To make this watermarking scheme reversible, RLE is used to embed the original LSBs in the RONI to get higher embedding capacity. The experimental results show that this watermarking system can detect and localize tamper with up to 100% accuracy and perform image recovery up to 100% recovery rate until 20% of tempered area in ROI.**

***Keywords*—LSB modification, medical image, tamper detection, recovery, RLE, reversible, watermarking**

## I. Introduction

DIGITAL medical images have been used as one of the objects to diagnose the patient in the modern health care facilities. Medical images are produced by various medical devices that can take the picture or representation of organs inside the human body, one of the examples is ultrasound image. The medical images are often converted into digital forms to make it easier to be stored and distributed.

Authenticity and integrity of the medical images is very important because can affects the doctor's diagnoses to a patient or disease. Authenticity means that the image is really what the user supposes it is. Integrity means that the image has not been modified by non-authorized person. In the other hand, digitally formatted medical images are very easy to be modified for illegal purposes using software. This is very dangerous because can cause diagnoses error. So, a system that can verify the integrity and authenticity of medical images is needed to protect the medical images.

One of methods to protect medical images is a digital image watermarking. Digital image watermarking is a practice of imperceptibility altering a piece of data embeds data called watermark into a digital image (host/carrier image). Watermark can be text, logo, or feature extraction of the host image. The embedding process is done in a particular way so that the original image will not be damaged. The image that embedded the watermark is called a watermarked image. The watermarked image then could be stored or distributed, and the owner can prove the authenticity and integrity of a suspected image by retrieving the watermark from the watermarked image. According to the retrieved results, we can determine whether the suspected image has been modified or not.

An important aspect for authentication is how to detect a tampered watermarked image. Once tampering is detected, tampered section can be recovered [3]. The other challenge is to allow the watermark to be reversible. Reversible watermarking is where embedded watermark is removed and the original pixel value is restored.

There are some studies about medical image watermarking for tamper detection and recovery. Jasni [1] developed a watermarking scheme in the spatial domain that can localize tamper and recover the tampered area. The method is by dividing the image into small blocks then the average intensity of each block is embedded in another block to be used as the recovery information of that block. By dividing image into blocks, the authentication process can be done separately for each block so the tampered area can be localized. The tampered block then can be recovered using its recovery information that embedded in another block.

Liew [3] proposed a design of watermarking scheme based on Jasni's method to make the watermarking scheme reversible. In this scheme, image is divided into ROI (Region of Interest) and RONI (Region of Non-Interest). ROI is the significant part of the medical images that is used by doctors to diagnose the patient, and RONI is the area outside the ROI. Watermarking for tamper detection and recovery is done in the

This work was supported in part by the IT Telkom under Grant 11KM004-1

ROI area based on Jasni's scheme. The original LSBs that are removed in watermark embedding process is stored in RONI after compressed using RLE. The stored LSBs later can be used to restore the image to its original bits value so the watermarking scheme can be reversible.

In this paper, we proposed a modification of reversible watermarking for tamper detection and recovery of medical images based on Jasni's method and Liew's design. The modifications conduct by compress the removed ROI LSB before embedded in RONI using two bits LSB. The design of the watermarking scheme is described on the next section. In the third section, the experimental result will be discussed and the conclusion is in the fourth section.

## II. Watermarking Scheme

The reversible watermarking scheme used in this paper is based on Liew's design [3] in term of using RLE to embed the original LSBs in RONI. This scheme is also based on tamper detection and recovery watermarking by Jasni [1]. Further modifications were developed in the image preparation process when determining the location of ROI and RONI to make it more compatible with our sample images. Other modification is in the process of embedding the removed LSBs and the RLE compression method.

### A. Image Preparation

We use some 8-bit grayscale ultrasound images with 640x480 pixels resolution in bitmap format. The sample images are downloaded from www.ultrasound-images.com. First, an image is divided into ROI and RONI. Watermarking for tamper detection and recovery process will be done in ROI. RONI will be used to embed the original LSBs of the image so the watermark can be reversible. We embed all LSBs of the image instead only LSB from ROI. To make it general for all of our sample images, we use static size of ROI and RONI as shown in the figure below.

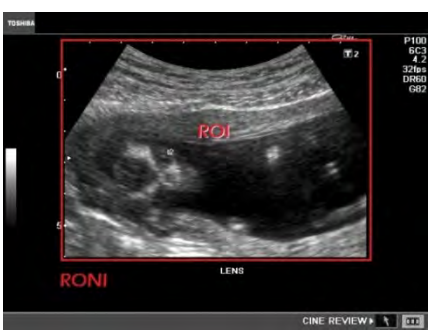



Fig. 1 Location of ROI and RONI

ROI is defined as a rectangle around the center of the image. The ROI will be divided into blocks of 6x6 pixels. We use smaller 6x6 pixels block size instead of 8x8 pixels to achieve better accuracy of tamper localization an better quality of recovered image [5]. We need to prepare a one to one block mapping sequence A→B→C→D→…→A for watermark embedding in ROI, where each symbol denotes an individual block. The recovery information of block A will be embedded in block B, recovery information of block B will be embedded in block C, and so on. We use similar mapping sequence proposed by Zain [1]:

$$\vec{B} = [(k \times B) mod N_b] + 1 \qquad (1)$$

where $B$, , $k$ [1, $N_b$] , $k$ is a prime number, and $N_b$ is the total number of blocks in the ROI. Each block in the ROI is assigned with an unique integer $B$ {1, 2, 3, ..., $N_b$ }. In this scheme, raster scan (left-right top-bottom) is used to assign number to each block.

RONI is later divided into 6x1 pixels blocks. After the original LSBs is compressed using RLE, each resulting RLE package will be embedded in a block in RONI.

### B. Watermark Embedding in ROI

Before embedding the watermark, the original LSBs of the image is removed and the LSB of each pixel is set to zero. Later the removed LSBs will be compressed and embedded in the RONI. The watermarking scheme in ROI is based by Jasni's [1] with 6x6 pixels block size [3]. Each block then divided into 4 sub blocks of 3x3 pixels. The watermark for each sub block is 3x3 bits which contains 2-bit authentication watermark (1-bit $v$ and 1-bit $p$) and 7-bit recovery watermark $r$. Authentication watermark is used to check whether the block is tampered or not. Recovery watermark is the recovery information of corresponding sub block from another block (target block) which is embedded in this block. The form of recovery information is 7-bit MSBs of sub block's average intensity. The 3x3 bits watermark is embedded in the LSB of the sub block to minimize image degradation.

For each block, compute average intensity of block (*Avg_B*) and average intensity of its sub block (*Avg_Bs*) then generate the watermark $v$ (authentication bit) for each sub blocks as:

$$v = \begin{cases} 0, & if\ Avg\_Bs > Avg\_B \\ 1, & otherwise \end{cases} \qquad (2)$$

The watermark $p$ (parity bit) is generated as:

$$p = \begin{cases} 1, & if\ Avg\_Bs\ is\ odd \\ 0, & otherwise \end{cases} \qquad (3)$$

The watermark ($v$, $p$, $r$) for each sub block is then embedded in its LSB as described in the following figure:

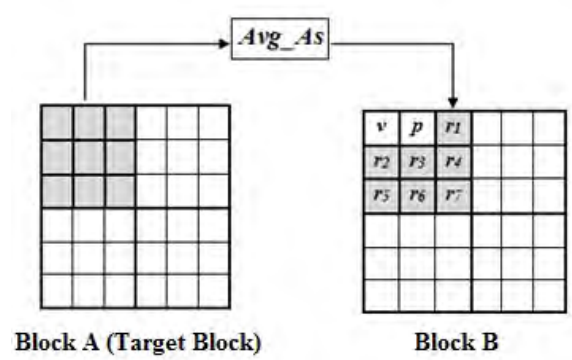



Fig. 2 Watermark Embedding in ROI

### C. Embedding Original LSBs in the RONI

The original LSBs of the image will be compressed and stored in the RONI. The stored LSB is used for restoring the image to its original pixel values later.

