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Homepage

ICoICT 2018 is jointly-organized by Telkom University (Bandung, Indonesia) and Multimedia University (Malaysia) and held in Bandung. Bandung is a unique historical city with a rich trading history and multicultural heritage background inherited from previous Netherlands.

ICoICT 2018 intends to be the premier forum for academicians, industrials, professionals, and students to exchange knowledge and sharing research finding in a broad scope of coverage of information communication technology (ICT). The conference features traditional paper presentations, tutorials, as well as keynote speech by renowned ICT experts.

ICoICT 2018's theme is "Connecting Sensors, Machines and Societies". Papers on original works are solicited on a variety of tracks including Connecting Sensors, Connecting Machines, Connecting Societies, Connect with Confidence, Connecting Data, and Ambient Intelligence for Smart Living.

Finally, we would like to express our sincere appreciation to all the authors and attendees for their contributions to ICoICT 2018

ICoICT 2018

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US	14,278	SG	1,474	FR	893
IN	7,306	DE	1,469	SA	764
CN	5,370	NG	1,334	RU	732
JP	2,691	PK	1,114	FI	728
KR	2,369	TW	1,068	VN	670
TH	2,026	BD	1,053	IR	667
GB	1,758	BR	1,028	IT	532

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PRESENTATION SCHEDULE

PRESENTATION GUIDELINES

- Each session room will be preset with a LCD projector & screen, and one laptop with MS PowerPoint & Adobe Acrobat Reader.
- Presenter to provide presentation materials in the form of PowerPoint slides or PDF. Please arrive at the designed room location 10 minutes before the session begins and report to the session chair.
- Each regular oral session: 15-20 Minutes of Presentation including Q&A.

ROOM INFORMATION

Room	Location
Room 1	Panambulai Building, 3rd Floor
Room 2	Panambulai Building, 3rd Floor
Room 3	Panambulai Building, 3rd Floor
Room 4	Panambulai Building, 3rd Floor
Room 5	Graha Wiyata Cacuk Sudarijanto B, 1st Floor
Room 6	Graha Wiyata Cacuk Sudarijanto B, 1st Floor
Room 7	Graha Wiyata Cacuk Sudarijanto B, 1st Floor
Room 8	Graha Wiyata Cacuk Sudarijanto B, 1st Floor

Room 9	Graha Wiyata Cacuk Sudarijanto B, 1st Floor
Room 10	Graha Wiyata Cacuk Sudarijanto B, 1st Floor

ROOM 2 – CONNECTING MACHINES

THURSDAY, MAY 3, 2018

14:00

1570432463
Toward Full Enterprise Software Support on nDPI

Charles Lim (Swiss German University, Universitas Indonesia, Indonesia)

14:15

1570432262
Utilization of Onboard Diagnostic II (OBD-II) on Four Wheel Vehicles for Car Data Recorder Prototype

Satrio Nugroho and Endro Ariyanto (Telkom University, Indonesia); Andrian Rakhmatsyah (School of Computing - Telkom University, Indonesia)

14:30

1570425155
Collision-Aware Rate Adaptation Algorithm for High-Throughput IEEE 802.11n WLANs

Teuku Yuliar Arif (Syiah Kuala University, Indonesia)

14:45

1570432048
An Architecture for M2M Communications over Cellular Networks Using Clustering and Hybrid TDMA-NOMA

Md. Farhad Hossain (Bangladesh University of Engineering and Technology (BUET), Bangladesh); Anthonya Rozario (BRAC University, Bangladesh)

15:00

1570431935
Implementation of Vehicle Traffic Analysis Using Background Subtraction in The Internet of Things (IoT) Architecture

Aghus Sofwan (Diponegoro University, Indonesia)

ROOM 1 – CONNECTING SOCIETIES

THURSDAY, MAY 3, 2018

14:00

1570431716
An Assessment of eReadiness Cloud Computing Service Model on Indonesian Higher Education

Soni Fajar Surya Gumilang and Heru Nugroho (Telkom University, Indonesia)

14:15

1570432029
Throughput Maximization Based On User Association In Heterogeneous Networks

Khalid Mohamed and Mohamad Yusoff Alias (Multimedia University, Malaysia); Mardeni Roslee (MMU, Malaysia); Mohammed Jaber Alam (Multimedia University, Malaysia)

14:30 1570432057
Rejuvenation Action Model for Application Software
Jamaiah Yahaya (The National University of Malaysia; Faculty of Information Science and Technology, Malaysia); Zaiha Nadiah Zainal Abidin (Faculty of Information Science and Technology, UKM, Malaysia); Zuriani Hayati Abdullah (Universiti Kebangsaan Malaysia, Malaysia); Aziz Deraman (University Malaysia Terengganu, Malaysia)

14:45 1570430965
Artificial Neural Network for Predicting Indonesia Stock Exchange Composite Using Macroeconomic Variables
Andry Alamsyah (Telkom University, School of Economics and Business, Indonesia); Asri Nurfathi (Telkom University, Indonesia)

15:00 1570432179
Usability Evaluation of Digital Service Company Portal Using Importance Performance Analysis
Kartika Sari (Telkom University, Indonesia)

ROOM 3 – CONNECTING DATA

THURSDAY, MAY 3, 2018

14:00 1570432229
Analysis of Non Negative Double Singular Value Decomposition Initialization Method on Eigenspace-based Fuzzy C-Means Algorithm For Indonesian Online News Topic Detection
Raden Sutrisman and Hendri Murfi (Universitas Indonesia, Indonesia)

14:15 1570418073
TCP Congestion Window Analysis of Twitter with Exponential Model
Hilal H. Nuha (King Fahd University of Petroleum, Minerals , CeGP, Saudi Arabia); Sidik Prabowo (Telkom University, Telkom University, Indonesia)

14:30 1570417739
Hadoop High Availability with Linux HA
Diamun Solissa (Telkom Institute of Technology, Indonesia); Maman Abdurohman (Telkom University, Indonesia)

14:45 1570431788
Recommendation System Based on Item and User Similarity on Restaurants Directory Online
Aji Mustofa (Universitas Indonesia, Indonesia); Indra Budi (Computer Science, Indonesia)

15:00

1570436407
Computational Analysis on Rise and Fall of Indonesian Vocabulary

Faisal Rahutomo (State Polytechnic of Malang, Indonesia)

