Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Preface

To cite this article: 2021 *J. Phys.: Conf. Ser.* **1869** 011001

View the article online for updates and enhancements.

This content was downloaded from IP address 180.245.156.107 on 15/08/2021 at 00:02

Preface

This present volume contains the proceeding of the 2nd Annual Conference of Science & Technology (Ancoset) 2020. In this year, the 2nd Ancoset was virtually delivered through online platform due to Covid-19 Pandemic on November 28, 2020. This conference was organized by Universitas PGRI Kanjuruhan Malang and co-organized by Rumah Publikasi Indonesia.

Taking the theme of *The Role of Science and Technology Application on Building Community Resilience during New Normal*, we provided intellectual forum for students, researchers, lecturers, and practitioners. There are 221 papers collected which propose an insightful thought on the frontier knowledge about science and technology and its application. This conference opens an opportunity for scientific cooperation as well as international collaboration as it attended by almost two hundreds participants both across Indonesia and Asia.

We really appreciate all support given for the success of the 2nd Ancoset 2020 and thus would like to express our gratitude to everyone who has taken part in this event:

- The scientific reviewers for helping authors come up with a good quality paper,
- The distinguished keynote speakers: **Assoc. Prof. Sudi Dul Aji, M.Pd** (Universitas PGRI Kanjuruhan Malang), **Assoc. Prof. Dr. Massudi Mahmuddin** (Universiti Utara Malaysia), **Prof. Ida Hamidah, M.Si** (Universitas Pendidikan Indonesia), **Prof. Dr. