LEMBAGA PENELITIAN DAN PENGABDIAN KEPADA MASYARAKAT
UNIVERSITAS MULTIMEDIA NUSANTARA (LPPM – UMN)

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SURAT TUGAS

No.: 132/LPPM/II/2017

Yang menugaskan:

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Jabatan	:	Direktur LPPM - UMN

Yang diberi tugas:

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Program Studi	:	Sistem Komputer
Jabatan Fungsional	:	Dosen Tetap (Lektor Kepala)
Tugas yang diberikan	:	Menulis dan mengirimkan karya ilmiah untuk dipublikasikan dan dipresentasikan secara oral pada *The 1st International Conference on Signals and Systems 2017* dengan judul "*Enhanced three-dimensional HRIRs interpolation for virtual auditory space*", pada tanggal 16-18 Mei 2017
Penyelenggara	:	IEEE SPS Indonesia Chapter dan Universitas Telkom
Lama Tugas	:	Semester Genap 2016/2017 (1 Semester)

Tangerang, 14 Februari 2017

Yang memberi tugas,

LEMBAGA PENELITIAN & PENGABDIAN MASYARAKAT
UMN UNIVERSITAS MULTIMEDIA NUSANTARA

(Dr. P.M. Winarno, M.Kom.)
NIP/NIK: 000632 / UMN

CERTIFICATE OF APPRECIATION

This is to certify that

DR. HUGENG HUGENG

Actively participated in the 1st International Conference on Signals and Systems 2017 as a Paper Presenter

Granted on this day, May 16 - 18, 2017
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Enhanced Three-Dimensional HRIRs Interpolation for Virtual Auditory Space

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***Abstract*—Production of 3D sound for virtual auditory space needs interpolated head related impulse responses (HRIRs), due to limitation of real-time system for storing HRIR measurements. Fortunately, interpolation of HRIRs can reduce much cost and effort in measuring many HRIRs. This research analyses three interpolation techniques, namely bilinear rectangular, bilinear triangular, and tetrahedral by using PKU-IOA HRTF Database.**

Bilinear triangular interpolation has been applied to estimate a target HRIR from 3 surrounding measured HRIRs that form a triangle. Accordingly, bilinear rectangular interpolation uses 4 surrounding rectangular measured HRIRs. These geometrical approaches compute weights from relative angular distances of a target HRIR from measured HRIRs. Tetrahedral interpolation, in other hand, is an interpolation technique in 3D using barycentric weights. An optimal framework in obtaining estimated HRIRs is proposed here by interpolating minimum phase HRIRs using tetrahedral interpolation.

Keywords*— *Bilinear interpolation; 3D HRIR interpolation; 3D HRTF interpolation; Tetrahedral interpolation

I. Introduction

Three-dimensional sound is applied extensively in various advanced technologies. All sophisticated products, e.g. smartphones, laptops, PCs and other gadgets, implement 3D sound as a medium, either for entertainment, communication, or some other purposes. Almost all computers apply head related impulse responses (HRIRs) in their soundcards, so that they can produce 3D sound and the sound can be heard naturally by human's ears. HRIR describes how unique a sound from a certain point heard by our ears. Every sound source point is heard with different pair of HRIRs. Amongst many HRIRs, there is a best pair of HRIRs that produces sound that come from certain direction. This is commonly applied in game development, so that the player can hear various sound sources clearly and precisely.

A desired HRIR in a certain sound source point can be attained by interpolating several adjacent HRIRs. Interpolation can increase the number of required HRIRs. It reduces required HRIR measurements, and also stored HRIRs data. Several HRIR interpolation techniques that use all or most measurement points, have been proposed, for example those using spherical splines or rational state-space interpolation. Hartung et al. [1] compared several algorithms for head related transfer function (HRTF) interpolation. Interpolation in frequency domain, using spherical splines, gives better results than that performed in time domain. The quality of interpolation can be enhanced by smoothing those HRTFs. Diepold and Keyrouz [2] stated that in attaining a realistic synthesis of a moving sound source and changes in listener position in real time virtual auditory spaces, one requires a dense grid of HRTFs for interpolation. They proposed an interpolation algorithm based on a block Loewner matrix to avoid results caused by dynamic changes in HRTFs. Although these approaches are very potential in resulting estimates of HRTFs that are more accurate than the methods that use few HRTF measurements, they cause a higher computation cost. The computation complexity of an interpolation algorithm is a key hindrance when creating virtual moving sources. It is also computationally more complex when the reproduction is accomplished in a device that has low computation power, as in a cellular phone, or when many room reflections and/or sources are concurrently reproduced. Interpolation must be achieved quickly in a real-time system, however with the increase in speed, the result should not be affected at the end. That's why the used algorithm should be efficient and uses least memory [3].

We analyzed three interpolation techniques in this research, i.e. bilinear rectangular interpolation, bilinear triangular interpolation, and tetrahedral interpolation. We evaluated those interpolation techniques using the same HRTF database, finally concluded conveniently the best out of the three interpolations. Unlike the works by [4-7], here a new interpolation technique for HRTFs interpolation, was not proposed. Instead, we proposed an optimal framework for HRTFs interpolation. This proposed framework constitutes the interpolation of HRIRs using minimum phase HRIRs as input data and the tetrahedral interpolation technique with barycentric weights. This conclusion came from the analysis to the performance of these three interpolation techniques for estimating minimum phase HRIRs and magnitude HRTFs, from the same database, PKU-IOA HRTF Database. The results of our research show that tetrahedral interpolation was the best technique in estimating minimum phase HRIRs.

This paper is organized as follows: Section 2 contains explanation about the tetrahedral interpolation. Our research

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methodology is covered in Section 3, including explanation about the used HRTF database and performance parameters. Experiments and discussion of their results are explained in Section 4. Finally, we conclude our paper in Section 5.

II. TETRAHEDRAL INTERPOLATION

Interpolation of three measurement points that form a triangle closuring a target source position, can be used to produce an estimated HRTF. Tetrahedral interpolation can be obtained by extending this approach to include the target source distance, namely through direct interpolation of HRTF measurements attained at various distances. Tetrahedral interpolation is a kind of 3D interpolations, which is based on searching four measurement points that form a tetrahedron and enclosure the target position.