ROOM 4 – AMBIENT INTELLIGENCE FOR SMART LIVING

THURSDAY, MAY 3, 2018

14:00

1570434333
Simulation of Rotating a Robot Arm by Non-Metamorphic Animation Method in IFS Fractal Model Based on Shifting Centroid Technique

Tedjo Darmanto (STMIK AMIK Bandung, Indonesia)

14:15

1570436570
A Multi-Level Genetic Algorithm Approach for Generating Efficient Travel Plans

Fajar Hendra and Zk Abdurahman Baizal (Telkom University, Indonesia); Kemas Lhaksmana (Telkom University, Kyoto University, Indonesia)

14:30

1570436669
SocioEmpathy: A Social-Sensitivity Application to Reduce Stress and Depression of Divorce or Domestic Violence Victims

Arga Panatagama (Bogor Agricultural University, Indonesia)

14:45

1570432388
Analyzing 4G Adoption in Indonesia Using a Modified Unified Theory of Acceptance and Use of Technology 2

Indrawati Indrawati and Kedar Utama (Telkom University, Indonesia)

15:00

1570427431
A Multi-label Classification on Topics of Quranic Verses in English Translation Using Tree Augmented Naïve Bayes

Mohamad Syahrul Mubarok, Al Mira Khonsa Izzaty, Nanang Saiful Huda and A Adiwijaya (Telkom University, Indonesia)

ROOM 1 – CONNECTING SOCIETIES

THURSDAY, MAY 3, 2018

15:40

1570417985
Travel Route Optimization Using Dynamic Programming

Yoe One Ariestya Niovitta (ITS Surabaya, Indonesia); Riyanarto Sarno (Institut Teknologi Sepuluh Nopember, Indonesia)

15:55

1570436319
Route Recommendation using Community Detection Algorithm (Case: Kota Bandung)

Yahya Peranginangin (Telkom University, Indonesia)

16:10 | 1570431423
Improving Node Popularity Calculation using Kalman Filter in Opportunistic Mobile Social Networks
Bambang Soelistijanto (Sanata Dharma University, Indonesia)

16:25 | 1570436556
Increasing Students Interaction in Distance Education using Gamification Case Study: IDEA Telkom University
Anisa Herdiani, M. Rizky Ferianda and Indra Lukmana Sardi (Telkom University, Indonesia)

16:40 | 1570419524
The Effectiveness of Low-Level Structure-based Approach Toward Source Code Plagiarism Level Taxonomy
Oscar Karnalim (Maranatha Christian University, Indonesia)

ROOM 3 – CONNECTING DATA

THURSDAY, MAY 3, 2018

15:40 | 1570418294
Link Failure Emulation with Dijkstra and Bellman-Ford Algorithm in Software Defined Network Architecture (Case Study: Telkom University Topology)
Anggie Nastiti (Telkom University, Indonesia); Andrian Rakhmatsyah (School of Computing - Telkom University, Indonesia); Muhammad Arief Nugroho (Telkom University, Indonesia)

15:55 | 1570430974
Finding Pattern in Dynamic Network Analysis
Andry Alamsyah (Telkom University, School of Economics and Business, Indonesia); Kevin Bratawisnu, Made and Puput Sanjani (Telkom University, Indonesia)

16:10 | 1570434675
A Lightweight Semantic-based Medical Document Retrieval
Dhomas Hatta Fudholi (Universitas Islam Indonesia, Indonesia)

16:25 | 1570417819
Context-aware ontological hybrid recommender system for IPTV
Mohammad Wahiduzzaman Khan (Multimedia University, Cyberjaya, Malaysia); Chan Gaik Yee (MMU, Malaysia); Fang-Fang Chua (Multimedia University, Malaysia); Su-Cheng Haw (MMU, Malaysia); Muhsin Hassan and Fatimah Saaid (Telekom Malaysia, Malaysia)

16:40 | 1570436463
Tokenization and N-gram for Indexing Indonesian Translation of the Quran
Syopiansyah Jaya Putra (Syarif Hidayatullah State Islamic University Jakarta, Indonesia);

Muhamad Gunawan (Islamic State University Syarif Hidayatullah, Indonesia)

ROOM 4 – AMBIENT INTELLIGENCE FOR SMART LIVING

THURSDAY, MAY 3, 2018

15:40

1570427452
News Topic Classification using Mutual Information and Bayesian Network

Mohamad Syahrul Mubarok, Fahmi Salman Nurfikri and A Adiwijaya (Telkom University, Indonesia)

15:55

1570432058
Analyzing Factors Influencing Continuance Intention of E-Payment Adoption Using Modified UTAUT 2 Model (A Case Study of Go-Pay from Indonesia)

Indrawati Indrawati and Dianty Putri (Telkom University, Indonesia)

16:10

1570417750
High Performance Streaming Based on H264 and Real Time Messaging Protocol (RTMP)

Anif Nurrohman and Maman Abdurohman (Telkom University, Indonesia)

16:25

1570436645
An Android Application for Predicting Traffic Congestion using Polling Method

Nuzulul Perdana Putra (Telkom University, Indonesia); Kemas Lhaksmana (Telkom University, Kyoto University, Indonesia); Bambang Wahyudi (Telkom University, Indonesia)

16:40

1570436605
Design and Implementation of Water Heater Activation and Monitoring of Water Temperature and Water Supply with Ultrasonic and Temperature Sensor Using Arduino Based on Android

Muhammad Khairunnas and Endro Ariyanto (Telkom University, Indonesia); Sidik Prabowo (Telkom University, Telkom University, Indonesia)

ROOM 5 – CONNECTING SENSORS

FRIDAY, 4 MAY 2018

8:00

1570434552
2.4 GHz Wireless Data Acquisition System for FIToplankton ROV

Muhammad Ikhsan Sani and Simon Siregar (Telkom University, Indonesia); Marlindia Sari (Telkom Unversity, Indonesia); Lisa Mardiana (Telkom University, Indonesia)

8:15

1570434341
Person Locator Using GPS Module and GSM Shield Applied for Children Protection

Fahmi Fahmi (University of Sumatera Utara, Indonesia)

8:30

1570417980

Android Application For Controlling Air Conditioner using Fuzzy Logic

Andhika Cahya Pratama and Riyanarto Sarno (Institut Teknologi Sepuluh Nopember, Indonesia)

8:45

1570432296

Connectivity Control Algorithm for Autonomous Wireless Agents

Syifa Hersista (The Sirindhorn International Thai-German Graduate School of Engineering, KMUTNB, Thailand, Institute for Communication Technologies and Embedded System, RWTH Aachen University, Germany)

9:00

1570433300

A Capacitive Model of Water Salinity Wireless Sensor System Based on WIFI-Microcontroller

Suryono Suryono, Sr. (Diponegoro University, Indonesia)

ROOM 7 – CONNECTING MACHINES

FRIDAY, 4 MAY 2018

8:00

1570432027

Development of Qibla Direction Cane for Blind using Interactive Voice Command

Gita Hapsari and Giva Mutiara (Telkom University, Indonesia); Asrin Asmianti (Telkom University, Applied Science School of Telkom University, Indonesia)

8:15

1570417981

Equal-Cost Multipath Routing in Data Center Network Based on Software Defined Network

Fiqih Rhamdani, Novian Anggis Suwastika and Muhammad Arief Nugroho (Telkom University, Indonesia)

8:30

1570434351

A framework of wireless maintenance system monitoring(A case study of automatic filling machine at SB company)

Fransiskus Tatas Dwi Atmaji (Telkom University, Bandung-Indonesia, Indonesia); Judi Alhilman (Telkom University, Indonesia)

8:45

1570417984

Automation Canal Intake Control System Using Fuzzy Logic and Internet of Things (IoT)

Radityo Putro Wibisono and Novian Anggis Suwastika (Telkom University, Indonesia); Sidik Prabowo (Telkom University, Telkom University, Indonesia); Tri Santoso (Estetika Multikreasi Rancana, Indonesia)

9:00

1570417890

Fast UART and SPI Protocol for Scalable IoT Platform

Rizka Reza Pahlevi, Aji Gautama Putrada Satwiko and Maman

Abdurohman (Telkom University, Indonesia)

ROOM 10 – CONNECTING SOCIETIES

FRIDAY, 4 MAY 2018

8:00

1570434099
Verifying Vaccine Supply Chain System in Indonesia Using Linear-Time Temporal Logic

Muhammad Wikatama (Telkom University, Indonesia); Muhammad Arzaki (Telkom University, Computing Lab - ICM Research Group, Indonesia); Yanti Rusmawati (Telkom University, Indonesia)

8:15

1570434242
Dynamic Large Scale Data on Twitter using Sentiment Analysis and Topic Modelling Case Study Uber

Andry Alamsyah (Telkom University, School of Economics and Business, Indonesia); Wirawan Rizkika, Ditya Nugroho and Farhan Renaldi (Telkom University, Indonesia); Siti Saadah (Telkom University d/h Telkom Institute of Technology, Indonesia)

8:30

1570435743
Detecting Indonesian Spammer on Twitter

Erwin B. Setiawan (Telkom University, Indonesia); Dwi H Widyantoro (Institut Teknologi Bandung, Indonesia); Kridanto Surendro (Institu Teknologi Bandung, Indonesia)

8:45

1570436504
Quranic Concepts Similarity Based on Lexical Database

Dony Arisandy Wiranata, Moch Arif Bijaksana and Mohamad Syahrul Mubarok (Telkom University, Indonesia)

9:00

1570434829
Searching Quran Chapters Verses Weight with TF and Pareto Principle to Support Memorizing (Case Study Juz Amma)

Eko Darwiyanto and Moch Arif Bijaksana (Telkom University, Indonesia)

ROOM 6 – CONNECT WITH CONFIDENCE

FRIDAY, 4 MAY 2018

8:00

1570433920
Strengthening Megrelishvili Protocol Against Man-in-The-Middle Attack

Muhammad Arzaki (Telkom University, Computing Lab - ICM Research Group, Indonesia)

8:15

1570436307
Analysis and Classification of Danger Level in Android Applications using Naive Bayes Algorithm
Ridho Alif Utama, Parman Sukarno and Erwid M Jadied (Telkom University, Indonesia)

8:30
1570434657
QIM-based Audio Watermarking with Combined Techniques of SWT-DST-QR-CPT Using SS-based Synchronization
Gelar Budiman (Telkom University, Indonesia)

8:45
1570416861
Counterexample Generation for Ping-Pong Protocols Security Checking Algorithm
Erwin Eko Wahyudi and Reza Pulungan (Universitas Gadjah Mada, Indonesia)

9:00
1570417983
Design and Implementation Adaptive Intrusion Prevention System (IPS) for Attack Prevention in Software-Defined Network (SDN) Architecture
Novian Anggis Suwastika, Rifqi Pratama and Muhammad Arief Nugroho (Telkom University, Indonesia)

ROOM 8 – CONNECTING DATA

FRIDAY, 4 MAY 2018

8:00
1570432390
Mining Customer Opinion for Topic Modeling Purpose: Case Study of Ride-Hailing Service Provider
Reggia Wayasti, Isti Surjandari and Zulkarnain Zulkarnain (Universitas Indonesia, Indonesia)

8:15
1570434240
Indexing Voronoi Cells for Highest Order VoronoiDiagram using R-Tree
Kiki Maulana Adhinugraha and Ibnu Asror (Telkom University, Indonesia)

8:30
1570436411
Development of e-Kanban Application Using Stock-Needs Rule Prioritizing Policy to Reduce 0-Pick for Pharmaceutical Warehousing
Raihan Razafuad (Telkom University, Indonesia)

8:45
1570436438
Study of Wavelet and Line Search Techniques on Modified Backpropagation Polak-Ribiere Algorithm for Heart Failure Detection
Dinda Destiani, A Adiwijaya and D Utama (Telkom University, Indonesia)

9:00
1570417936
Rainfall Forecasting in Bandung Regency using C4.5 Algorithm
Joko Azhari, Fhira Nhita and Aniq Atiqi (Telkom University, Indonesia)

ROOM 9 – AMBIENT INTELLIGENCE FOR SMART LIVING

FRIDAY, 4 MAY 2018

8:00	1570434290 **Mongoloid and non-Mongoloid Race Classification From Face Image using Local Binary Pattern Feature Extractions**	Kurniawan Nur Ramadhani (Telkom University, Indonesia)
8:15	1570418950 **Distributed Campus Bike Sharing System Based On Internet Of Things (IoT)**	Fauzan Adhi Rachman, Maman Abdurohman and Aji Gautama Putrada Satwiko (Telkom University, Indonesia)
8:30	1570434570 **Mapping Walls of Indoor Environment using Moving RGB-D Sensor**	Ismail Rusli (Telkom University, Indonesia)
8:45	1570421624 **Fatigue Monitoring based on Yawning and Head Movement**	Kirbana Jai Raman (Multimedia University (MMU), Malaysia)

