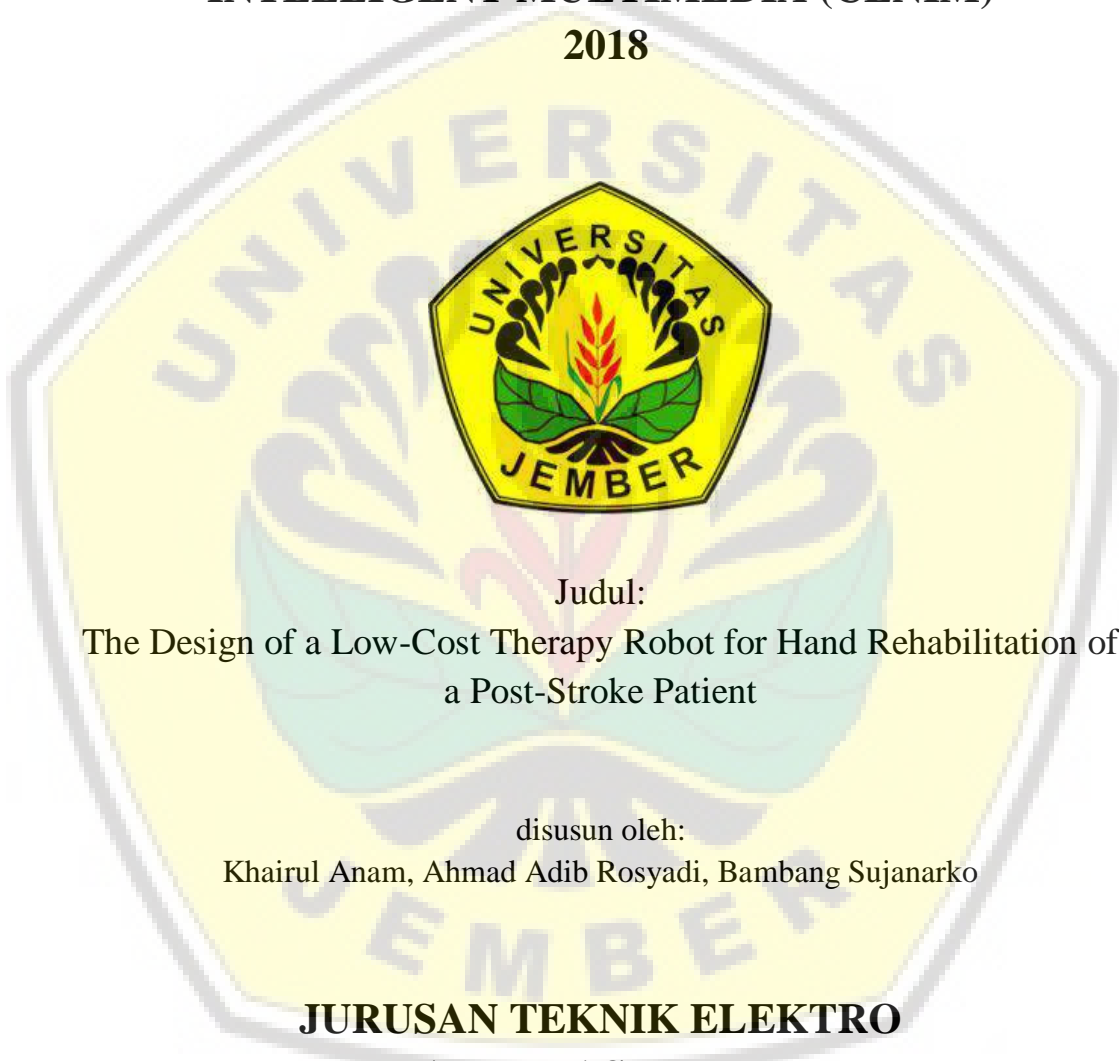


**MAKALAH ILMIAH
PROSIDING SEMINAR INTERNASIONAL
TERINDEKS SCOPUS**

**THE INTERNATIONAL CONFERENCE ON
COMPUTER ENGINEERING, NETWORK AND
INTELLIGENT MULTIMEDIA (CENIM)
2018**



Judul:

The Design of a Low-Cost Therapy Robot for Hand Rehabilitation of
a Post-Stroke Patient

disusun oleh:

Khairul Anam, Ahmad Adib Rosyadi, Bambang Sujanarko

**JURUSAN TEKNIK ELEKTRO
FAKULTAS TEKNIK
UNIVERSITAS JEMBER
2018**

Diseminarkan di Contemporary Surabaya, Indonesia
26 - 27 Nopember 2018

**CENIM
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2018 INTERNATIONAL CONFERENCE ON COMPUTER ENGINEERING, NETWORK AND INTELLIGENT MULTIMEDIA (CENIM)

IEEE Part Number : CFP18NIM-ART
ISBN 978-1-5386-7509-0

NOVEMBER 26-27, 2018
SURABAYA, INDONESIA



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ENGINEERING, NETWORK AND INTELLIGENT
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PROCEEDING



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Proceeding

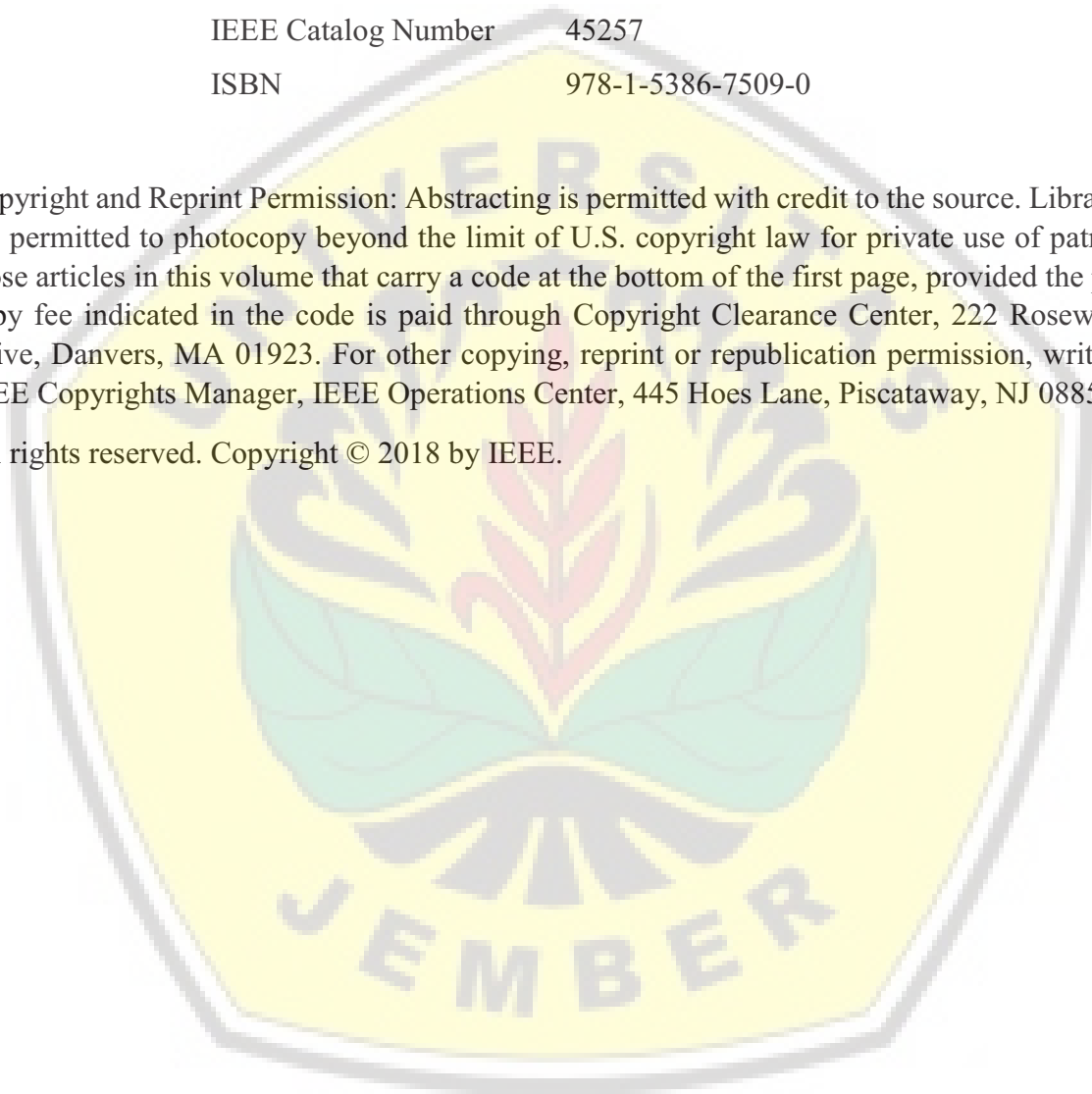
2018 International Conference on Computer Engineering, Network and Intelligent Multimedia (CENIM) took place November 26-27, 2018 in Surabaya, Indonesia.