A set of points in 2D that are grouped into non-overlapping triangles can be created by Delaunay triangulation (DT) [8]. These triangles should be nearly equiangular when they are applied for interpolation. DT maximizes the minimum angle of the generated triangles, so that it is optimal in this sense. Triangles are created such that the circumcircle of each triangle contains no other points. DT produces tetrahedral three-dimensionally, such that each tetrahedron's circumsphere contains no other points. A graphical interpretation of tetrahedral interpolation is shown in Fig. 1. As observed in this figure, X is the position of the target HRTF, but A, B, C, and D are positions of given measured HRTFs from different sound source distances. Eq. (1) can be used to calculate any target point, **X**, inside the tetrahedron, as a linear combination of the vertices,

$$\mathbf{X} = g_1\mathbf{A} + g_2\mathbf{B} + g_3\mathbf{C} + g_4\mathbf{D}, \quad (1)$$

where g_i are scalar weights, those sum to one. The weights g_i are the barycentric coordinates of point **X**. For estimating the target HRTF, $\hat{\mathbf{H}}_x$, at point **X** as the weighted sum of the HRTFs, $\mathbf{H}_i$, measured at A, B, C, and D, the barycentric coordinates can be used as interpolation weights, as follow,

$$\hat{\mathbf{H}}_x = \sum_{i-1}^{4} g_i \mathbf{H}_i \quad . \quad (2)$$

By reducing both sides of (1) with **D** yields

$$\mathbf{X} - \mathbf{D} = [g_1\ g_2\ g_3]\ \mathbf{T}, \quad (3)$$

where

$$\mathbf{T} = \begin{bmatrix} \mathbf{A}-\mathbf{D} \\ \mathbf{B}-\mathbf{D} \\ \mathbf{C}-\mathbf{D} \end{bmatrix} \quad (4)$$

By rearranging (3), the weights of g_1, g_2, and g_3, can be obtained with

$$[g_1\ g_2\ g_3] = (\mathbf{X} - \mathbf{D})\ \mathbf{T}^{-1}. \quad (5)$$

The other weight, g_4, can be calculated by

$$g_4 = 1 - g_1 - g_2 - g_3. \quad (6)$$

Note that **T** is independent of the desired source position, **X**, and depends solely on the geometry of the tetrahedron. Therefore, we can calculate $\mathbf{T}^{-1}$ in advance for all tetrahedra during initialization and store it in memory.

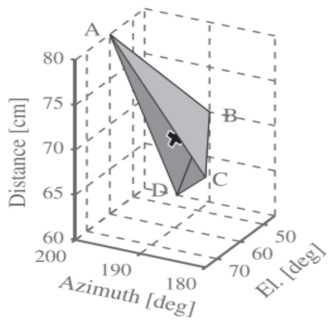

Fig. 1. Graphical interpretation of tetrahedral interpolation [6]

III. RESEARCH METHODOTOLOGY

Tetrahedral interpolation is a 3D interpolation technique and then can only be performed using HRTFs datasets which were acquired at different distances from the center of the human head, so that the datasets formed various spheres of HRTFs. An example of such dataset is the PKU-IOA HRTF Database.

A. PKU-IOA HRTF Database

PKU-IOA HRTF database is a HRTF database which has been released for public and are available at http://www.cis.pku.edu.cn/auditory/Staff/Dr.Qu.files/Qu-HRTF-Database.html [9]. This database contains HRIR measurements using the KEMAR (Knowles Electronics Mannequin for Acoustics Research) mannequin. In a sphere, this database has 6,344 points of measured HRIRs for one ear of KEMAR mannequin, with distances from 20 cm to 160 cm, elevation angles from -40º to 90º, and azimuth angles from 0º to 360º.

This database includes data on various distances, namely 20 cm, 30 cm, 40 cm, 50 cm, 75 cm, 100 cm, 130 cm, and 160 cm. Meanwhile, for elevation, it contains data with angles from -40º to 90º with step of 10º. For azimuth, the angles range from 0º to 360º, however the step is depending on the elevation angle, with constraint as the following:

a. the azimuth step is 5º on elevation -40º to 50º;
b. the azimuth step is 10º on elevation 60º;
c. the azimuth step is 15º on elevation 70º;
d. the azimuth step is 30º on elevation 80º;
e. the azimuth step is 360º on elevation 90º.

On each point, it has a data with the size of 2048 samples, with data type of double. The first 1024 samples are HRIR for left ear, and the remaining 1024 samples are HRIR for the right ear. A sampling rate of 65,536 Hz is used in this database.

For both bilinear interpolations, we use parameter azimuth-elevation, distance-elevation, and distance-azimuth for interpolation. For parameter azimuth-elevation, we use the HRIRs data on a sphere with distance 75 cm, where a target HRIR is estimated from adjacent HRIRs with different azimuths and elevations on the same sphere. For parameter distance-elevation, target HRIRs are on the sphere with distance 75 cm, whereas interpolating HRIRs come from the same elevation but from adjacent spheres with distance 50 cm and 100 cm. Similar to this, for parameter distance-azimuth, we interpolate target HRIRs on the sphere with distance 75 cm, by using HRIRs that come from the same azimuth but from two spheres with distance 50 cm and 100 cm. For tetrahedral interpolation, the target HRIRs are on the sphere with distance 75 cm, whereas the interpolating HRIRs which form tetrahedra come from spheres with distance 50 cm and 100 cm.

B. Performance Parameters for Interpolation

Most researchers in modeling and interpolating HRTFs in the world use mean square error (MSE) and spectral distortion (SD) to measure the performance of interpolation technique. MSE, $e(\phi,\theta)$, is usually used to compare the estimated/interpolated HRIR, $\hat{h}(\phi,\theta)$, to the original HRIR, $h(\phi,\theta)$, as given by (7) below,

$$e(\phi,\theta) = 100\% \times \frac{\left\| h(\phi,\theta) - \hat{h}(\phi,\theta) \right\|^2}{\left\| h(\phi,\theta) \right\|^2} \tag{7}$$

where (ϕ,θ) is the position of sound source of HRIR with elevation ϕ and azimuth θ.

In the meanwhile, SD is actually the root mean square error between log-magnitude HRTF from measurement and estimated log-magnitude HRTF. SD is defined as:

$$SD = \sqrt{\frac{1}{K}\sum_{k=1}^{K}\left[20\log_{10}\frac{|H(k)|}{|\hat{H}(k)|}\right]^2} \text{ [dB]}, \tag{8}$$

where K is the number of frequency components, $|H(k)|$ is magnitude HRTF from measurement, and $|\hat{H}(k)|$ is the estimated magnitude HRTF.

C. Research Method

Three optimal interpolation techniques are applied to two data types of HRTFs in this research. These interpolation techniques are elaborated and tested conveniently on the same HRTF database and using same performance parameters.