ROOM 7 – CONNECTING MACHINES

FRIDAY, 4 MAY 2018

09:40	1570434671 **Enterprise Architecture for The Sensing Enterprise: A Research Framework**	Erda Guslinar Perdana (Telkom University, Indonesia); Husni Sastramihardja (Universitas Esa Unggul, Indonesia); Iping Supriana Suwardi (Bandung Institute of Technology, Indonesia)
09:55	1570417956 **Modeling User Interface of First-Aid Application Game using User Centered Design (UCD) Method**	Ervira Wulandari, Veronikha Effendy and Gede Wisudiawan (Telkom University, Indonesia)
10:10	1570432144 **Design and Implementation Cyber-Physical System on Plant Chemical Process: Study Case Mini Batch Distillation Column**	Irvan Budiawan (Bandung Institute of Technology, Indonesia)
10:25	1570436541 **Indonesian License Plate Recognition Using Convolutional Neural Network**	Ignatius Notonogoro and Jondri Jondri (Telkom University, Indonesia); Anditya Arifianto (Telkom University, Artificial Intelligence Laboratory, ICM Research Group, Indonesia)
10:40	1570436658 **Decision System for Reservoir Upwelling using Fuzzy Logic based on Internet of Things**	Bayu Erfianto (TELKOM University, School of Computing, Indonesia); Novian Anggis

Suwastika (Telkom University, Indonesia); Sidik Prabowo (Telkom University, Telkom University, Indonesia)

ROOM 10 – CONNECTING SOCIETIES

FRIDAY, 4 MAY 2018

09:40

1570436198
A Preliminary Study on Detection System for Assessing Children and Foster Parents Suitability

Rachmadita Andreswari, Warih Puspitasari and Irfan Darmawan (Telkom University, Indonesia)

09:55

1570436443
Measurement of Digital Divide for Provinces in Indonesia Using DIDIX Method

Nori Wilantika (University of Indonesia, Indonesia)

10:10

1570436078
Automatic Tweet Classification based on News Category in Indonesia Language

Jaka Eka Sembodo, Erwin B. Setiawan, Moch Arif Bijaksana and Erwin Budi Setiawan (Telkom University, Indonesia)

10:25

1570432307
Analysis of the Technology Acceptance Model (TAM) on Survey SystemBased Smartphone by the National Population and Family Planning Indonesia

Sukarno Sono (National Population and Family Planning Board, Indonesia); Nur Laila Meilani (Universitas Riau, Indonesia)

10:40

1570435713
Learning basic algorithm using gamification for novice programmer

Yadhi Aditya Permana (Telkom University, Politeknik Negeri Bandung, Indonesia); Dana Kusumo and Dade Nurjanah (Telkom University, Indonesia)

ROOM 6 – CONNECT WITH CONFIDENCE

FRIDAY, 4 MAY 2018

09:40

1570436306
An SSH Honeypot Architecture Using Port Knocking and Intrusion Detection System

Ridho Maulana Arifianto, Parman Sukarno and Erwid M Jadied (Telkom University, Indonesia)

09:55

1570430468
On Generalized Divide and Conquer Approach for Group Key Distribution: Correctness and Complexity

Ridhwan Dewoprabowo (Telkom University, Indonesia); Muhammad Arzaki (Telkom University, Computing Lab - ICM Research Group, Indonesia); Yanti Rusmawati (Telkom University, Indonesia)

10:10

1570434310
Security Protection Profile on Smart Card System Using ISO 15408 Case Study: Indonesia Health Insurance Agency

Yoso Setyoko and Rahmat Yasirandi (Telkom University, Indonesia)

10:25

1570417888
Hardening the Virtual Password Authentication Scheme

Mohammad Zakie Faiz Rahiemy, Parman Sukarno and Erwid M Jadied (Telkom University, Indonesia)

10:40

1570432165
Digital Contract Using Block Chaining and Elliptic Curve Based Digital Signature

Sony Kalamsyah (Telkom University, Indonesia); Ari Moesriami Barmawi (Telkom University, Indonesia); Muhammad Arzaki (Telkom University, Computing Lab - ICM Research Group, Indonesia)

ROOM 8 – CONNECTING DATA

FRIDAY, 4 MAY 2018

09:40

1570432387
Mining Web Log Data For Personalized Recommendation System

Asma Rosyidah, Isti Surjandari and Zulkarnain Zulkarnain (Universitas Indonesia, Indonesia)

09:55

1570434722
Empowering Wearable Sensor Generated Data to Predict Changes in Individual's Sleep Quality

Wahyu Hidayat, Toufan Tambunan and Reza Budiawan (Telkom University, Indonesia)

10:10

1570436422
The Spreading Prediction of Dengue Hemorrhagic Fever (DHF) In Bandung Regency Using K-Means Clustering and Support Vector Machine Algorithm

Mufli Muzakki and Fhira Nhita (Telkom University, Indonesia)

10:25

1570432198
Increasing SDN Network Performance using Load Balancing Scheme on Web Server

I Putu Suwandika (School of Computing, Telkom University, Indonesia); Muhammad Arief Nugroho and Maman Abdurohman (Telkom University, Indonesia)

10:40

1570433834
Social Network Performance Analysis and Content Engagement on Indonesia's E-Commerce Case Studies Tokopedia and Bukalapak

Andry Alamsyah (Telkom University, School of Economics and Business, Indonesia); Affrilia Utami (Telkom University, Indonesia)

10:55

1570417972
Endorsement Recommendation using Instagram Follower Profiling

Anditya Arifianto (Telkom University, Artificial Intelligence Laboratory, ICM Research Group, Indonesia); Qhansa Bayu, Mahmud Dwi Sulistiyo, Ignatius Notonogoro, Naufal Anwari, Muhammad Adhi Satria, Rachmi Azanisa Putri, Isma Dewi Liana, Ni Darmayanti, Pima Safitri and Admining Hastuti (Telkom University, Indonesia)

ROOM 9 – AMBIENT INTELLIGENCE FOR SMART LIVING

FRIDAY, 4 MAY 2018

09:40

1570436417
Enhancing Online Classroom towards Personalized Learning Environment

Dawam Dwi Jatmiko Suwawi, Kusuma Ayu Laksitowening and Irwinda Putri (Telkom University, Indonesia)