The removed original LSBs can be represented as a 640x480x1-bit binary matrix that we call LSB matrix. An RLE based compression we called RLE block method is developed to achieve higher embedding capacity. The LSB matrix is divided into LSB-blocks which are blocks of 3x3 bits. The 9-bits of each LSB block then are converted to a decimal value as shown in the figure below:

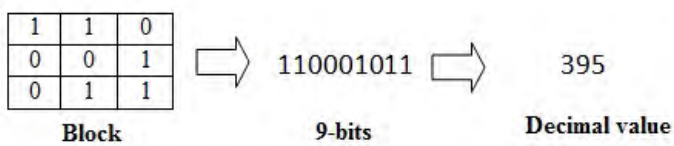



Fig. 3 Process of converting 9-bits LSB-blocks to decimal values

The decimal value is from 0 to 511 (9-bits). The collection of decimal value of each LSB block is scanned using raster scan and will form a data run that will be used as the input of RLE. RLE process will result a set of RLE package, each package contains *run value* (RV) and *run count* (RC). Each RLE package which is 12-bits length is embedded into 6x1 pixels block in the RONI. Range of RV is from 0 to 511 so we need 9-bit storage for each RV. RC is limited to seven, so we need 3-bits storage for each RC. The embedding scheme of each 12-bits RLE package in the RONI is described as follow:

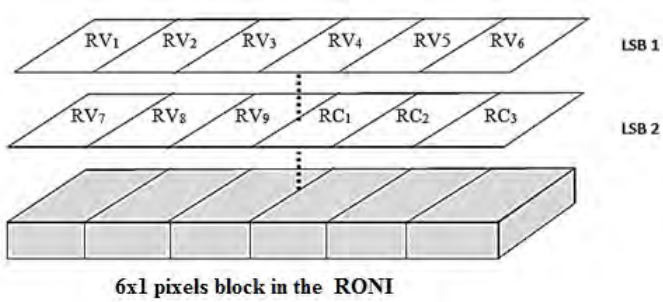



Fig. 4 The scheme of embedding an RLE package into a block in RONI

Based on our experiment, there will be not enough space to embed the compressed LSBs if we only use the LSB in RONI. We need to use the second LSB (LSB 2) in RONI so all the RLE packages can be embedded in RONI without storage issue.

### D. Tamper Detection and Recovery

The suspected image is divided into ROI and RONI as in the image preparation process. Divide ROI into blocks of 6x6 pixels. For each block, divide it into four 3x3 pixels sub block. As proposed by Zain [1], for each sub-block of 3x3 pixels, authentication bit *v* and parity bit *p* will be extracted. Set the LSBs of the block to zero and compute the average intensity of block (*Avg_B*) and average intensity of this sub block (*Avg_Bs*). Generate the authentication bit as *v'* and the parity bit as *p'*. Compare the generated *v'* and *p'* with the extracted *v* and *p* to know whether the block is a tampered block or a valid block. Tampered blocks will be recovered by locating its recovery blocks using the mapping sequence used in image preparation. As shown in Fig. 2, assume block A is tampered. To recovery block A, we use information that embedded in block B. For each sub block in block A, replace the value of all pixels with the 7-bits MSB of the recovery information obtained from its corresponding sub block in the block B.