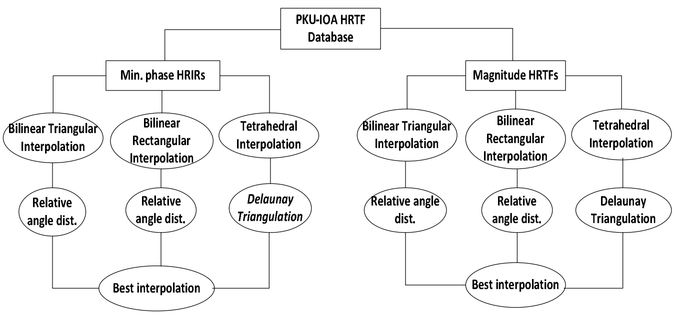

Fig. 2. Block diagram of research method

From the results of our previous work in [10], minimum phase HRIRs and magnitude HRTFs are used as input data types of HRTFs to the explored interpolation techniques. These techniques are bilinear triangular interpolation with relative angle distance, bilinear rectangular interpolation with relative angle distance, and tetrahedral interpolation with barycentric weights. We intend to find the best interpolation that is applied to a certain HRTF data type by combining the use of three interpolation techniques and two types of input data. Fig. 2 describes the block diagram of our research method.

IV. Experimental Results and Discussion

Experimental results of the applied interpolation techniques can be seen at Table 1. It is found that interpolating minimum phase HRIRs and magnitude HRTFs using parameter distance-azimuth gives the best results, those have least average MSE and least average SD, compared to when using two others parameters (azimuth-elevation, distance-elevation). However, in general bilinear rectangular interpolation results in more optimal average MSE and average SD than bilinear triangular interpolation when we compare both 2D interpolation techniques. The reason might be that contributions are balance among four HRTFs in different positions with two same azimuth angles and two same elevation angles, as shown in a figure in [5]. Based on our previous research [11], linear interpolation between two HRTFs in a straight line with the same elevation angles performed better than between two HRTFs with the same azimuth angles. A target HRTF is located between two HRTFs in the hypotenuse of a right triangle for bilinear triangular interpolation. Thus, these HRTFs contribute more dominant than another HRTF. As we know that the positions of two HRTFs in hypotenuse have different azimuth angles and elevation angles. This fact causes the bilinear triangular interpolation performed worst compared to others.

TABLE I. Experiment Results from Three Interpolation Techniques [12]

	Interpolation: Bilinear	Rectangular	Triangular	**Tetrahedral**
Az. – Elev.	MSE HRIR min ph.	7.13%	7.26%	**3.72%**
	SD HRTF min ph.	3.65 dB	3.74 dB	**2.80 dB**
	SD HRTF Interpol.	3.73 dB	3.77 dB	**2.79 dB**
Dist. – Elev.	MSE HRIR min ph.	7.69%	9.52%	**3.72%**
	SD HRTF min ph.	3.74 dB	4.03 dB	**2.80 dB**
	SD HRTF Interpol.	4.07 dB	4.13 dB	**2.79 dB**
Dist. – Az.	MSE HRIR min ph.	4.34%	9.5197%	**3.72%**
	SD HRTF min ph.	2.83 dB	4.03 dB	**2.80 dB**
	SD HRTF Interpol.	2.86 dB	4.13 dB	**2.79 dB**

As obtained from our experiment in Table 1, that tetrahedral interpolation with 3D property, provides best average MSE of 3.72% in estimating minimum phase HRIRs and best average SD of 2.79 dB in estimating magnitude HRTFs. A pair of estimated magnitude HRTFs and minimum phase HRIRs, using tetrahedral interpolation, are shown in Fig. 3, for point location at azimuth angle of 180^o, elevation angle of 50^o, and distance of 75 cm. It is discovered that both the estimated magnitude HRTFs and minimum phase HRIRs are almost identic with their original ones. This come from the fact that, in average, SD and MSE of are small for tetrahedral interpolation (Table 1). It is also observed from Table 1 that the usage of minimum phase HRIRs in general gives more optimal interpolation performance than the usage of magnitude HRTFs, as can be seen from comparison of SD HRTF minimum phase and SD HRTF Interpolation in each case. SD HRTF minimum phase is calculated from magnitude HRTFs of interpolated minimum phase HRIRs, in other hand, SD HRTF Interpolation from interpolated magnitude HRTFs. The calculation of SD HRTF minimum phase is intended to compare interpolation of minimum phase HRIRs in time domain and interpolation of magnitude HRTFs in frequency domain.

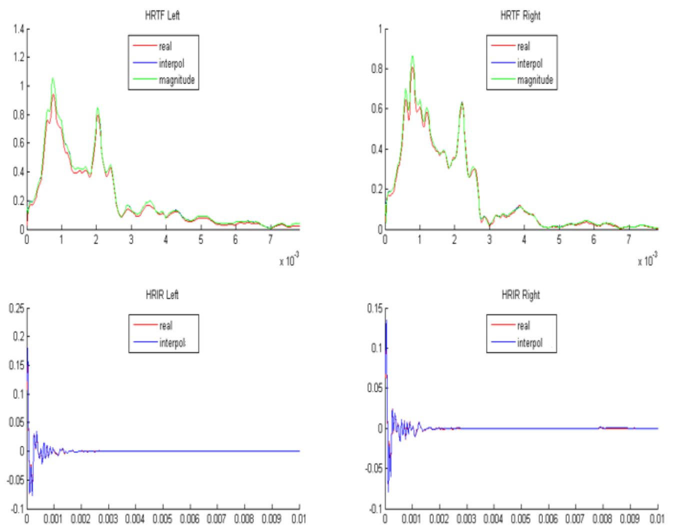

Fig. 3. Estimated magnitude HRTFs (top) and minimum phase HRIRs (bottom) using tetrahedral interpolation at (180º,50º,75)

Our result using tetrahedral interpolation with minimum phase HRIRs as input data, with SD HRTF minimum phase of 2.80 dB, is comparable with the result of tetrahedral interpolation with magnitude HRTFs as input data [6] with SD HRTF Interpolation of 2.79 dB. The proposed framework here is interpolating measured HRTFs in 3D, those are azimuth, elevation, and distance, using tetrahedral interpolation with minimum phase HRIRs as its input and barycentric weights. A tetrahedral mesh is generated via Delaunay triangulation and search via an adjacency walk. This method makes the framework robust due to irregularly positions of measured HRTFs and computationally efficient. The framework can be seen in third path from left in Fig. 2.

A number of 143 estimated HRIRs using tetrahedral interpolation has been simulated to produce virtual 3D moving sound in horizontal plane with difference of 2.5º of azimuth angle. The simulated moving sound is heard naturally moving in clockwise direction from azimuth angle of 0º to 360º. The designed graphical user interface (GUI) using Matlab is shown in Fig. 4.