09:55

1570427439
A Multi-label Classification on Topics of Quranic Verses in English Translation using Multinomial Naive Bayes

Mohamad Syahrul Mubarok, Reynaldi Pane, Nanang Saiful Huda and A Adiwijaya (Telkom University, Indonesia)

10:10

1570434292
Visual Based Fire Detection System using Speeded Up Robust Feature and Support Vector Machine

Kurniawan Nur Ramadhani (Telkom University, Indonesia)

10:25

1570434092
Development of Low-Cost Autonomous Surface Vehicles (ASV) for Watershed Quality Monitoring

Khafidurrohman Agustianto (Gadjah Mada University, Indonesia)

ROOM 8 – CONNECTING DATA

FRIDAY, 4 MAY 2018

13:00

1570432466
Visiting Time Prediction Using Machine Learning Regression Algorithm

Indri Hapsari (Universitas Indonesia, Universitas Surabaya, Indonesia); Isti Surjandari and Komarudin Komarudin (Universitas Indonesia, Indonesia)

13:15

1570426429
Detection of Atrial Fibrillation Disease Based on Electrocardiogram Signal Classification Using RR Interval and K-Nearest Neighbor

Kartika Findra Resiandi, A Adiwijaya and D Utama (Telkom University, Indonesia)

13:30	**1570431475** **Ontology Modelling Approach for Personality Measurement based on Social Media Activity**	Andry Alamsyah (Telkom University, School of Economics and Business, Indonesia); Muhammad Rizqy Dwi Putra and Darin Fadhilah (Telkom University, Indonesia); Fivi Nurwianti (Universitas Indonesia, Indonesia); Ening Ningsih (Universitas Islam Negeri Sunan Gunung Djati, Indonesia)
13:45	**1570418880** **Sentiment Detection of Comment Titles in Booking.com Using Probabilistic Latent Semantic Analysis**	Dewi Ayu Khusnul Khotimah and Riyanarto Sarno (Institut Teknologi Sepuluh Nopember, Indonesia)
14:00	**1570432249** **Kernelization of Eigenspace-Based Fuzzy C-Means for Topic Detection on Indonesian News**	Mukti Ari and Hendri Murfi (Universitas Indonesia, Indonesia)

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"Improving Node Popularity Calculation using Kalman Filter in Opportunistic Mobile Social Networks"

in the

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Improving Node Popularity Calculation using Kalman Filter in Opportunistic Mobile Social Networks

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***Abstract*—Opportunistic mobile social networks (OMSNs) exploit human mobility to physically carry messages to the destinations. Routing algorithms in these networks typically favour the most popular individuals (nodes) as optimal carriers for message transfers to achieve high delivery performance. The state-of-the-art routing protocol BubbleRap uses a cumulative moving average technique (called C-Window) to identify a node's popularity level, measured in node degree, in a time window. However, our study found that node degree in real-life OMSNs varies quickly and significantly in time, and C-Window moreover slowly adapts to this node degree changes. To tackle this problem, we propose a new method of node degree computation based on the Kalman-filter theory. Using simulation, driven by real human contact traces, we showed that our approach can increase BubbleRap's performance, in terms of delivery ratio and traffic (load) distribution fairness.**

Keywords: node degree, cumulative moving average, Kalman-filter

I. INTRODUCTION

In recent years, opportunistic mobile networks (OMNs) have gained popularity in research and industry as a natural evolution from mobile ad hoc networks (MANETs). OMNs maintain the MANET's basic features of cost-efficiency and self-organization, as nodes still self-organize in order to build multi-hop message transfers without requiring any pre-existing infrastructure. However, they completely redesign the characteristics of networking protocols proposed in MANETs, making them able to support the absence of a stable path between pairs of nodes that wish to communicate. In these networks, forwarding is not "on the fly" since the relay nodes store the messages when no forwarding opportunity exits and exploits their mobility to increase message delivery probability. This forwarding paradigm is known as *store-carry-forward*, and in OMNs node mobility creates opportunities for communication; in contrast, in MANETs node mobility is viewed as a potential disruption. Moreover, OMNs are delay-tolerant in nature since contacts between nodes occur unpredictably because the node's movement is effectively random. Technological advances are leading to a world replete with mobile devices, such as cellular phones, notebooks and gadgets, thus paving the way for a multitude of opportunities for device contacts. Examples of OMNs include animal wildlife monitoring networks [1], vehicular networks [2], and mobile human (social) networks [3].

This paper focuses on opportunistic mobile social networks (OMSNs) (called social pocket switched networks in [3]), a specific scenario of OMNs that exploits contact between mobile devices carried by individuals to enable message forwarding. As the mobile devices are carried by humans, knowledge of social behaviour and structure can be one of the key information sources for designing and providing efficient and effective routing protocols. Moreover, the authors in [4,5,6] showed that humans tend to move in a way that is influenced by their social relations. Consequently, social-based routing algorithms, e.g. [7,8,9], use structural information of individuals in the social network to select optimal carriers for message transfers. In general, we can identify two main properties involved when social-aware routing algorithms make forwarding decisions, namely *social closeness* and *global popularity*. Social closeness exploits a strong (social) relation between two nodes to increase message delivery probability: during a node contact, if either the current node or the contacted node has knowledge of the message destination, the algorithm selects the encountered node as a carrier of the message if it is socially closer to the destination, e.g. the node is in the same community (social clique) with the destination. However, when the destination is unknown to both nodes, the routing algorithm routes the message to a more globally popular node.

This paper aims at improving node (global) popularity calculation in OMSNs. Our contribution in this paper is twofold: first, we confirm that in a real scenario of OMSNs, node popularity varies rapidly and significantly in time. Therefore, detecting a node's popularity level at a time is a non-trivial task in this setting. Indeed, properly identify an instantaneous node popularity is required to keep the routing algorithms' performances high. A prominent social-based routing algorithm in the literature, BubbleRap [7], uses a cumulative moving average technique (called C-window) to calculate a node's popularity level (measured in node degree) in a time interval (or time window). However, we show that the C-Window calculation slowly adapts to the node popularity changes and hence disregards the existence of the fast, significant variations of node popularity in real-life OMSNs. Our second contribution is therefore we propose a new method of OMSN node popularity computation based on the Kalman-filter theory [10]. In mobile communication networks, Kalman-filter has been used in [11,12] to achieve a more accurate

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prediction of the evolution of the context of a host (mobile device), such as battery level, storage space and connectivity change rate. Our work, to the best of our knowledge, is the first one that applies Kalman-filter on node popularity calculation in OMSNs. Using simulation driven by real human contact traces, we furthermore show that our approach can increase BubbleRap's performance, in terms of delivery success ratio and traffic (load) distribution fairness.

The rest of the paper is organized as follows. In Section II, we discuss OMSN node popularity change characteristics. Our proposed method of node popularity computation based on the Kalman-filter theory is given in Section III. Section IV describes the performance improvement of BubbleRap when it applying our method in real-life OMSNs. Finally, Section V concludes the paper.

II. Node Popularity Change Characteristics

In social network analysis (SNA), node popularity in a (social) network can be evaluated by a centrality metric. Centrality can be seen as a quantitative measure of the structural importance of a given node within the graph, e.g. the Freeman's centrality metrics [13], i.e. degree centrality, betweeness centrality and closeness centrality. Degree centrality, the simplest one, is defined as the number of links incident upon a given node. It is a local metric as it is only determined by the number of neighbours of the node. The other two are based on measuring shortest paths to quantify the relevance of a node. On the one hand, there is closeness centrality, which can be defined as the total geodesic (i.e. shortest path) distance from a given node to all other nodes. On the other hand, there is betweeness centrality that can be defined as the number of shortest paths passing through a given node. Both centrality metrics take into account the global structure of the network; therefore, their computations require complete network information, which is not normally available in the networks with very long transfer delays, such as OMSNs.

In OMSNs, the most popular individuals (hub nodes) can be seen as good candidates to be relay nodes for message transfers. In these networks, node popularity depends on a node's own social behaviour, which in turn depends on its sociability level or mobility pattern in the network. A higher sociability level or mobility rate results in a node that is more popular in the network and hence is a better candidate to act as an information carrier. In practice, this measure can be quantified by looking at metrics such as connectivity change rate [11,14] or the number of distinct nodes encountered in a given time interval [7]. In the literature, the latter is equal to the node degree centrality (or node degree in the graph theory) in an aggregated contact graph. Moreover, BubbleRap [7] uses the C-window technique for determining node degree in a time interval (or time window). This technique is a cumulative moving average that determines node i's degree value in a time window t, denoted $\overline{d_i}(t)$, by calculating the node degree value averaged over all previous time windows as follows

$$\overline{d_i}(t) = avg(d_i(t-1),\ d_i(t-2), \ldots,\ d_i(0)) \qquad (1)$$

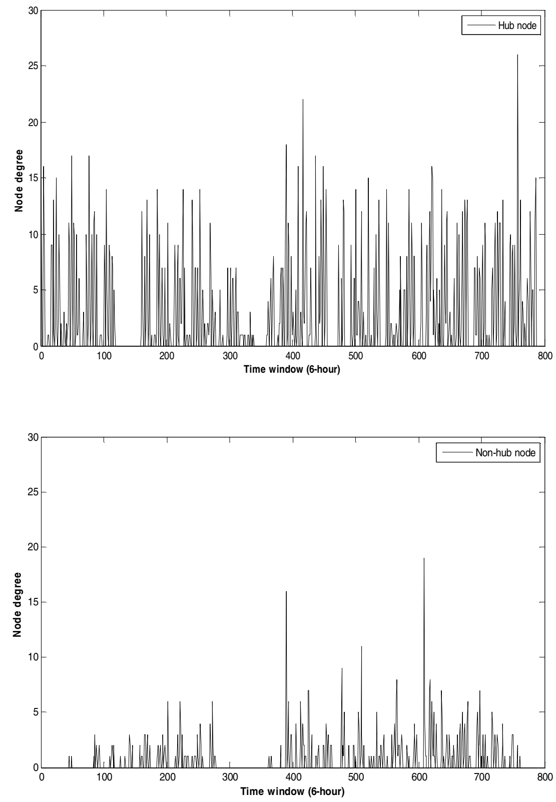


Fig. 1. The changes of popularity level (measured in node degree) of an illustrative hub node (upper) and non-hub node (lower) in Reality

However, our following investigation shows that node popularity in real-life OMSNs varies rapidly and significantly in time; it is therefore important to consider these characteristics when calculating a node's popularity level at a time.

In this study, we use a real human contact dataset, namely Reality [15]. This dataset captured academic activities of the students and staffs of Massachusetts Institute of Technology (MIT) over an academic year. In Fig. 1, we depict the changes of node popularity level, measured in node degree, of an illustrative hub node and non-hub node in Reality. Here, a node's degree value in a time window is calculated as the number of distinct nodes encountered aggregated in a 6-hour time interval: we choose this calculation since we agree with the authors of BubbleRap in that human daily life intuitively can be divided into 4 main periods: morning, afternoon, evening and night - each almost 6 hours.

Fig. 1 shows that the popularities of both nodes vary rapidly in time, with the significant changes mainly occur in the hub node. Furthermore, as we show later in Section IV.B, the C-window calculation (1) fails to capture this such changes of node degree in OMSNs. This therefore motivates us to improve the C-window method of BubbleRap, and eventually we propose the Kalman-filter prediction technique [10] used to estimate a node's degree value at a given time interval. Kalman-filter was originally developed in the control systems theory. The technique is the minimum-variance state estimator for linear dynamic systems with Gaussian noise. Even if the noise is non-Gaussian, Kalman-filter is the best linear estimator [16].

III. Node Popularity Calculation using Kalman-Filter

We now discuss a new approach of OMSN node degree computation using the Kalman-filter prediction technique. In this method, node degree values in all previous time windows are considered as a discrete time series. Subsequently, they are treated as inputs to the Kalman-filter system in order to estimate a node's degree value in the current time window. We now show our estimation model derived based on the Kalman-filter theory. We use a state space model [17] to describe our problem. A state space model for a time series Y_t is composed of the following two scalar equations. The first one is the observation equation as follows

$$Y_t = X_t + W_t , \qquad t = 1,2, \ldots$$

with $W_t = WN(0, Q_t)$ is white noise with zero mean and variance Q_t. The second one called the state equation is the following

$$X_{t+1} = X_t + V_t , \qquad t = 1,2, \ldots$$

with $V_t = WN(0, R_t)$. We assume that V_t is uncorrelated with W_t and the initial state X_1 is uncorrelated with all of the noise terms V_t and W_t. We now briefly describe the derivation of the Kalman-filter prediction for this state space model. With the notation of $P_t(X)$, we refer to the best linear predictor of X in term of Y at time t as follows