### E. Restoring the Original LSBs

The original LSBs can be restored so the watermarked image can be reverted to its original pixel values. The RONI is divided into blocks of 6x1 pixels. Each RLE package embedded into a block in RONI as shown in Fig. 4 will be obtained and decoded. Decoding RLE packages will result a set of decimal values in range of 0 to 511. Each decimal value then converted to 3x3x1 bits binary number. This is the opposite of the process shown in Fig. 3. The resulting 3x3x1 bits will be the LSBs of a 3x3 pixels block of the image. Divide the image into 3x3 pixels block. Each 3x3x1 bits LSB is then restored to the each block of image using raster scan.

As shown in Fig. 4, in the RONI the second LSB (LSB 2) of the pixels is used to embed the RLE packages. This second LSBs cannot be restored because we do not store them. But the beauty of ultrasound images is that almost all pixel values of the RONI is zero (Black). So, after the restoration of original LSBs, The second LSB of any pixel in the RONI with pixel value less than 3 is simply set to zero to increase the PSNR of the restored image. For the ROI, we can say that the ROI can be fully reversible, which means that all the pixel values in the ROI can be restored to its original value.

## III. Experiment Results

We have build a MATLAB program to implement this watermarking scheme. The purpose of the experiment is to know the quality of the watermarked image, watermark reversibility, and performance of the image tamper detection and recovery.

### A. Watermarked Image

Watermark embedding is done for some sample images with the result below:

TABLE I
WATERMARKED IMAGE PSNR

| Image | PSNR (dB) |
|---|---|
| anembryonic-gestation-1a.bmp | 47.7949 |
| anembryonic-gestation-1b.bmp | 47.4966 |
| breast-abscess-1c.bmp | 48.5741 |
| fetal-lens-1b.bmp | 47.0075 |
| fibroadenoma-1b.bmp | 47.4085 |
| prostatitis-acute-1d.bmp | 46.8191 |
| riedels-lobe-mass-1c.bmp | 47.5073 |

In the Table 1, the PSNR of the watermarked images are above 46 dB (excellent quality) which means the watermarking scheme can produce a watermarked image with minimum degradation and very similar to the original one.

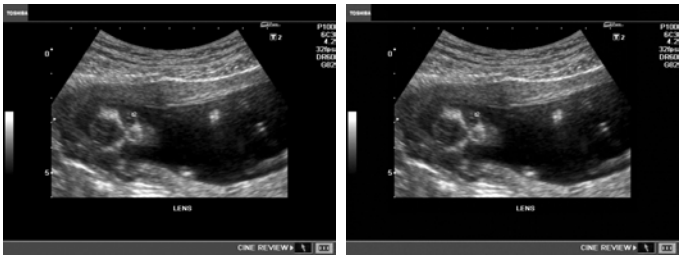


Fig. 5 Original Image (left) and Watermarked image, PSNR=47.0075 dB (right)

### B. *Watermark Reversibility*

In the testing of watermark reversibility, we restored the original LSBs of the watermarked image without giving any tamper before. The compressed LSBs that embedded in the RONI will be obtained, decoded, and restored to each pixel. The result image from this process, called extracted image, is then compared to the original one. The PSNR is between 56 dB and 61 dB which means that although the extracted image is nearly similar to the original one, there still a little difference between them. We have compared the pixel values of the extracted image and the original one and the result is shown in the Fig 7.

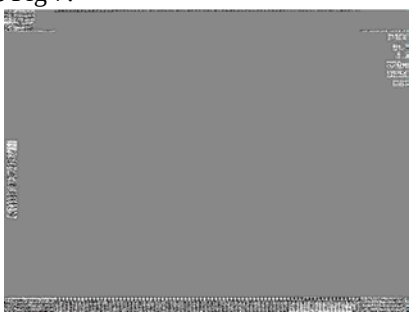


Fig. 7 Pixel differences between extracted image and original image

The grey color means that the pixel values are similar. The black or white color means that the pixel values are different. From here, we can say that the pixel differences only occur in the RONI. So the ROI is fully reversible or all the pixel values can be restored successfully. As mentioned before, the RONI is not fully reversible because we use the second LSB in RONI to embed the compressed data to ensure that all the image LSBs can be stored. At the Table II below we can see that we need near to 2 bits/pixel embedding ratio in RONI although after the original LSBs have been compressed using our method. We also have test Huffman compression but we still need more than 1.5 bits/pixel embedding ratio. What we need to make this scheme fully reversible is a lossless compression method that will result less than 1 bits/pixel embedding ratio in the RONI.