In Fig. 4, bottom-left diagram shows a set of left-ear HRTFs from the corresponding set of HRIRs (top-left). This set of left-ear HRTFs is plotted with respect to frequency and azimuth angle. Top-right and bottom-right diagram show a set of right-ear HRIRs and the corresponding set of HRTFs, respectively. We can see that the left diagram is almost a reflected version of the right diagram because human left and right ear is almost symmetric. When the button 'PLAYING MOVING SOUND' is pushed, we can hear moving sound in horizontal plane as explained before.

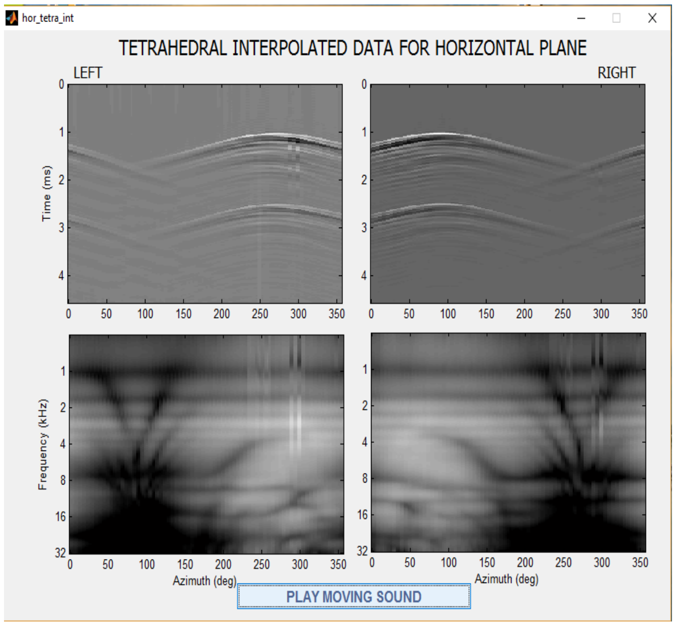

Fig. 4. GUI for simulation of 3D moving sound in horizontal plane using tetrahedral interpolation of 143 estimated HRIRs

V. CONCLUSION

We conclude from our objective evaluation, that optimal interpolation algorithm in estimating HRIRs are provided by tetrahedral interpolation with minimum phase HRIRs as its input, rather than using magnitude HRTFs. In this paper, we propose an optimal framework in producing estimated HRIRs by interpolating minimum phase HRIRs using tetrahedral interpolation. The interpolated magnitude HRTFs and minimum phase HRIRs, in general, are very similar to their corresponding measured ones. The simulated virtual 3D moving sound is heard naturally moving around horizontal plane as intended in the design, as discovered in subjective listening test.

ACKNOWLEDGMENT

This research was funded by Directorate General of Research and Development Strengthening, Ministry of Research, Technology and Higher Education, Republic of Indonesia; we are gratefully thankful for. We also thank to Peking University and Chinese Academy of Sciences for giving PKU-IOA HRTF Database freely for academic use. We appreciate Electrical Engineering Department, Universitas Indonesia (UI) and Computer Engineering Department, Universitas Multimedia Nusantara in providing their laboratories for our experiments. Great appreciation is also delivered to our colleges from research group of Wireless and Signal Processing – UI for the great discussion and support about our research.

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ABOUT

ICSIGSYS 2017

ICSigSys 2017 is organized and sponsored by the IEEE Signal Processing Society (SPS) Indonesia Chapter and technical co-sponsored by IEEE Communications Society (ComSoc) Indonesia Chapter. Thus, it has a strong foundation of bringing together industry and academia from around the globe.

The ICSigSys 2017 Conference provide a wonderful forum for you to refresh knowledge base and explore the innovations in signal processing and systems. It is also for researchers, academias, professionals, and students to disseminate information on the latest developments of signal processing and systems. We strive to offer plenty of networking opportunities, providing you with opportunity to meet and interact with leading scientists and researchers, friends and colleagues.

The conference include technical sessions, tutorials and technology and business panels. Accepted papers will be published in the ICSigSys 2017 Conference Proceedings and presented papers will be submitted to IEEE Xplore after each paper is thoroughly reviewed and (if any) satisfactorily modified according to the reviewer comments.

WELCOME MESSAGE

GENERAL CHAIR OF ICSIGSYS 2017

DR.-ING. FIKY YOSEF SURATMAN

Dear Friends & Colleagues,
It is our pleasure to welcome you to the 2017 IEEE International Conference on Signals and System (ICSigSys), which is the first international conference focuses on signals and systems in Indonesia, initiated by Signal Processing Society (SPS) Indonesia Chapter. To know that this is the first ICSigSys, we are very pleased to find that the conference have wide acceptances from researchers, scientists, students, and professionals around the globe. We received more than 130 submitted papers from 29 countries which was then reduced to 66 accepted papers, after each paper has been carefully reviewed minimum by 3 international reviewers.

The ICSigSys 2017 is to provide a wonderful forum for you to refresh knowledge and to explore the innovations in signal processing and systems. It is also to disseminate information among researchers, scientists, students, and professionals on the latest developments of signal processing and systems. We have been striving to offer plenty of networking opportunities and to provide meeting and interacting with leading scientists and researchers, friends and colleagues.

We would like to express our appreciation to the authors who have contributed their papers to the conference. We are indebted also to Technical Program Committee, International Steering Committee, and particularly to all reviewers who have invested hours in reviewing papers, criticizing the works and offering suggestions for improvements. We thank IEEE SPS Indonesia Chapter, Telkom University and IEEE Comsoc Indonesia Chapter for their supports. Our most gratitude goes to the small army of people in organizing committee, who made significant contributions of time and intellect, we could not have completed the conference without them.

We have chosen Bali since Bali is always an exceptional location for leisure as well as for conference. It is renowned as one of the world's most outstanding island which provides a unique and spectacular setting. Bali is always amazing for both local and international visitors. Here, we can find a variety of visitors from around the globe from those who love the panoramic beauty mountains and lakes at Batur, Kintamani, or Lake Beratan at Bedugul, to others who come to surf the waves of Uluwatu and Kuta, and to those who merely spend endless days on the beautiful beach.

Enjoy!!!

Warmest Regards,
Fiky Y. Suratman
The ICSigSys 2017 Chair

WELCOME MESSAGE

TPC CHAIR OF ICSIGSYS 2017

DR. RINA PUDJI ASTUTI

Welcome to ICSigSys 2017,

It is a great honor for all of us to host the ICSigSys in Bali, where the high qualified papers in Signal Processing and Systems will be presented. The conference received 133 papers with 341 authors from 29 countries. After carefully peer reviews by 182 reviewers, we have 66 accepted papers from 23 countries. By acceptance ratio 49.62 %, and finally we have 58 registered papers from 23 countries. ICSigSys2017 has maintain high quality technical program.

We also would like to thank to SPS Indonesia Chapter and Telkom University as the organizer of 1st ICSigSys 2017, and ComSoc Indonesia Chapter that involved as Technical Co-Sponsor of the conference.

We hope that fruitful discussions and exchange of ideas between researchers during conference will yield new technological innovations for contributing to a better life for humans in the coming decades.

Best Regards,

Rina Pudji Astuti
The ICSigSys 2017 TPC Chair

Program at a Glance

DAY ONE, MAY 16TH 2017

- 07.00 - 08.30 Registration
- 08.30 - 08.45 Speech from the chair of ICsigSys 2017
- 08.45 - 09.00 Opening Speech
- 09.00 - 09.45 Keynote Speech 1, Prof. Yunghsiang S. Han
- 09.45 - 10.15 Photo Session and Coffee Break
- 10.15 - 11.00 Keynote Speech 2, Prof. Sangarapillai Lambotharan
- 11.00 - 11.45 Keynote Speech 3, Prof. Tom Moir
- 11.45 - 13.00 Break & lunch
- 13.00 - 17.00 Parallel Session 1-2 & Tutorial
- 19.00 - 21.00 Gala Dinner

DAY TWO, MAY 17TH 2017

- 08.00 - 09.40 Parallel Session 3
- 09.40 - 10.00 Coffee Break
- 10.00 - 12.00 Parallel Session 4
- 12.00 - 13.00 Break and Lunch
- 13.00 - 15.00 Parallel Session 5
- 15.00 - 15.20 Coffee Break
- 15.20 - 17.00 Parallel Session 6

DAY THREE, MAY 18 2017

- SOCIAL ACTIVITY : TOUR

KEYNOTE SESSION

KEYNOTE SPEECH 1:
16 MAY 2017,
09.00-09.45

Prof. Yunghsiang S. Han
School of Electrical Engineering & Intelligentization, Dongguan University of Technology, China

REED-SOLOMON CODES ON SECURITY APPLICATIONS

Abstract:
Recently, coding theory has found many applications on information security. In this talk we will introduce how (n; k) Reed-Solomon codes apply on secrete sharing, key distribution systems, and networked distributed (big data) storage. We start from a generalization of Shamir's famous (k; n) threshold scheme on secrete sharing, where any k or more users who pool their secret shares may easily recover the initial secret S but any group of users knowing only k-1 or fewer shares may not.

Then we pay attention to a forgotten key distribution scheme, Blom's scheme, which has found to be useful in wireless sensor networks. During an initialization stage of key distribution, a base station generates and distributes secret data values to sensors and then any pair of sensors may compute a shared key unknown to all others aside from the base station. Blom's scheme guarantees that any coalition of k-1 or fewer sensors can do no better at computing the key shared by the two than a party which guesses the key without any secret data values. Each sensor only carries k secret data values in Blom's scheme. Recently, organizations need to manage, process, and store huge amounts of data. Since these data are large and complex, they are very difficult to process, manage, and store by traditional database tools and data processing applications. Large data centers with storage nodes (disks) have been built to store "big data." One critical requirement of a data center is to assure data integrity. Due to the use of commodity software and hardware, crashstop and Byzantine failures (or attacks) are likely to be more prevalent in today's large-scale data centers or distributed storage systems. Regenerating codes have been shown to be a more efficient way to disperse information across multiple storage nodes and recover crash-stop failures in the literature. Finally, we introduce a class of error-correcting regenerating codes based on Reed-Solomon codes . Error-correcting regenerating codes are not only capable of resisting crash-stop failures but also Byzantine attacks.

KEYNOTE SESSION

KEYNOTE SPEECH 2:
16 MAY 2017,
10.15-11.00

Prof. Sangarapillai Lambotharan
The Head of Signal Processing and Networks Research Group at Loughborough University, UK

GAME THEORY AND ITS APPLICATIONS IN WIRELESS COMMUNICATIONS AND SENSING SYSTEMS.

Abstract:
With the development of the Internet of Things and an abundance of sensors, it is expected that the number of connected devices will reach 50 billion globally by 2020. All these devices will need to operate in a radio congested environment and will compete for the scarce frequency spectrum.

This competition for resources between fixed and mobile users presents major challenges to future generation wireless systems and needs a mathematical framework for its solution. Likewise, in emergent wireless networks and sensor systems, there is competitive demand for higher data rates, efficient spectrum utilization and autonomous operation. The talk presents the successful application of game theoretic methods in economics, political science and evolutionary biology, to embed strategic operation in such wireless communications and sensing systems. In particular, the focus will be on the application of these methods to enable wireless and sensor systems to adapt to changes in their environment, optimise operational parameters in a distributed manner and interact strategically to mitigate disturbances caused by malicious transmitters. The talk will be concluded by presenting a collection of current and future application scenarios including 5G networks, distributed radars, smart grids and data mining.

KEYNOTE SESSION

KEYNOTE SPEECH 3:
16 MAY 2017,
11.00-11.45

Prof Tom J Moir
School of Engineering, Computing and Mathematical Sciences
Auckland University of Technology (AUT), New Zealand

THE HIDDEN WORLD OF CONTROL-SYSTEMS IN DIGITAL SIGNALS AND SYSTEMS ALGORITHMS

Abstract:
There is an old saying that "East is east and West is West and never the twain shall meet". The same can be said of control-systems and signal processing. The two subjects are often studied separately with no care as to how the two relate. This talk examines the relationships of negative feedback and stability and how it appears in some commonly (and some not so common) digital signal processing algorithms.

For example, the idea of Steepest Descent was founded by Louis Augustin Cauchy, in his Compte Rendu `a l'Acad´emie des Sciences of October 18, 1847. At that time the theory of negative feedback was not developed until Maxwells paper on Governors (1868), and any explanation Maxwell gave was not immediately recognisable with the modern day Laplace-Transform operator methods we use. Yet the steepest descent method is the simplest and earliest example of a mathematical feedback-type algorithm. At the time it wasn't greatly understood of course but forms the basis for the famous least-mean-squares algorithm (LMS) which is commonly used today. Even in 1960 when the LMS algorithm appeared, it's recognition as a system with feedback was not exploited until over 20 years later. The speaker will explore such cases as steepest descent, matrix inversion, least-squares and spectral-factorization and show alternative approaches derived from a control-systems point of view. Moreover, it will be shown how the conventional algorithms can be improved by using no more than classical control theory.

TUTORIAL SESSION

TUTORIAL:
16 MAY 2017,
13.00-15.00

Dr. Eng. Khoirul Anwar
Center for Advanced Wireless Technologies (AdWiTech), School of Electrical Engineering, Telkom University, Bandung, Indonesia

CHALLENGES ON MASSIVE INTERNET OF THINGS: INSPIRATIONS FROM CODING THEORY

Abstract:
Applications based on the Internet of things (IoT) supported by Machine-type communication technologies are expected to grow exponentially. Forecasts indicate that the number of connected things will reach about 30 to 50 billion in 2020 reaching a ratio of human and machine closes to 1:7 or 1:10.

This situation requires the development of efficient wireless technologies serving massive number of users or devices. We may also need to find new resources beyond frequency, time and space for 5G and 6G wireless networks. Inspired by the recent development of coding theory, this talk addresses a technique solving multiple access involving massive number of IoT devices, of which are not solved by the current technologies. We consider interference and dynamic fading channels as two new resources, where conventionally they are treated as 'enemies' in communication systems. Based on the concept of low density parity check (LDPC) codes, LT codes, Raptor codes, and turbo processing principle allowing slight computational complexity, we can improve the traffic of massive IoT networks about 10 times and even approaching the network capacity limit of future wireless networks, of which is higher than the conventional IoT technologies, e.g., pure ALOHA, slotted ALOHA, pure carrier sense multiple access with collision avoidance (CSMA/CA) and slotted CSMA/CA.

16 May 2017

Session 1 : 13.00-15.00, ROOM 1

Tracks: SPOC		**Room: 1**	
No	Time	Title	Authors
1	13.00-13.20	Modeling of Massive MIMO Transceiver Antenna for Full-Duplex Single-Channel System (In Case of Self Interference Effect)	Giashinta Larashati, Rina Pudjiastuti and Bambang Nugroho (Telkom University, Indonesia)
2	13.20-13.40	A Multiuser Interference Mitigation Scheme in Uplink MC-CDMA with Enhanced MMSE-FDE Technique	Akalily Mardhiyya and Rina Pudjiastuti (Telkom University, Indonesia); Nachwan Mufti Adriansyah (Universitas Telkom, Indonesia)
3	13.40-14.00	Using MIMO and Cross Layer Design for VANETs: A Review	Andy Triwinarko (IEMN-DOAE/UVHC, France); Iyad Dayoub (University Lille Nord de France IEMN-DOAE CNRS UMR 8520 UVHC, France & Concordia University, Canada); Prasaja Wikanta (IEMN-DOAE/UVHC, France)
4	14.00-14.20	Header Detection for Massive IoT Wireless Networks over Rayleigh Fading Channels	Juansyah Juansyah and Khoirul Anwar (Telkom University, Indonesia)
5	14.20-14.40	Low Density Generator Matrix (LDGM)-Based Raptor Codes for Single Carrier Internet of Things (SC-IoT)	Fadilah Nur Hidayah and Khoirul Anwar (Telkom University, Indonesia)
6	14.40-15.00	A Complete Algorithm to Diagnose and Alleviate the Effects of Physical Layer Attacks	Sasa Maric, Audri Biswas and Sam Reisenfeld (Macquarie University, Australia)

Session 2: 15.20-17.00, ROOM 1

Tracks: SPIM		**Room: 1**	
No	Time	Title	Authors
1	15.20-15.40	Sonar Beam Steering Using Grating Lobes	Shahzad A Bhatti (Heriot-Watt University, United Kingdom); Keith Brown (Heriot-Watt University & Institute Signals, Systems and Sensors, United Kingdom)
2	15.40-16.00	Multivariate Mutual Information of Interferometric Radar Altimeter	Youngjoo Kim (Korea Advanced Institute of Science and Technology, Korea); Hyochoong Bang (KAIST, Korea)
3	16.00-16.20	Phased MIMO Radar with Coherent Receive Arrays	Syahfrizal Tahcfulloh (Institut Teknologi Sepuluh Nopember Surabaya, Indonesia); Gamantyo Hendrantoro (Institut Teknologi Sepuluh Nopember, Indonesia)
4	16.20-16.40	Frequency Tracking Algorithm Based on Adaptive Fading Kalman Filter	Chan Gook Park (Seoul National University, Korea)
5	16.40-17.00	Multi-scaled Power Spectrum Based Features for Landmine Detection Using Ground Penetrating Radar	Budiman Putra Asma'ur Rohman and Masahiko Nishimoto (Kumamoto University, Japan)

Session 2: 15.20-17.00, ROOM 2

Tracks: DSP		**Room: 2**	
No	Time	Title	Authors
1	15.20-15.40	Enhanced Three-Dimensional HRIRs Interpolation for Virtual Auditory Space	Hugeng Hugeng and Jovan Anggara (Universitas Multimedia Nusantara, Indonesia); Dadang Gunawan (Universitas Indonesia, Indonesia)
2	15.40-16.00	Biometric Personal Authentication Using Images of Forearm Vein Patterns	Ryszard S. Choras (University of Technology and Life Sciences, Poland)
3	16.00-16.20	Video Based Motion Capture in Environments with Non-Stationary Background	Huyuan Shangguan and Ramakrishnan Mukundan (University of Canterbury, New Zealand)
4	16.20-16.40	Electrical Capacitance Volume Tomography Static Imaging Using Compressive Sensing with L1 Sparse Recovery	Nur Afny Catur Andryani (University of Indonesia & Tanri Abeng University, Indonesia); Dodi Sudiana and Dadang Gunawan (Universitas Indonesia, Indonesia)
5	16.40-17.00	The Flow Rate of Debris Estimation on the Sabo Dam Area with Video Processing	Agus Harjoko, Lukman Awaludin and Roghib Muhammad Hujja (Department of Computer and Electronics, Universitas Gadjah Mada, Yogyakarta, Indonesia)

17 May 2017

Session 3: 08.00-09.40, ROOM 1

Tracks: DSP		**Room: 1**	
No	Time	Title	Authors
1	08.00-08.20	Low Complexity Kernel Affine Projection-type Algorithms with a Coherence Criterion	Felix Albu (Valahia University of Targoviste, Romania); Kiyoshi Nishikawa (Tokyo Metropolitan University, Japan)
2	08.20-08.40	Parallel Architecture for Implementation of Frequent Itemset Mining Using FP-Growth	Sajid Gul Khawaja (National University of Sciences and Technology (NUST), Pakistan); Muhammad Usman Akram (CEME NUST, Pakistan); A Khan (NUST, Rawaplpindi, Pakistan)
3	08.40-09.00	Enhanced LSB Steganography with People Detection as Stego Generator	Pande Gede Jaya, Bambang Hidayat and Fiky Suratman (Telkom University, Indonesia)
4	09.00-09.20	Stability and Convergence of a Class of Nonlinear Algorithms in Digital Signal Processing	Tom J Moir (Auckland University of Technology, New Zealand)
5	09.20-09.40	Cryptanalysis of a Chaos Based Random Number Generator: Lessons Learned	Salih Ergun (TUBITAK BILGEM - Informatics and Information Security Research Center, Turkey)

Session 3: 08.00-09.40, ROOM 2

Tracks: SPOC		**Room: 2**	
No	Time	Title	Authors
1	08.00-08.20	On the Design of LDPC-based Raptor Codes for Single Carrier Internet of Things (SC-IoT)	Nur Kamila and Khoirul Anwar (Telkom University, Indonesia)
2	08.20-08.40	A New Step-by-Step Complete Decoding Algorithm for Binary Cyclic Codes	Yunghsiang Sam Han (Dongguan University of Technology, P.R. China); Shu-Wei Fu (Taipei Vehicle Office, Taiwan); Po-Ning Chen (National Chiao Tung University, Taiwan)
3	08.40-09.00	Design of LDGM-based Raptor Codes for Broadband Internet of Things Using EXIT Chart	Ines Visyeri Yuliani and Khoirul Anwar (Telkom University, Indonesia)
4	09.00-09.20	The Application of Compression Methods for RoIP Data Transmission Efficiency in the HFC Network	Chulsun Park, Kim Taeil and Sung-kwon Park (Hanyang University, Korea)
5	09.20-09.40	Performance Evaluation of the Key Extraction Schemes in Wireless Indoor Environment	Mike Yuliana (EEPIS, Indonesia); Iwan Wirawan and Suwadi Suwadi (ITS, Indonesia)

Session 4: 10.00-12.00, ROOM 1

Tracks: SPIM		**Room: 1**	
No	Time	Title	Authors
1	10.00-10.20	Proposed FPGA Implementation of Goertzel Algorithm in the Non-Destructive Eddy Current Testing	Matija Kekelj (INETEC - Institute for Nuclear Technology & Faculty of Engineering University of Rijeka, Croatia); Neven Bulic (University of Rijeka Faculty of Engineering, Croatia); Viktor Sučić (Faculty of Engineering University of Rijeka, Croatia)
2	10.20-10.40	An FPGA-based Pattern Generation System for Functionality Test of TFT-LCD Panels	Wei Li, Yongjian Liu and Zhixiang Deng (Hohai University, P.R. China)
3	10.40-11.00	A Software Infrastructure for Firmware-Software Interaction: The Case of TPMs	Alessio Magro (University of Malta, Malta); Riccardo Chiello (University of Oxford, United Kingdom); Cristian Albanese (SanitasEG, Italy); Jeremy Baker (STFC, RAL, United Kingdom); Gianni Comoretto (Istituto Nazionale di Astrofisica, Italy); Andrea DeMarco (University of Malta, Malta); Alessio Gravina (SanitasEG, Italy); Rob Halsall and Matt Roberts (STFC, RAL, United Kingdom); Kristian Zarb Adami (University of Malta, Malta)
4	11.00-11.20	The Development of Hybrid Methods in Simple Swarm Robots for Gas Leak Localization	Husnawati Husnawati and Gita Fadila Fitriana (Computer Science Faculty, Universitas Sriwijaya, Indonesia); Siti Nurmaini (University of Sriwijaya, Indonesia)
5	11.20-11.40	Shear Effect Elimination on Hand Force Measurement with Flexible Piezo-Resistive Sensor During Hand Manipulation	Ye Qiang (The Institute of Intelligent Machines, P.R. China)
6	11.40-12.00	A Performance Comparison of Auto-Encoder and Its Variants for Classification	Keun-Chang Kwak (Chosun University, Korea); Jae Neung Lee (Chosun University, Seosuk-dong, Gwangju, Korea)

Session 4: 10.00-12.00, ROOM 2

Tracks: SPIM & SPOC		**Room: 2**	
No	Time	Title	Authors
1	10.00-10.20	On the Use of Second Level Adaptation for Networked Adaptive Systems	Koshy George (PES Institute of Technology & PES Centre for Intelligent Systems, India); Rajini Makam (PES University)
2	10.20-10.40	Radio frequency Energy Harvesting System Based on a Rectenna Array in Urban Environments	Jayme Milanezi, Jr. (University of Brasilia & Brazilian Electrical Regulatory Agency (ANEEL), Brazil); Joao Paulo Carvalho Lustosa da Costa (University of Brasília & Ilmenau University of Technology and Fraunhofer Institute for Integrated Circuits IIS, Brazil); Ricardo Kehrle Miranda and Ronaldo S Ferreira, Jr. (University of Brasilia, Brazil); Giovanni Del Galdo (Fraunhofer Institute for Integrated Circuits IIS & Technische Universität Ilmenau, Germany); Edison Pignaton de Freitas (Federal University of Rio Grande do Sul, Brazil); Wolfgang Felber (Fraunhofer Institute for Integrated Circuits IIS, Germany)
3	10.40-11.00	Dual Polarized Antenna Decoupling for 60 GHz Planar Massive MIMO	Muhsin Muhsin, Rina Pudjiastuti and Bambang Nugroho (Telkom University, Indonesia)
4	11.00-11.20	The Development of IoT LoRa®: A Performance Evaluation on LoS and Non-LoS Environment at 915 MHz ISM Frequency	Arrief Rahman and Muhammad Suryanegara (University of Indonesia, Indonesia)
5	11.20-11.40	A Hybrid C/Ku-band High Throughput Satellite Systems as an Optimal Design for Indonesia	Dani Widjanarko (Universitas Indonesia & PT. Pasifik Satelit Nusantara, Indonesia); Dadang Gunawan (Universitas Indonesia, Indonesia)
6	11.40-12.00	Fast Acquisition and Time Synchronization of Frequency Hopping Burst Signals	Syed Naveen Altaf Ahmed (School Of Computer Science and Engineering, Nanyang Technological University, Singapore); Pramod Kumar Meher (Nanyang Technological University, Singapore); A P Vinod (NTU, Singapore)

Session 5: 13.00-15.00, ROOM 1

Tracks: DSP		**Room: 1**	
No	Time	Title	Authors
1	13.00-13.20	A New Algorithm for Classification of Ictal and Pre-Ictal Epilepsy ECoG Using MI and SVM	Zhiyang Chen (Nanjing University of Posts and Telecommunications & Nanjing, Jiangsu, P.R. China); Liya Huang, Yangyang Shen, Jun Wang and Ruijie Zhao (Nanjing University of Posts and Telecommunications, P.R. China); Jiafei Dai (Nanjing Medical University, P.R. China)
2	13.20-13.40	A Practical Approach to OCT Based Classification of Diabetic Macular Edema	Samra Naz (National University of Sciences and Technology Islamabad, Pakistan); Taimur Hassan (Bahria University, Islamabad, Pakistan); Shoab Khan (National University of Science and Technology, Pakistan); Muhammad Usman Akram (CEME NUST, Pakistan)
3	13.40-14.00	Single Sperm Tracking Using Intersect Cortical Model-Mean Shift Method	Weng Chun Tan and Nor Ashidi Mat Isa (Universiti Sains Malaysia, Malaysia)
4	14.00-14.20	Benchmark Data Set for Glaucoma Detection with Annotated Cup to Disc Ratio	Anum Abdul Salam (College of Electrical & Mechanical Engineering NUST & NUST, Pakistan); Muhammad Usman Akram (CEME NUST, Pakistan); Amna Arouj (NUST, Pakistan)
5	14.20-14.40	A Model Based Inference Engine for Stress Estimation	Midhun Parakkal Unni (TCS, India); Jayaraman Srinivasan (TCS Innovation Labs, Bangalore, TCS, India); P. Balamuralidhar (Tata Consultancy Services, India)

Session 5: 13.00-15.00, ROOM 1

Tracks: SPOC		**Room: 2**	
No	Time	Title	Authors
1	13.00-13.20	Practical Schemes for Throughput Improvement in Live Networks	Mohammad Rasoul Tanhatalab (MTN Irancell, Iran); Seyed Majid Jafari Jour Jadeh and Amirhossein Orouji Esfahani (MTNIrancell, Iran)
2	13.20-13.40	Cross-Layer Stream Provisioning Scheme in Massive MIMO Cellular Networks	Wen-Hsing Kuo and Ying-Hsueh Lu (Yuan Ze University, Taiwan)
3	13.40-14.00	Enhanced Graph Transforming Algorithm to Solve Transitive Dependency Between Vertices	Sutedi Sutedi (Universitas Gadjah Mada, Indonesia); Teguh Bharata Adji (Gadjah Mada University, Indonesia); Noor Akhmad Setiawan (Universitas Gadjah Mada, Indonesia)
4	14.00-14.20	Throughput Evaluation of Raspberry Pi Devices on Multihop and Multiflow Wireless Sensor Network Scenarios	Mike Cristian Gragasin, Nemesio Macabale and Miguel Paulo Talplacido (Central Luzon State University, Philippines)
5	14.20-14.40	Efficient IEEE 802.15.4 ZigBee Standard Hardware Design for IoT Applications	Tarek Elarabi (Penn State University, USA); Vishal Deep (N/A, USA)
6	14.40-15.00	Effect of External Factors on Accuracy of Distance Measurement Using Ultrasonic Sensors	Markus Borschbach (University of Applied Sciences, FHDW, Germany); Navya Amin (Steinbeis SIZ Center, Germany)

Session 6: 15.20-17.00, ROOM 1

Tracks: DSP		**Room: 1**	
No	Time	Title	Authors
1	15.20-15.40	Multi-scale Color Features Based on Correlation Filter for Visual Tracking	Suryo Adhi Wibowo (Pusan National University, Indonesia); Hansoo Lee, Eun Kyeong Kim and Sungshin Kim (Pusan National University, Korea)
2	15.40-16.00	Synthetic Models of Ultrasound Image Formation for Speckle Noise Simulation and Analysis	Prerna Singh and Ramakrishnan Mukundan (University of Canterbury, New Zealand); Rex De Ryke (Christchurch District Health Board, New Zealand)
3	16.00-16.20	Low-Cost 3D Surface Reconstruction Using Stereo Camera for Small Object	Agus Harjoko, Roghib Muhammad Hujja and Lukman Awaludin (Department of Computer and Electronics, Universitas Gadjah Mada, Yogyakarta, Indonesia)
4	16.20-16.40	3D Model Retrieval Based on Deep Autoencoder Neural Networks	Zhao-Ming Liu (NTUST, Taiwan); Yung-Yao Chen (National Taipei University of Technology, Taiwan); Shintami Chusnul Hidayati (National Taiwan University of Science and Technology & Academia Sinica, Taiwan); Shih-Che Chien and Feng-Chia Chang (National Chung-Shan Institute of Science and Technology, Taiwan); Kai-Lung Hua (National Taiwan University of Science and Technology, Taiwan)
5	16.40-17.00	Integrating Embedded Color Vision to Bioloid Robot for Playing Soccer	Siti Sendari and Dyah Lestari (Universitas Negeri Malang, Indonesia); Choirul Ulfa Kusumohadi (Universitas Negeri Malang & PT. Satunol Mikrosistem, Indonesia); Fauzy Satrio Wibowo (Universitas Negeri Malang, Indonesia)

Session 6: 15.20-17.00, ROOM 2

Tracks: SPOC		**Room: 2**	
No	Time	Title	Authors
1	15.20-15.40	RGB MIMO Optical Camera Communication with Histogram Equalization	Won Jae Ryu and Soo Young Shin (Kumoh National Institute of Technology, Korea)
2	15.40-16.00	DOA Estimation Method for Co-arrays with Unknown Number of Sources	Anh-Tuan Nguyen, Takashi Matsubara and Takakazu Kurokawa (National Defense Academy, Japan)
3	16.00-16.20	Developing Portable Instrument Based on Internet of Things for Air Quality Information System	Fauzy Satrio Wibowo, Febrianto Alqodri, Nurani Lathifah, Siti Sendari, Dyah Lestari, Anik Nur Handayani and Yuni Rahmawati (Universitas Negeri Malang, Indonesia); Choirul Ulfa Kusumohadi (Universitas Negeri Malang & PT. Satunol Mikrosistem, Indonesia)
4	16.20-16.40	Optimum UAV Flying Path for Device-to-Device Communications in Disaster Area	Evander Christy, Rina Pudjiastuti, Budi Syihabuddin, Bhaskara Narottama, Obed Ludwiniananda and Furry Rachmawati (Telkom University, Indonesia)

PAPERS INDEX

International Conference on Signals and Systems (ICSigSys 2017)

AUTHORS INDEX

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