$$P_t(X) \equiv P(X \mid Y_0, Y_1, Y_2, \ldots , Y_t)$$

From [18], it is possible to prove that the one step predictor $\hat{X}_t \equiv P_{t-1}(X_t)$ and its covariance $\Omega_t = E\left[(X_t - \hat{X}_t)^2\right]$ are determined by these initial conditions

$$\hat{X}_1 = P(X_1 | Y_0)$$

$$\Omega_1 = E\left[\left(X_1 - \hat{X}_1\right)^2\right]$$

and this recursive equation

$$\hat{X}_{1+1} = \hat{X}_t + \frac{\Omega_t}{\Omega_t + R_t}(Y_t - \hat{X}_t) \qquad (2)$$

with

$$\Omega_{t+1} = \Omega_t + Q_t - \frac{{\Omega_t}^2}{\Omega_t + R_t}$$

We eventually use (2) to calculate a node's popularity value at time window t as follows: given the previous observed node degree value at time window $t-1$, denoted d_{t-1}, and the predicted node degree value at time window $t-1$, denoted $\hat{d}_{t-1}$, the node degree value at time window t, $\hat{d}_t$, is estimated using (2).

TABLE I. The simulation main parameters

Simulation Parameters		
Mobility scenario	Reality	Sassy
Number of nodes	100	25
Simulation time	16981816 sec (~ 196 days)	6413284 sec (~ 74 days)
Msg. creation interval	~ 12 msgs/h	~ 6 msgs/h
Node buffer size	20 MB	
Message TTL	7 days	
Message size	10 kB	

IV. Performance Evaluation

A. Simulation Setup

To investigate the performance of our proposed method of node degree computation, we consider BubbleRap routing [7]. BubbleRap was developed based on two aspects of society: *community* and *popularity*. Community is defined as a subset of nodes with stronger connections among themselves than towards other nodes. It usually implies a social group, e.g. friends, family, co-workers etc. Consequently, in this algorithm each node has global popularity in the entire network and also local popularity within its community. When either a node or its contact is in the message destination's community, local popularity is considered in the forwarding decision. However, when the destination is unknown to both nodes, the algorithm selects the contacted node as a carrier of the message if its global popularity is higher than the current node's. BubbleRap uses node degree to quantify both node global and local popularities. Here, node degree is determined as a count of the unique nodes seen by the node during a certain time window. A cumulative moving average (C-window) technique is subsequently used to smoothing the value of node degree.

In this paper, we only focus on improving node global popularity calculation in OMSNs: we improve BubbleRap by applying Kalman-prediction on the computation of node global popularity (hereafter, we call this improved algorithm *Bubble-Kalman*). In consequence, to calculate node local popularity in a given community we follow BubbleRap that uses C-window. Finally, we compare the delivery performance of BubbleRap with that of Bubble-Kalman in real-life OMSNs.

We implement both algorithms using the ONE simulator [19], an event-driven simulator for opportunistic networks. The main simulation parameters for the evaluation are given in TABLE 1. The number of nodes and the length of simulation time vary depending on the node mobility scenario. For the simulation's node mobility scenario, we use real human contact data traces, namely Reality [15] and Sassy [20]. In Reality, 100 smart phones were deployed among the students and staffs of MIT over period of 9 months. It captured academic activities in the campus over an academic year. In contrast, the Sassy trace was collected using a mobile sensor network with TMote invent devices carried by 25 participants from the University of St. Andrews for period of 74 days. For community detection, we use the *k*-clique distributed community detection algorithm proposed by Hui *et.al* [21] for both BubbleRap and Bubble-Kalman. For the *k*-clique parameters, we choose k=5 and a familiar threshold T_{th}=250ks for Reality, and k=3 and T_{th}=3ks for Sassy.

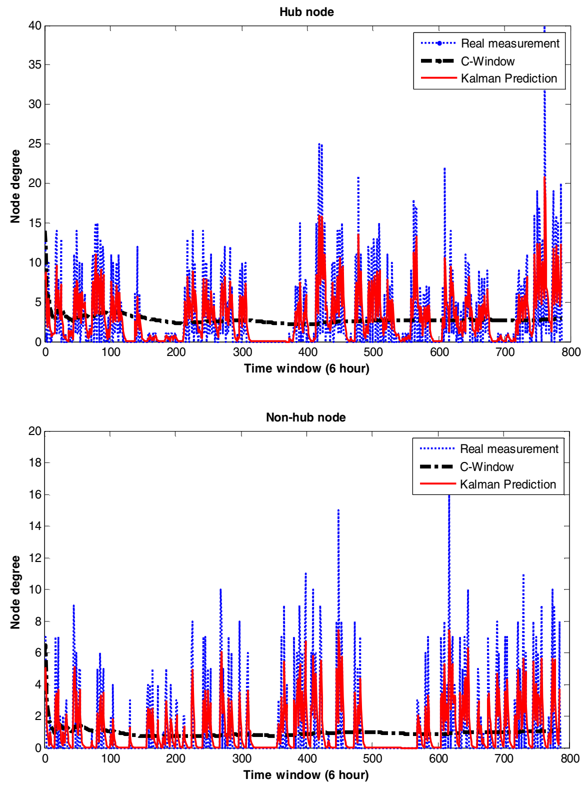


Fig. 2. Time series for node degree values of an illustrative hub node (upper) and non-hub node (lower) in Reality, comparing the measured value, the C-window estimate, and the Kalman prediction values

For performance analysis, we use several evaluation metrics as follows:

a) **Delivery ratio**: the ratio of the number of messages successfully delivered divided by the total number of message created.

b) **Delivery delay**: the time between the creation of a message and the delivery of the message to its final destination.

c) **Message overhead ratio**: the ratio of the number of overhead messages to the number of messages successfully delivered. The total number of overhead messages is calculated as the total forwarded (copy) messages minus the total number of messages successfully delivered.

d) **GINI index**: this measure [22] of statistical dispersion calculates the inequality among values of a frequency distribution. In this paper, the GINI index gauges the traffic distribution fairness level in the network, i.e. an index of 0 means that the traffic is distributed evenly, and a value of 1 indicates only a single node processes all the network traffic.

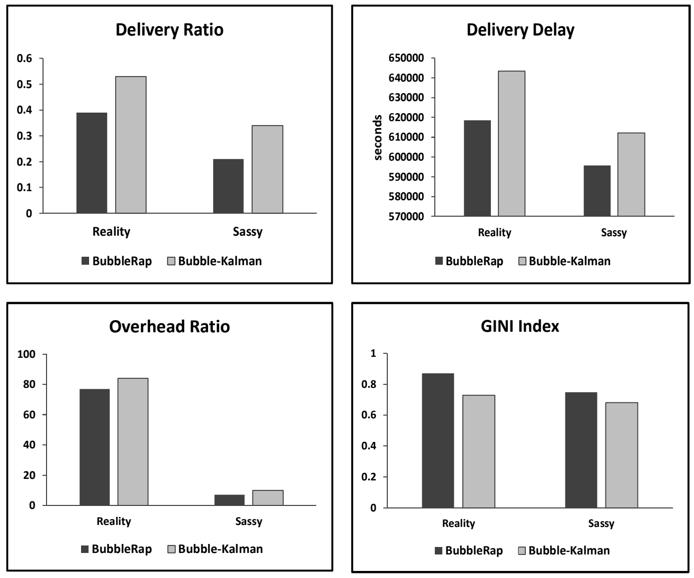


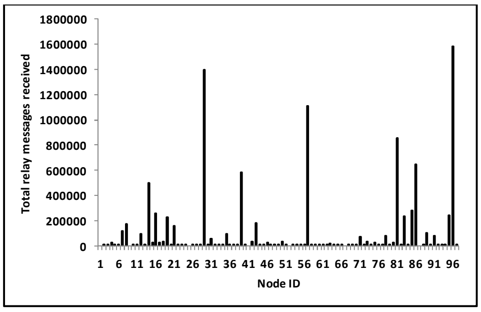
Fig. 3. Delivery performances of BubbleRap and Bubble-Kalman in Reality and Sassy

B. Simulation Results

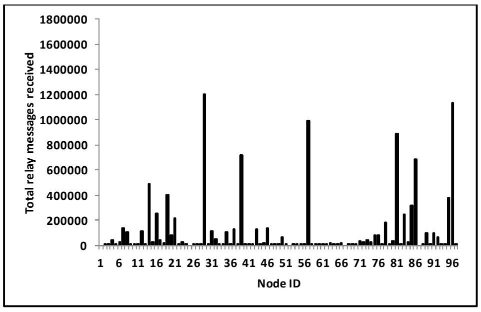
We now discuss the simulation results of BubbleRap and Bubble-Kalman in two node mobility scenarios, Reality and Sassy. Initially, in Fig. 2 we depict the degree value of an illustrative hub node and non-hub node in a time series in Reality. For each time window (i.e. a 6-hour time interval), a node degree level is calculated using real measurement (d_t), C-window ($\bar{d}_t$) and Kalman-prediction ($\hat{d}_t$). It is clear from the figure that Kalman-prediction captures the variations of node degree values and hence provides better estimates of the node popularity in a given time window than C-window (i.e. $\hat{d}_t$ is a better estimator of d_t than $\bar{d}_t$). C-window slowly adapts to the node popularity changes and thus disregards the existence of the rapid, significant variations of node degree, particularly in the most popular node.

We next consider the delivery performance of BubbleRap and Bubble-Kalman. In Fig. 3, we show the performance evaluation results of BubbleRap and Bubble-Kalman in Reality and Sassy. The evaluation metrics described in Section IV.A are considered in this performance analysis.

In Fig. 3, we see that Bubble-Kalman produces in a better message delivery ratio in both Reality and Sassy. Moreover, the improvement in delivery ratio is not associated with an increase in delivery cost (measured by the overhead ratio), and Bubble-Kalman manages this cost as well as BubbleRap. On the other hand, Bubble-Kalman can improve the BubbleRap's traffic distribution fairness (measured by GINI index) in both node mobility scenarios and the decrease in GINI index is more obvious in Reality. However, Bubble-Kalman increases the average delivery delay beyond that of BubbleRap in both scenarios. Bubble-Kalman's worse delivery latency performance is related to the reduced traffic at the most popular node (hub nodes). As shown in Fig. 3 (GINI Index), Bubble-Kalman has a lower GINI index than BubbleRap's; hence it produces a better traffic (load) distribution.



(a) BubbleRap



(b) Bubble-Kalman

Fig. 4. Total relay messages received by each node in Reality for BubbleRap (upper) and Bubble-Kalman (lower)

Even though the decrease in GINI index seems insignificant in both mobility scenarios, in fact the total traffic processed by hub nodes is reduced considerably. For instance, in Fig. 4(a) and 4(b) we show the total relay messages received by each node in Reality for BubbleRap and Bubble-Kalman, respectively. It is clear that Bubble-Kalman is able to significantly reduce the total relay traffic in a few hub nodes. However, when Bubble-Kalman successfully redirects much of the traffic away from the hub nodes, this leads to a significant increase of the delivery latency in the network (Fig. 3 (Delivery Delay)). Since the message deliveries in the network now prefer to use alternative paths (rather than shortest-paths via hub nodes), this leads to the increase of the overall network delivery latency. Thus we see a trade-off between traffic (load) distribution fairness and delivery delay performance.

In the literature, several papers highlight an important issue of unbalanced traffic (load) distribution in OMSNs: the works in [23,24,25,26] have identified that favouring higher popularity nodes contributes to the unfair traffic distribution in the network. The authors of SimBet [8] found that use of (ego) betweeness centrality alone as the routing metric yielded traffic overloading at the central (hub) nodes. In this paper, on the other hand, we show that Bubble-Kalman is able to reduce traffic in a few hub nodes, leading to the increase in traffic distribution fairness in the network; however, this increases delivery latency beyond that of BubbleRap. Given that OMSNs are assumed to be delay-tolerant, this increase in delivery time is not considered significant; instead, the reduced load on the most popular nodes, reflected in the improved GINI index, represents a substantial improvement in the performance of the network.

V. Conclusions

This paper presents two important contributions in the area of node popularity computation in OMSNs: firstly, we confirmed that in real-life OMSNs node popularity changes rapidly and significantly in time. Moreover, the C-window calculation of BubbleRap is insensitive to this such node degree changes. Secondly, we therefore proposed the Kalman-prediction technique used to identify a node's global popularity level at a time interval. We next applied our method on BubbleRap (called Bubble-Kalman hereafter). We showed that Bubble-Kalman achieves better delivery ratio and increases traffic distribution fairness, reducing the GINI index below that of BubbleRap, but at the cost of high delivery latency beyond that of BubbleRap. Given that OMSNs are assumed to be delay-tolerant, this increase in delivery time represents an acceptable trade-off compared to the improved fairness in the network and the reduced resource consumption in the most popular nodes.

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