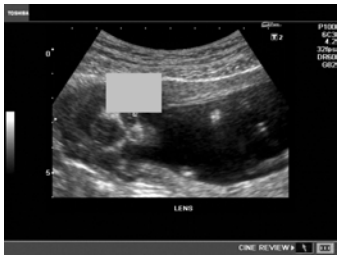
TABLE II
COMPESSION METHOD COMPARISON

| Compression | Bits after compression | Compression Ratio | Embedding Ratio in RONI (bits/pixel) |
|---|---|---|---|
| None | 307200 | 1 | 2.28571 |
| RLE, RC treshold=15 | 404115 | 1.31548 | 3.00681 |
| RLE, RC treshold=7 | 379604 | 1.23569 | 2.82443 |
| RLE block 2x2, RC treshold=7 | 280749 | 0.91390 | 2.08891 |
| RLE block 3x3, RC treshold=7 | 232500 | 0.75684 | 1.72991 |
| Huffman block 2x2 (16 symbols) | 209774 | 0.68286 | 1.56082 |

### C. *Tamper Detection and Recovery*

Block tampering attack, sharpening, contrast and brightness adjustment is given to the watermarked image to know the performance of tamper detection and recovery. From the experimental result we can see that the scheme can perform tamper localization from block attack with up to 100% accuracy. For sharpening attack the localization accuracy is up to 99%. For brightness and contrast adjustment attack the localization accuracy approximately from 60% to 98%.

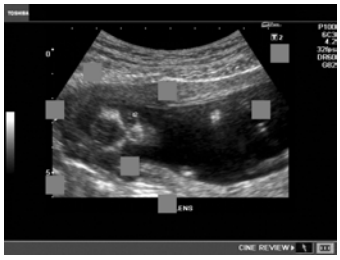
The recovery performance for block tampering attack with area < 20% is very good with up to 100% of recovery rate and PSNR. For sharpening, brightness, and contrast adjustment attack the recovery rate is low (from 6% to 48%) because the attack will damage the most of recovery information.



(a)

(b)

Fig. 8 (a). Block tampering attack PSNR=22.8173 dB; (b). Recovered Image, Recovery Rate=100%, PSNR=42.3158 dB



(a)

(b)

Fig. 8 (a). Spread block tampering attack PSNR=23.7108 dB; (b). Recovered Image, Recovery Rate=91.67%, PSNR=35.0793 dB

## IV. CONCLUSION

Experiment result show that the proposed watermarking scheme is more suitable for block tampering attack where the attack is occurred on a local section of images. The defect from attack in ROI area can be localize and recovered with good quality of image. For global attack like sharpening, brightness, and contrast adjustment attack the proposed scheme show a good performance in localize the defect area but poor in recovery process. Further development is needed to make this watermarking scheme is fully reversible for global attack.

## REFERENCES


[1] Jasni M. Zain, Abdul R.M. Fauzi, "Medical Image Watermarking with Tamper Detection and Recovery", in *Proc. 28th Annual International Conference of the IEEE EMBS*, New York,USA,Sept. 2006,pp. 3270-3273,doi: 10.1109/IEMBS.2006.260767.

[2] D. Anand and U. Niranjan, "Watermarking Medical Images with Patient Information," in *IEEE/EMBS Conference*, 1998, pp. 703-706.

[3] Liew, Siau-Chuin. et. al. "Reversible Medical Image Watermarking For Tamper Detection And Recovery With Run Length Encoding Compression". World Academy of Science, Engineering and Technology 72.2010,pp. 799-803.