IEEE Catalog Number 45257

ISBN 978-1-5386-7509-0

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MESSAGE FROM THE GENERAL CHAIRMAN

Welcome to Surabaya and welcome to our Joint International Conference, International Conference on Computer Engineering, Network and Intelligent Multimedia (CENIM 2018) and The 11th AUN/SEED-Net Regional Conference on Computer and Information Engineering (RC CIE). The theme of this joint conference is "Sharpening the Contribution of Computer Engineering and Telematics in Smart City to Improve the Quality of Human Life". CENIM 2018 is an international conference that is organized by The Department of Computer Engineering - Institut Teknologi Sepuluh Nopember (DCE-ITS), and has been approved by IEEE for technical co-sponsorship. This conference is an excellent event where researchers and engineers from academia and industry, majority locally from Indonesia as well as from abroad, to meet and share their recent findings for the advancement of the field in Computer Engineering and its application.

The Regional Conference Program (RC) is a platform to share the most updated technology and research in regional common issues. It aims at maximizing the outreach of the AUN/SEED-Net for stronger impacts by involving external participants such as representatives from the government, industry, community, non-Member Institutions (MIs), and other professional organizations.

In our records, CENIM 2018 has received 147 paper submission with authors coming from 9 different countries. This conference has accepted 83 papers for presentation from 6 countries such as Malaysia, Singapore, Hong Kong, Japan, Vietnam and India. While, RC CIE 2018 has received 61 paper submission and accepted 38 papers for presentation. The RC CIE authors are mainly from the AUN/SEED-Net region. The topics of the papers are various including Biomedical Signal and Image Processing, Computer and Communication Networks, Game Technology and Game Engineering, Information System and Management, Soft Computing, Embedded System, and also ICT in Smart City.

This conference has received tremendous help and support. Therefore, we would like to thank all the international advisory board, technical programme committee (TPC) for their contribution to reviews and selecting high-quality paper. We would also like to thank AUN/SEED-Net for their generous support and contributions to the conference. We also thank PT Telkomsigma for the support in organizing the conference. Our gratitude also goes to Lembaga Penelitian dan Pengabdian Masyarakat (LPPM), Institut Teknologi Sepuluh Nopember, Surabaya, distinguished invited speakers who are experts in the topics related to the theme of the conference, and members of the local organizing committee, for their teamwork at preparing the conference.

Lastly, we hope that you can have a great time at the conference, and we wish you a pleasant stay in Surabaya, Indonesia.

Dr. I Ketut Eddy Purnama
General Chairman

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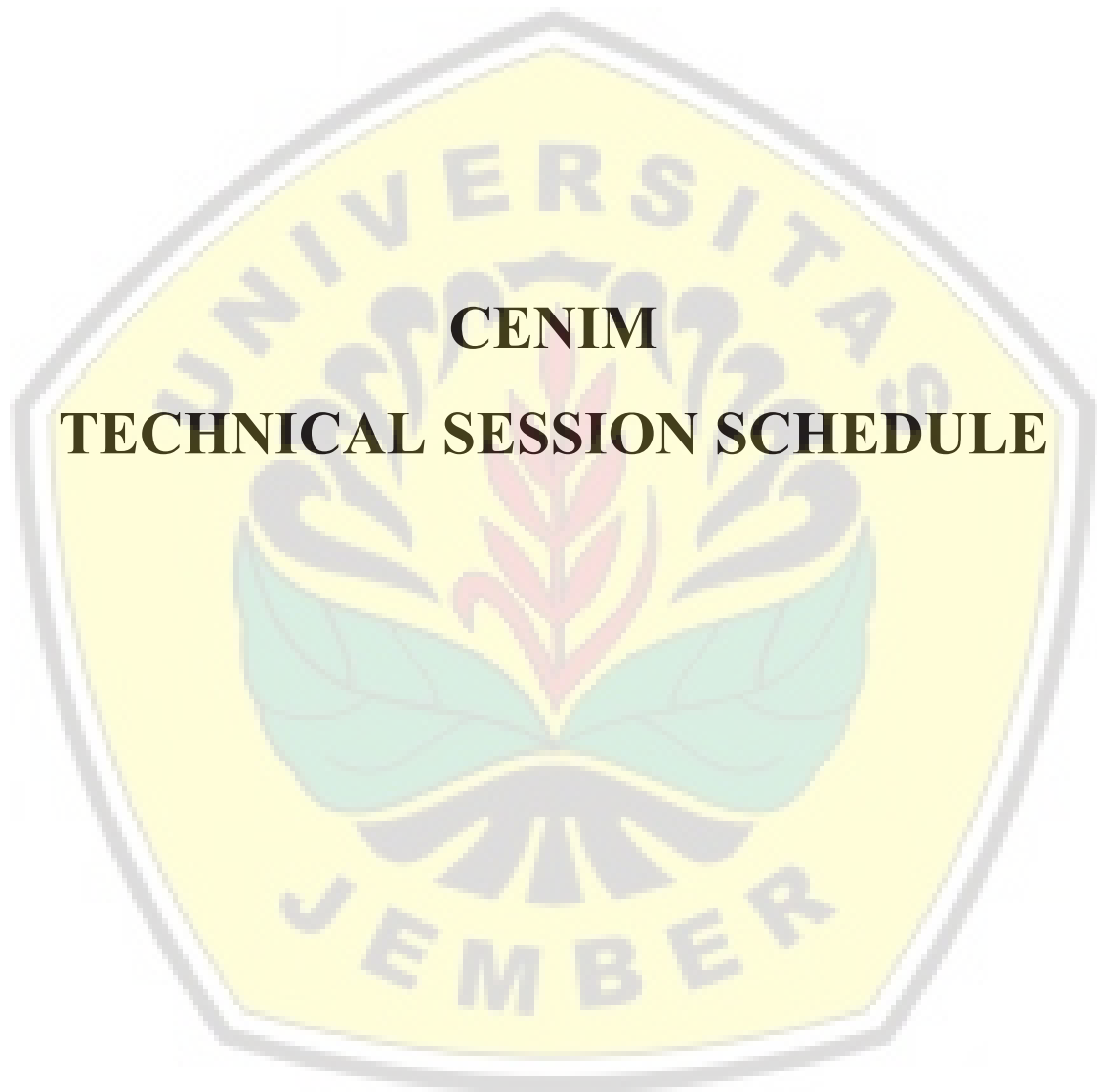
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Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh Nopember, Indonesia)



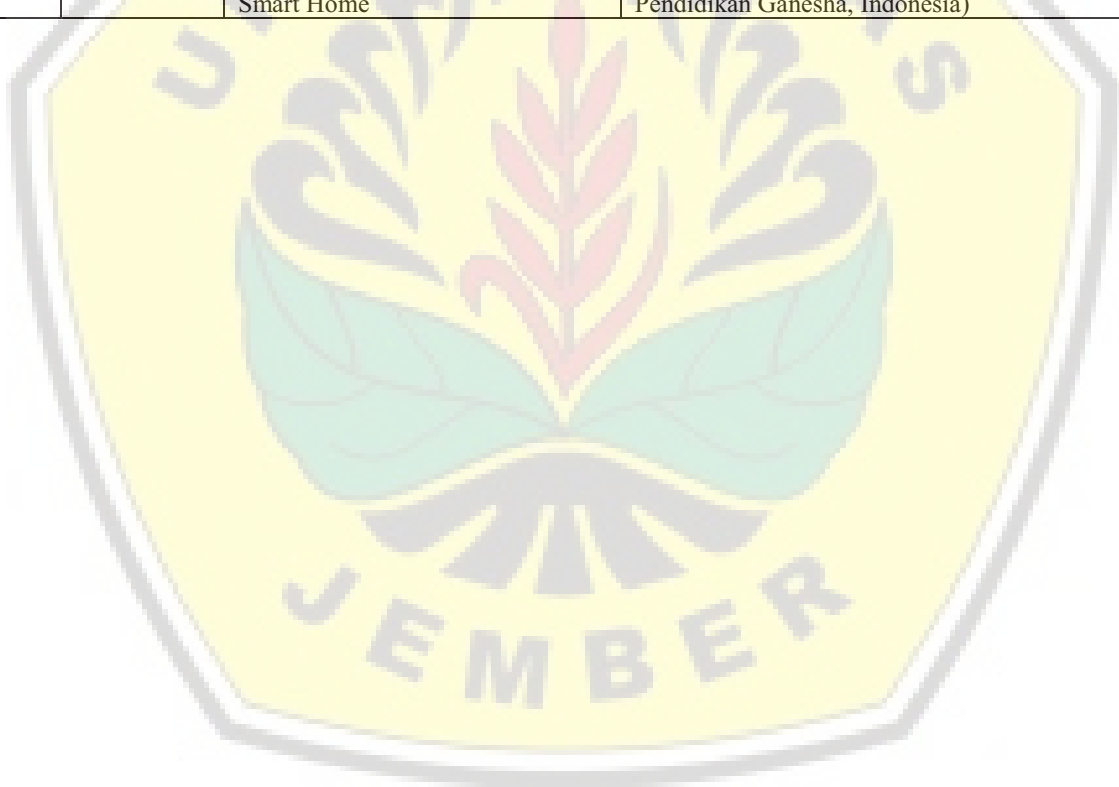


Session 1 - Track: Biomedical Signal and Image Processing 1 Monday, 26th November 2018, 15.15 - 17.15, Java Room

Code	Paper ID	Title	Authors
BI01	1570497587	Semi Automatic Method for Basal Ganglia and White Matter Lesion Segmentation in MRI of Cronic Stroke Patients	Andi Nugroho and I Ketut Eddy Purnama (Institut Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); Terawan Putranto (RSPAD Gatot Subroto, Indonesia)
BI02	1570486441	Visualization of Epilepsy Patient's Brain Condition based on Spectral Analysis of EEG Signals using Topographic Mapping	Diah Wulandari and Thalia Elyantono (Institut Teknologi Sepuluh Nopember Surabaya, Indonesia); Yoyon Suprpto and Santi Wulan Purnami (Sepuluh Nopember Institute of Technology, Indonesia); Anda Juniani (Shipbuilding Institute of Polytecnic Surabaya, Indonesia); Wardah Islamiyah (Univeristas Airlangga, Surabaya, Indonesia)
BI03	1570490250	Channel Selection of EEG Emotion Recognition using Stepwise Discriminant Analysis	Evi Pane (Institut Teknologi Sepuluh Nopember & Industrial Training Centre of Surabaya, Ministry of Industry, Indonesia); Adhi D Wibawa (Institute Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)
BI04	1570489729	Comparison of Tuberculosis Bacteria Classification from Digital Image of Sputum Smears	Lalitya Nindita Sahenda and I Ketut Eddy Purnama (Institut Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); I Dewa Gede Hari Wisana (Politeknik Kesehatan Surabaya, Indonesia)
BI05	1570493680	Analysis on Human Heart Signal during Sad Video Stimuli using Heart Rate Variability Triangular Index (HRVi)	Lantana Dioren Rumpa (Universitas Kristen Indonesia Toraja, Indonesia); Adhi D Wibawa (Institute Teknologi Sepuluh Nopember, Indonesia); Muhammad Attamimi (Institut Teknologi Sepuluh Nopember, Indonesia); Petrus Sampelawang and Srivan Palelleng (Universitas Kristen Indonesia Toraja, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)
BI06	1570492334	Classification of EEG Signal for Detecting Cybersickness through Time Domain Feature Extraction using Naïve Bayes	Mochammad Asyroful Mawalid (Institut Teknologi Sepuluh Nopember, Indonesia); Alfi Khoirunnisaa (Insitut Teknologi Sepuluh November, Indonesia); Adhi D Wibawa (Institute Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)

Session 1 - Track: Computer and Communication Networks 1
Monday, 26th November 2018, 15.15 - 17.15, Flores Room

Code	Paper ID	Title	Authors
CN01	1570486884	Enhancing Channel Reciprocity of Secret Key Generation Scheme by Using Modified Polynomial Regression Method	Mike Yuliana (EEPIS, Indonesia); Iwan Wirawan and Suwadi Suwadi (ITS, Indonesia)
CN02	1570486843	An Implementation of Secure Monitoring System to Track Member in a Tour Group Using Group Signature	Amang Sudarsono (Politeknik Elektronika Negeri Surabaya (PENS), Indonesia); Mike Yuliana (EEPIS, Indonesia); Prima Kristalina (Politeknik Elektronika Negeri Surabaya (PENS), Indonesia)
CN03	1570486613	Audio Data Hiding Using Octal Modulus Function Based Unsigned Integer Samples Values	Mohammed Hatem Al-Hooti (Institut Teknologi Sepuluh Nopember (ITS), Indonesia); Tohari Ahmad (Institut Teknologi Sepuluh Nopember (ITS), Indonesia); Supeno Djanali (Sepuluh Nopember Institute of Technology, Indonesia)
CN04	1570490219	Energy Monitoring and Sensor Devices Management for the Internet of Things (IoT) Based Smart Home	I Komang Agus Ady Aryanto (STMIK STIKOM Bali, Indonesia); Gede Suweken, Gede Indrawan and Kadek Yota Ernanda Aryanto (Universitas Pendidikan Ganesha, Indonesia)



Session 1 - Track: Soft Computing 1
Monday, 26th November 2018, 15.15 - 17.15, Banda Room

Code	Paper ID	Title	Authors
SC01	1570490255	Performance Comparison of Biometric System with and without EVCS: Study Case for Palmprint Authentication System	Rosmawati Dwi (STMIK Raharja, Indonesia); Lukas Lukas (Universitas Katolik Indonesia Atma Jaya, Indonesia)
SC02	1570489942	An Improved Secret Message Capacity Using Modulus Function Based Color Image Data Hiding	Mohammed Hatem Al-Hooti (Surabaya, Sukelilo, Institut Teknologi Sepuluh Nopember (ITS), Yemen); Supeno Djanali (Sepuluh Nopember Institute of Technology, Indonesia); Tohari Ahmad (Institut Teknologi Sepuluh Nopember (ITS), Indonesia)
SC03	1570487145	Utilization of Hexadecimal Numbers In Optimization of Balinese Transliteration String Replacement Method	Arik Aranta and IGede Aris Gunadi (Ganesha University of Education, Indonesia); Gede Indrawan (Universitas Pendidikan Ganesha, Indonesia)
SC04	1570490318	On The Comparison: Random Forest, SMOTE-Bagging, and Bernoulli Mixture to Classify Bidikmisi Dataset in East Java	Wahyuni Suryaningtyas (Muhammadiyah University of Surabaya, Indonesia); Nur Iriawan, Kartika Fithriasari, Brodjol Ulama, Sinta S. Pangastuti, Nita Cahyani and Laila Qadrini (Institut Teknologi Sepuluh Nopember, Indonesia)
SC05	1570486861	Adding an Emotions Filter to Javanese Text-to-Speech System	Edy Mulyanto (Universitas Dian Nuswantoro & Institut Teknologi Sepuluh Nopember, Indonesia); Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh November, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)

Session 1 - Track: Embedded System 1
Monday, 26th November 2018, 15.15 - 17.15, Celebes Room

Code	Paper ID	Title	Authors
ES01	1570487527	Conflict of Interest based Features for Expert Classification in Bibliographic Network	Diana Purwitasari (Institut Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); Chastine Fatichah (Institut Teknologi Sepuluh Nopember, Indonesia); Surya Sumpeno (Institute Teknologi Sepuluh Nopember, Indonesia); Willy Achmat Fauzi and Akhmad Bakhrul Ilmi (Institut Teknologi Sepuluh Nopember, Indonesia)
ES02	1570490092	A Configurable High-Frequency SSB Signal Generation Method using SDR Approach Implemented on System-on-Chip FPGA	Tuan Do Trong and Ha Duyen Trung (Hanoi University of Science and Technology, Vietnam)
ES03	1570489592	Gas Source Localization Using an Olfactory Mobile Robot Equipped With Wind Direction Sensor	Helmy Widyantara, Muhammad Rivai and Djoko Purwanto (Institut Teknologi Sepuluh Nopember, Indonesia)
ES04	1570487191	PID-MPC Control Design To Control Oil Temperature In Main Fermentor Machine PT.Cheil Jedang, Jombang-Indonesia	Amirul Hakam and Mardlijah Mardlijah (Institut Teknologi Sepuluh Nopember, Indonesia); Didik Khusnul Arif (Institut Teknologi Sepuluh Nopember Indonesia, Indonesia)
ES05	1570486865	Design of a Low-Cost Therapy Robot for Hand Rehabilitation of a Post-Stroke Patient	Khairul Anam, Ahmad Rosyadi and Bambang Sujanarko (University of Jember, Indonesia)

Session 1 - Track: ICT in Smart City 1
Monday, 26th November 2018, 15.15 - 17.15, Ballroom B1 Room

Code	Paper ID	Title	Authors
IT01	1570486916	Study of Overcurrent Relay Coordination Using Non-Standard Tripping Characteristic Method in 150 kV and 20 kV Network of PT. PLN (LTD) APJ Gilimanuk	Margo Pujiantara, Vincentius Raki Mahindara and Talitha Puspita Sari (Institut Teknologi Sepuluh Nopember, Indonesia)
IT02	1570486269	Speed Monitoring for Multiple Vehicle Using Closed Circuit Television (CCTV) Camera	Arief Kurniawan (Institut Teknologi Sepuluh Nopember, Indonesia); Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh Nopember, Indonesia); Aldiansyah Ramadlan (Institut Teknologi Sepuluh Nopember, Indonesia)
IT03	1570482325	ISO 9126 Quality Model for Evaluation of Student Academic Portal	Haerullah Haerullah (College of Information & Computer Management (STMIK) Samarinda, Indonesia); Dolly Indra (Universitas Muslim Indonesia, Indonesia); Masna Wati (Universitas Mulawarman, Indonesia); Muh Jamil (Universitas Mulawarman & Departemen Of Information Technology And Computer Science, Indonesia); Hafizdzaki Mono Cikadiwa and Edy Budiman (Universitas Mulawarman, Indonesia)
IT04	1570486631	Analysis of Factors Affecting the Acceptance Rate of BloobIS Application	Tony Dwi Susanto (ITS, Indonesia)
IT05	1570486282	Coast Panic-Emergency Situation Monitoring System on West and East Sailing Lane of Surabaya Using LORAWAN Technology	Eko Pramunanto and Maria Ulfa (ITS, Indonesia); Arief Kurniawan (Institut Teknologi Sepuluh Nopember, Indonesia)

Session 1 - Track: ICT in Smart City 2
Monday, 26th November 2018, 15.15 - 17.15, Ballroom B2 Room

Code	Paper ID	Title	Authors
IT06	1570492197	Heart Rate Monitoring Device for Arrhythmia Using Pulse Oximeter Sensor Based on Android	Lanny Agustine, Albert Gunadhi, Ivan Muljono, Diana Lestariningsih and Peter Angka (Widya Mandala Catholic University Surabaya, Indonesia); Widya Andyardja Weliamto (Nanyang Technological University, Singapore)
IT07	1570492381	MatCounter: Footsteps Counter Using DanceMat by Bluetooth Based Android Application	Birou Novi Cahyani, Sri trusta Sukaridhoto and Hestiasari Rante (Politeknik Elektronika Negeri Surabaya, Indonesia)
IT08	1570478030	IoT-Enabled Door Lock System	Syifaul Fuada (Institut Teknologi Bandung, Indonesia); Trio Adiono (STEI ITB, Indonesia); Sinantya Feranti Anindya, Trio Adiono and Maulana Yusuf Fathany (Institut Teknologi Bandung, Indonesia); Irfan Purwanda (Pusat Mikroelektronika Institut Teknologi Bandung, Indonesia)
IT09	1570484440	Using A Smart Plug based on Consumer Electronics to Support Low-Power Smart Home	Syifaul Fuada (Institut Teknologi Bandung, Indonesia); Trio Adiono (STEI ITB, Indonesia); Sinantya Feranti Anindya (Institut Teknologi Bandung, Indonesia); Irfan Purwanda (Pusat Mikroelektronika Institut Teknologi Bandung, Indonesia)

Session 2 - Track: Biomedical Signal and Image Processing 2
Tuesday, 27th November 2018, 08.00 - 10.00, Java Room

Code	Paper ID	Title	Authors
BI07	1570487183	An image preprocessing method for kidney stone segmentation in CT scan images	Nilar Thein, Hanung Adi Nugroho and Teguh Bharata Adji (Universitas Gadjah Mada, Indonesia); Kazuhiko Hamamoto (Tokai University, Japan)
BI08	1570492324	Performance of Color Cascading Framework on Different Color-Space for Malaria Identification	Ari Kusumaningsih, Yonathan Ferry Hendrawan, Cucun Very Angkoso and Rima Tri Wahyuningrum (University of Trunojoyo Madura, Indonesia)
IS01	1570486929	Automatic Control Using Fuzzy Techniques For Energy Management On Smart Building	Nur Iksan (Universitas Negeri Semarang, Indonesia); Erika Devi Udayanti (Universitas Dian Nuswantoro, Indonesia); Arief Arfriandi (Semarang State University (UNNES), Indonesia); Djoko Adi Widodo (Universitas Negeri Semarang, Indonesia)
IS02	1570492206	Web-based Business to Customer (B2C) Implementation on the Unmanned Aerial Vehicle (UAV) Drone Services Business	Muhammad Setiawan (Jalan Raya ITS Kampus PENS, Indonesia); Firlian Fitriani Mashita (Airlangga University, Indonesia); Sritrusta Sukaridhoto and Hestiasari Rante (Politeknik Elektronika Negeri Surabaya, Indonesia)

Session 2 - Track: Computer & Communication Networks 2
Tuesday, 27th November 2018, 08.00 - 10.00, Flores Room

Code	Paper ID	Title	Authors
CN05	1570485695	Internet of Things for Monitoring and Controlling Nutrient Film Technique (NFT) Aquaponic	Ahmad Zaini, Arief Kurniawan and Andre Herdhiyanto (Institut Teknologi Sepuluh Nopember, Indonesia)
CN06	1570497322	Implementation of Object Following Method on Robot Service	Ketut Purnama and M. Ardi Pradana (ITS, Indonesia); Muhtadin Muhtadin (Institut Teknologi Sepuluh Nopember, Indonesia)
CN07	1570490101	Training Strategies for Remo Dance on Long Short-Term Memory Generative Model	Lukman Zaman (Sekolah Tinggi Teknik Surabaya, Indonesia); Surya Sumpeno (Institut Teknologi Sepuluh Nopember, Indonesia); Mochamad Hariadi (Sepuluh Nopember Institute of Tech. Surabaya, Indonesia)
CN08	1570489788	Design of Wireless Sensor Network (WSN) with RF Module for Smart Irrigation System in Plantation Area	Radi Radi (Universitas Gadjah Mada, Indonesia)



Session 2 - Track: Soft Computing 2
Tuesday, 27th November 2018, 08.00 - 10.00, Banda Room

Code	Paper ID	Title	Authors
SC06	1570485704	Brittle Ancient Document Using Adaptive Local Thresholding	Muhtadin Muhtadin (Institut Teknologi Sepuluh Nopember, Indonesia); Kiki Fatimah and Yoyon Suprpto (Sepuluh Nopember Institute of Technology, Indonesia)
SC07	1570492282	Micro Expression: Comparison of Speed and Marking Accuracy in Facial Component Detection	Ulla Rosiani (Institut Teknologi Sepuluh Nopember, Indonesia); Ariadi Ririd and Priska Choirina (Polinema, Indonesia); Surya Sumpeno (Institute Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); Adri Gabriel Soai (Institut Teknologi Sepuluh Nopember & Universitas Katolik Widya Mandira, Indonesia)
SC08	1570480285	Gamelan Simulator Multiplatform Application Development	Yoyon Suprpto and Syahri Maulana Ramadhan (Sepuluh Nopember Institute of Technology, Indonesia); Eko Pramunanto (ITS, Indonesia)
SC09	1570486842	Mobile Robot Based Autonomous Selection of Fuzzy-PID Behavior and Visual Odometry for Navigation and Avoiding Barriers in the Plant Environment	Sugianta Nirawana, Kadek Yota Ernanda Aryanto and Gede Indrawan (Universitas Pendidikan Ganesha, Indonesia)
SC10	1570490373	Cooperative Multi-agent on Head Yaw of Humanoid Robot using Consensus	Arif Nugroho (Institut Teknologi Sepuluh Nopember, Indonesia); Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh November, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)

Session 2 - Track: Game Technology & Game Engineering
Tuesday, 27th November 2018, 08.00 - 10.00, Celebes Room

Code	Paper ID	Title	Authors
GE01	1570488718	Visual Learning on Mobile Phone for Introduction Basic Programming in Vocational High School	Arik Kurniawati (University of Trunojoyo Madura, Indonesia); Nurrohmat Hidayatullah Akbar and Deny Prasetyo (University of Trunojoyo Madura Indonesia, Indonesia)
GE02	1570486852	HEIRDOM: Multiple Ending Scenario Game for Mathematics Learning Using Rule-Based System	Supeno Susiki (Sepuluh Nopember Institute Of Technology, Indonesia); Angga Utama (Institut Teknologi Sepuluh Nopember, Indonesia); Mochamad Hariadi (Sepuluh Nopember Institute of Tech. Surabaya, Indonesia); Umi Laili Yuhana (Institut Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)
GE03	1570483584	Implementation of Reconstruction Filter to Create Motion Blur Effect in URHO3D Game Engine	Anny Yuniarti (Institut Teknologi Sepuluh Nopember, Indonesia); Ridho Rahman Hariadi (Institut Teknologi Sepuluh Nopember (ITS) Surabaya Indonesia, Indonesia); Yusuf Syihab (Institut Teknologi Sepuluh Nopember, Indonesia)
GE04	1570486571	Closed Room Fire Propagation Modelling using Multiple State Variables Cellular Automata	Galih P Riatma and Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh Nopember, Indonesia); Supeno Mardi Susiki Nugroho (Institut Teknologi Sepuluh Nopember, Indonesia)
GE05	1570487000	Development of Eye-Gaze Interface System and Its Application to Virtual Reality Controller	Hanif Fermanda Putra and Kohichi Ogata (Kumamoto University, Japan)

Session 3 - Track: Soft Computing 3
Tuesday, 27th November 2018, 10.30 - 12.30, Java Room

Code	Paper ID	Title	Authors
SC11	1570490121	Modified Multi-scale Feature Extraction for Copy-Move Forgery Detection Based on CMFD-SIFT	Mohammed Ikhlayel (Institut Teknologi Sepuluh Nopember, Indonesia); Mochamad Hariadi (Sepuluh Nopember Institute of Technology, Indonesia); I Ketut Pumama (Institut Teknologi Sepuluh Nopember, Indonesia)
SC12	1570490331	Fast and Efficient Cluster Based Map for Ship Tracking	Andi M. Ali Mahdi Akbar (Sepuluh Nopember Institute of Technology, Indonesia); Ketut Purnama (ITS, Indonesia); Supeno Susiki (Sepuluh Nopember Institute Of Technology, Indonesia); Mochamad Hariadi (Sepuluh Nopember Institute of Tech. Surabaya, Indonesia)
SC13	1570490000	Comparison of Recognition Accuracy on Dynamic Hand Gesture Using Feature Selection	Adri Gabriel Sooi (Institut Teknologi Sepuluh Nopember & Universitas Katolik Widya Mandira, Indonesia); Patrisius Batarius, Yovinia Siki, Paskalis Nani, Natalia Mamulak and Emerensiana Ngaga (Universitas Katolik Widya Mandira, Indonesia); Ulla Rosiani (Institut Teknologi Sepuluh Nopember, Indonesia); Surya Sumpeno (Institute Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); Sisilia Mau (Universitas Katolik Widya Mandira, Indonesia)
SC14	1570487264	Adaptive Boosting Classifier for Pedestrian Attributes Identification with Color and Texture Features	Indah Agustien Siradjuddin and Helmi Achmani (University of Trunojoyo Madura, Indonesia); Arif Muntasa (Trunojoyo University & Informatics Department Trunojoyo University, Indonesia)
SC15	1570496257	Classifying the Complexity of Competency in Elementary School based on Supervised Learners	Umi Laili Yuhana (Institut Teknologi Sepuluh Nopember, Indonesia); Laszlo T. Koczy (Szechenyi Istvan University, Hungary); Tri Arief Sardjono (Institut Teknologi Sepuluh Nopember, Indonesia); Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh November, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); Ketut Purnama (ITS, Indonesia)

Session 3 - Track: Soft Computing 4
Tuesday, 27th November 2018, 10.30 - 12.30, Flores Room

Code	Paper ID	Title	Authors
SC16	1570490078	Analysis of Brain Tissue and Cerebrospinal Fluid Feature for Alzheimer's Disease Detection	Cucun Very Angkoso (University of Trunojoyo Madura, Indonesia); I Ketut Eddy Purnama (Institut Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)
SC17	1570490330	Comparative study of Brain Tumor Segmentation using Different Segmentation Techniques in Handling Noise	Nur Iriawan (Institut Teknologi Sepuluh Nopember, Indonesia); Anindya Apriliyanti Pravitasari (Institut Teknologi Sepuluh Nopember & Universitas Padjadjaran, Indonesia); Kartika Fithriasari and Irhamah Irhamah (Institut Teknologi Sepuluh Nopember, Indonesia); Santi Wulan Purnami (Sepuluh Nopember Institute of Technology, Indonesia); Widiana Ferriastuti (Universitas Airlangga, Indonesia)
SC18	1570486533	New Model for Hourly Solar Radiation Forecasting using ANN for Java Island, Indonesia	Mahmoud Abu Zalata, ENG (Institut Teknologi Sepuluh Nopember - ITS, Indonesia); Imam Robandi (Sepuluh November Institute of Technology, Indonesia); Dedet Riawan (Institut Teknologi Sepuluh Nopember, Indonesia)
SC19	1570484924	K optima Clustering as Determination of Optimum Flight Route	Mohammad Yazdi Pusadan (Institute Technology of Sepuluh Nopember & University of Tadulako, Indonesia)
SC20	1570490337	Nguyen-Widrow Neural Network for Distribution Transformer Lifetime Prediction	Rosmaliati Rosmaliati (Universitas Mataram & Institut Teknologi Sepuluh Nopember Surabaya, Indonesia); Novie Setiawati (Institut Teknologi Sepuluh Nopember, Indonesia); Ardyono Priyadi (ITS, Indonesia); Mauridhi Purnomo (Institut Teknologi Sepuluh Nopember, Indonesia)

Session 3 - Track: Soft Computing 5
Tuesday, 27th November 2018, 10.30 - 12.30, Banda Room

Code	Paper ID	Title	Authors
SC21	1570486795	Spectral Analysis of Familiar Human Voice Based On Hilbert-Huang Transform	Agustinus Bimo Gumelar (Institut Teknologi Sepuluh Nopember & Universitas Narotama, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia); Eko Mulyanto Yuniarno (Institut Teknologi Sepuluh November, Indonesia); Indar Sugiarto (University of Manchester, United Kingdom (Great Britain))
SC22	1570486071	Comparison of Supervised Learning Image Classification Algorithms for Food and Non-Food Objects	Reza Yogaswara (Institut Teknologi Sepuluh Nopember, Indonesia); Adhi Dharma Wibawa (Institut Teknologi Sepuluh Nopember Surabaya, Indonesia)
SC23	1570490168	N-Gram Keyword Retrieval on Association Rule Mining for Predicting Teenager Deviant Behavior from School Regulation	Esther Irawati Setiawan (Institut of Technology Sepuluh Nopember, Indonesia); Andy Januar Wicaksono (Universitas Atma Jaya Yogyakarta, Indonesia); Joan Santoso (Institut Teknologi Sepuluh Nopember & Sekolah Tinggi Teknik Surabaya, Indonesia); Yosi Kristian (Sekolah Tinggi Teknik Surabaya, Indonesia); Surya Sumpeno (Institute Teknologi Sepuluh Nopember, Indonesia); Mauridhi Hery Purnomo (Institut of Technology Sepuluh Nopember, Indonesia)
SC24	1570486982	Employing Sparsity Removal Approach and Fuzzy C-Means Clustering Technique on Movie Recommendation Systems	Noor Ifada, Eko Prasetyo and M Mula'ab (University of Trunojoyo Madura, Indonesia)
SC25	1570490243	Comparing Reduction Method Of Mutual Coupling between Ring Metamaterial and Square On Microstrip Array Antenna	Petrus Goran (Institut Teknologi Sepuluh Nopember, Indonesia)
SC26	1570490294	An Improved Iris Tracking Algorithm for Eye Identification under Visible Light	Eka Suryadana and Sunu Wibirama (Universitas Gadjah Mada, Indonesia); Igi Ardiyanto (Universitas Gadjah Mada & Faculty of Engineering, Indonesia)

Session 3 - Track: Embedded System 2
Tuesday, 27th November 2018, 10.30 - 12.30, Celebes Room

Code	Paper ID	Title	Authors
ES06	1570489394	Online Gas Mapping in Outdoor Environment using Solar-Powered Mobile Robot	Richa Watiasih (Institut Teknologi Sepuluh Nopember Surabaya Indonesia & Bhayangkara Surabaya University Indonesia, Indonesia); Muhammad Rivai, Ontoseno Penangsang and Fajar Budiman (Institut Teknologi Sepuluh Nopember, Indonesia); Yusril Izza (Institut Teknologi Sepuluh Nopember Surabaya, Indonesia); Tukadi Tukadi (Institut Teknologi Adhi Tama Surabaya, Indonesia)
ES07	1570490326	Preliminary Study on Movement Controls and Data Streaming in Mobile Robot Surveillance	Uti Solichah (Institut Teknologi Sepuluh Nopember, Indonesia)
SC27	1570487104	Development of Underwater Object Detection Method Base on Color Feature	Tri Susanto (ITS, Indonesia); Ronny Mardiyanto and Djoko Purwanto (Institut Teknologi Sepuluh Nopember, Indonesia)



The Design of a Low-Cost Therapy Robot for Hand Rehabilitation of a Post-Stroke Patient

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Abstract— A robot technology has been proven effective in recovering a post-stroke patient. However, the existing commercial robot therapy is expensive so that it cannot be afforded by the majority of people in developing and poor countries. Therefore, a robot that is affordable but effective and feasible for therapy is needed. This paper presents a development of a low-cost therapy robot for rehabilitation of upper extremity limb or hand. The cost production can be reduced using a cheap but strong material. In addition, a simple computer game was developed along with the robot to conduct a continuous passive motion (CPM) exercises. In this paper, the therapy was tested on ten healthy subjects. Based on the survey conducted on the ten subjects after doing therapy simulation indicates that the robot therapy is worth to be implemented for rehabilitation of the post-stroke patient.

Keywords—therapy robot, hand exoskeleton, post stroke rehabilitation

I. INTRODUCTION

Stroke is one of a cause of mortality and disability in a younger adult aged 20 – 64 from 1999 - 2013 [1]. This disability reduces the quality of life of the patient. Therefore, a rehabilitation to recover the motor functionality is needed. At least, the basic activities of daily living (ADL) can be recovered.

One of rehabilitation technology growing rapidly is robot technology [2]. One study conducted by [2] shows that there is no significant improvement in motor control compared to the traditional therapy. Nevertheless, this study also indicates that the robot therapy is able to intensify the number of therapies. On the contrary, Krishnamurthi [1] shows the efficacy of the robot therapy for hand recovery. This efficacy is proven by another researcher [3].

Regarding upper extremity limb rehabilitation especially for hand rehabilitation for the post-stroke patient, few technologies have been developed for decades [4]. Many of them are still in a prototype and few of them have been commercialized and implemented in the hospital such as Amadeo, a robot for finger rehabilitation [5], the Hand Wrist Assistive Rehabilitation Device (HOWARD) [6], HandCare [7], “Hand of hope” robot and so on [8].

From those robots, the “hand of hope” exoskeleton hand robot has been commercialized globally. It is a phenomenal therapy robot. Unfortunately, its cost is very expensive about €20,000 [9]. For sure, the majority of people in developing countries such as Indonesia cannot afford it. Therefore, a low-cost therapy robot for people in developing and poor countries is needed. This paper provides the preliminary result for a low-cost hand robot for therapy of a post-stroke patient following a stroke attack.

One of the advantages of the “Hand of Hope” Robot is its portability. The user can take it home and do the therapy anywhere. In addition to “hand of hope” robot, many other exoskeletons have developed such as Mula’s hand exoskeleton [10], Wege’s hand exoskeleton [11][12], and exofinger [13]. However, the “Hand of Hope” exoskeleton robot has been commercialized and delivered around the globe.

The organization of the paper is as follow. The section II will discuss the need of the hand anatomy. The following section, i.e. Section III will describe the methodology of the exoskeleton hand and the therapy mode designed. In section IV, the experimental result is presented and discussed. Finally, the paper is closed by the conclusion in section V.

II. THE HAND ANATOMY

The thumb and fingers are the main components of the hand. The thumb is composed of one metacarpal and two phalanges while each finger is composed of one metacarpal and three phalanges. The finger rays are numbered and named from the radial to ulnar side: I(thumb), II (index finger), III (middle finger), IV (ring finger) and V (little finger). Each finger ray proximally articulates with a carpal bone. This articulation forms the carpometacarpal (CMC) joint. The next joint in each ray is the metatarsophalangeal (MCP) joint. The MCP joint connects the metacarpal bone to the proximal phalanx. The interphalangeal (IP) joint links the phalanges of the fingers. In each finger, they are two IP joints: a proximal (PIP) and a distal (DIP) interphalangeal joints. As for the thumb, it has only one IP joint. In total, there are 19 bones and 14 joints in the hand, as shown in Fig. 1.

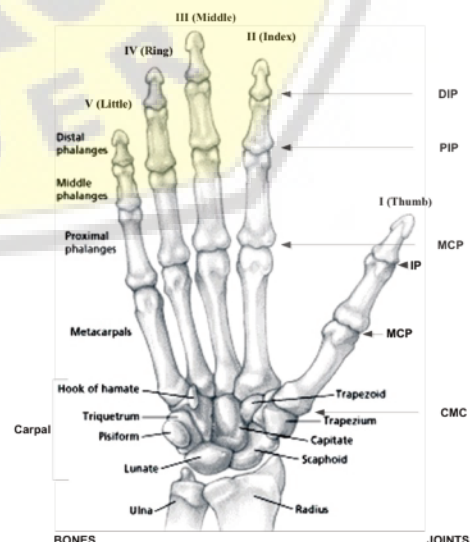


Fig. 1. Right hand, proximal view [14]

The shape variation of the joints of the thumb and the fingers results in the variation of the degree of freedom at these joints. The unique orientation and configuration of the CMC joint of the thumb give the digit large mobility and great flexibility [1]. The second (the index finger) and the third (the middle finger) CMC joints are an immobile unit of the hand because they are connected to the trapezoid and capitate bone that are immobile bones. The fourth (the ring finger) and the fifth (the little finger) CMC joint are able to move 10° to 15° and 20° to 30° of flexion and extension, respectively.

III. METHODOLOGY

A. Robot Design

The therapy robot designed in this paper is an exoskeleton robot that will be worn by the patient over their hand and fingers. Fig. 2 depicts the movement mechanism of the robot. Each finger is actuated by a motor linear that drives the MCP joint of the fingers. The finger is designed in such a way that the other joints move along with the MCP joint. Meanwhile, the concept of the hand exoskeleton is described in Fig. 3.

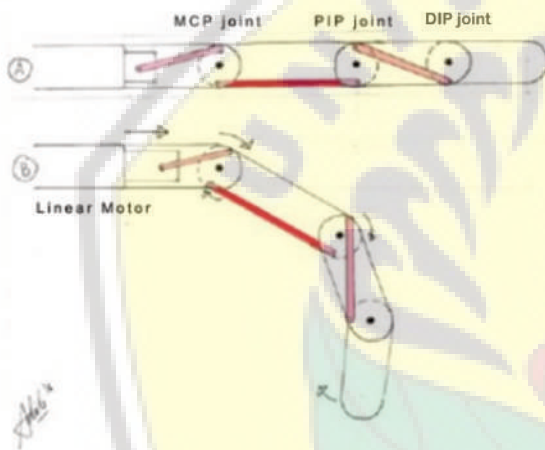


Fig. 2. The design of the exoskeleton from side

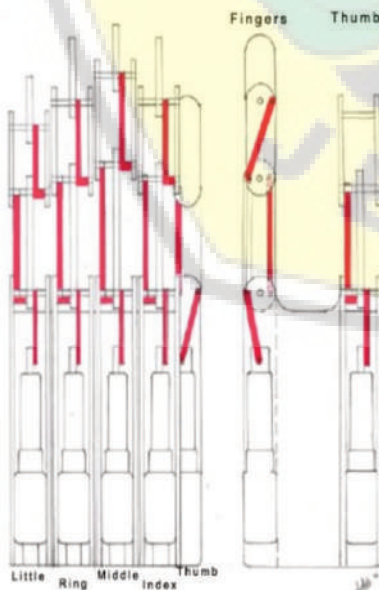


Fig. 3. The design of the therapy robot from above

As shown in Fig. 3, the position of the thumb is separated from other fingers with a similar mechanism. The finger material is from acrylic, as shown in Fig. 4. These acrylics are constructed in such a way that it can be moved by the motor linear L12-P from Actuonic. The L12-P has position sensor embedded in its construction. The traditional position control system using PID is embedded in a microcontroller Arduino Uno to control each linear motor. All components cost about US\$ 500 for one hand.

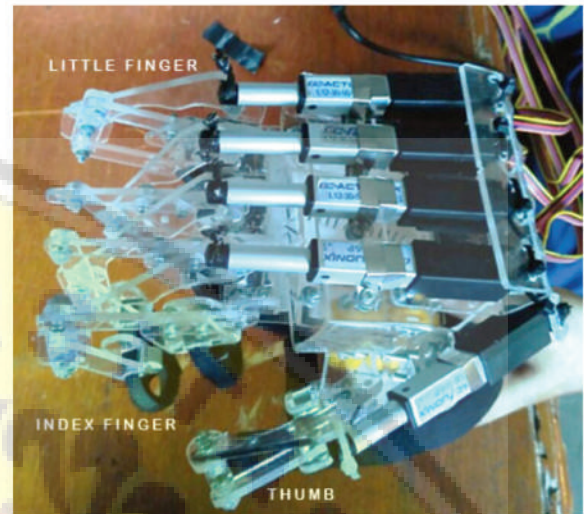


Fig. 4. The implementation of the exoskeleton robot

B. Experimental procedure

This paper presents the evaluation of the low-cost therapy robot for the post-patient. In the experiments, the robot was not tested on the stroke patient, but it was examined on the healthy people, as shown in Table 1. The main goal is to evaluate the performance of the robot as well as its comfort when worn by the user.

TABLE I. THE SUBJECT STATUS INCLUDED IN THE EXPERIMENT

No.	Subject	Gender	Age	Disability status
1.	S1	F	21	No
2.	S2	M	22	No
3.	S3	M	21	No
4.	S4	M	21	No
5.	S5	F	21	No
6.	S6	F	21	No
7.	S7	F	21	No
8.	S8	M	21	No
9.	S9	M	21	No
10.	S10	F	21	No

The experiment was conducted as described in Fig. 5. The user wore the low-cost therapy robot on their right hand. On the left, the user holds a handheld pushbutton to activate the robot. There was a computer screen in the front of the user displaying a catching-ball game. A ball came from the top of the screen and fell down to the end of the screen. At the bottom, a hand picture was ready to catch the ball. The user was instructed to push the handheld button whenever the ball got closer to the hand picture to catch it. This game is designed to perform the continuous passive movement (CPM) for the stroke patient. This experiment was performed three times for each subject.

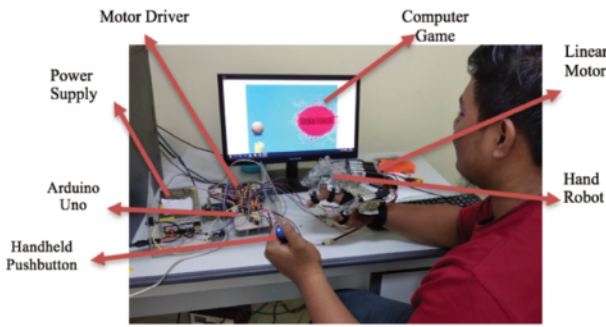


Fig. 5. The experimental apparatus

After conducting the experiment, the subject was asked several questions in a questionnaire survey, as in Table II.

TABLE II. A SURVEY AFTER WEARING THE ROBOT

Subject	Is it convenient to wear?*					Does it cause injury?					Is it potential for stroke therapy?				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1															
S2															

*1: Strongly Disagree; 2: Disagree; 3: Undecided; 4: Agree; 5: Strongly Agree

IV. RESULT AND DISCUSSION

This section presents the experimental results on the performance of the position control system and the user experience test.

A. Position control system performance

Each linear motor is controlled by a traditional position control using PID. The parameters of PID was determined using a Ziegler-Nichols method with $K_p = 0,0048$, $K_i = 0,00204$, and $K_d = 0,00282$. Two experiments were conducted. The first one was a free test on each linear motor without mechanical burden. In this test, the reference position was varied in deferent stroke lengths from 0 mm up to 30 mm and then it was moved down to 0. One of the experimental results is depicted in Fig. 6.

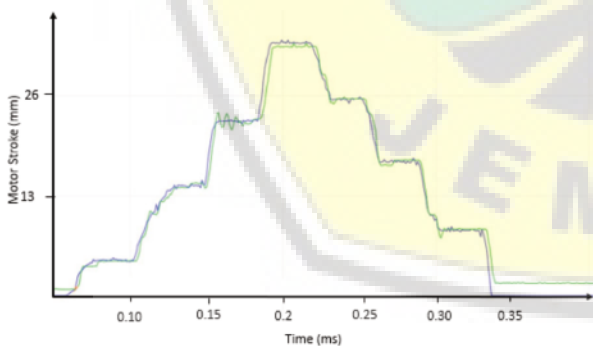


Fig. 6. The performance of the position control system on a linear motor without mechanical load (The blue line is the target and the green line is the actual stroke length)

Fig. 6 shows that the error state steady (ess) is varied about less than 5% except in the maximum stroke length. Furthermore, the percentage of the maximum overshoot (%Mp) is very small except for one or two set points. In term of speed, the rise time of the control system is quick enough about less than 0.01ms except for few set points. In general,

the performance of the position control system on the free test without a mechanical burden is acceptable.

The goal of the next experiment was to evaluate the performance of the linear motor when it is attached to the mechanical structure of the robot. The control system should be able to move the linear motor to desired length stroke. This movement will rotate the MCP joint of the exoskeleton fingers and simultaneously rotate PIP and DIP joint due to its mechanical structure. Because of the robot mechanic, the maximum full stroke is 20 mm. One of the experimental results is depicted in Fig. 7. This experiment examined the performance of the controller for closing the hand and then opening it afterward.

Fig. 7 shows that the rise time of the system is about 3 s. It indicates the time needed to close the hand completely. Similarly, the time to open the hand completely is around three minutes. Compared to the rise time in Fig. 6, this rise time is much longer because there is a load of mechanical robot that slows down the motor stroke. Fortunately, it is acceptable because this robot will be utilized for rehabilitation of the post-stroke patient. The speed does not matter.

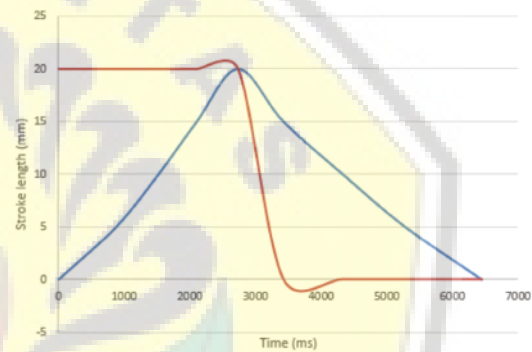


Fig. 7. The performance of the linear motor attached in the robot mechanic. (the red line is the target and the blue line is the stroke length of the linear motor)

B. The survey result

The purpose of this experiment is to examine the user experience when wearing this therapy robot along with the computer game and the handheld button, as shown in Fig. 5. Ten healthy subjects were involved in the experiment. Each subject was asked to wear the therapy robot on the right hand while the left hand was holding the handheld button. There was a catching-ball game on a computer screen with a hand and ball picture in it. The ball fell down from the top and the hand would catch it. The subject was asked to press the handheld button to catch the ball and at the same time, the robot therapy will close the hand as if the right hand caught the ball. This procedure was conducted three times for each subject. The results are presented in Table 2 and Fig. 8.

After completing the game, the subject was asked three questions. The first one is regarding the comfort in wearing the robot. About 80% of subjects felt the robot is convenient to wear while the rest could not decide to agree or disagree. Therefore, the comfort of this robot is not something problem.

Another question raised was about the injury possibility when wearing it. About 70% of them did not agree that the robot could injure the user. Interestingly, the majority of the subjects were very confident that this robot therapy will be

beneficial for the rehabilitation of the post-stroke patients. The description of the survey result is clearly shown in Fig. 8.

TABLE III. THE SURVEY RESULT

Subject	Is it convenient to wear?*					Does it cause injury?					Is it potential for stroke therapy?				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
S1					√					√					√
S2					√					√					√
S3				√						√					√
S4				√						√					√
S5					√					√					√
S6				√						√				√	
S7					√					√					√
S8			√						√					√	
S9				√					√					√	
S10				√					√					√	
Total	0	2	4	4	4	7	3	0	0	0	1	1	1	8	

*1: Strongly Disagree; 2: Disagree; 3: Undecided; 4: Agree; 5: Strongly Agree

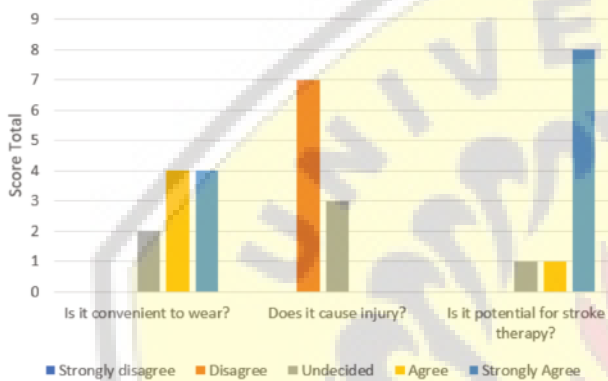


Fig. 8. The survey result of the user experience

C. Discussion

The low-cost therapy robot for hand rehabilitation has been developed and tested on the healthy subjects. The chance of this robot in real rehabilitation is good. Therefore, the clinical test should be conducted in long-term rehabilitation therapy to measure the efficacy of the robot therapy. One thing should be considered is about the safety of the user in term of electric and mechanical failure. These two issues have not been addressed properly. The improvement will be focused on these issues.

Another issue that needs more attention is the appearance of the robot. The survey shows that the tested subjects who do not have a problem with the hand fell all right with the robot. However, for the stroke patient may get scared when looking a robot. Therefore, the appearance of the robot should be modified so as to friendlier and nice looking.

Beside two aforementioned issues, the various computer games with a different level of difficulties should be developed. The computer game increases the interest of the users and removes the boring when doing the rehabilitation procedure.

V. CONCLUSION

This paper presents the preliminary result for a low-cost therapy robot for hand rehabilitation. The robot along with a rehabilitation procedure using a computer game has been

developed and tested on the healthy subjects. The experimental results indicate that the low-cost therapy robot is very potential to implemented in the clinical application. However, few issues should be considered before the application such as the safety issue, the aesthetics, and the variation of the computer game for the therapy.

ACKNOWLEDGMENT

We would like to thank to Directorate of Research and Development, Ministry of Research, Technology, and Higher Education, Republic of Indonesia, for financial support in the applied research scheme contract number067/SP2H/LT/DRPM/IV/2017.

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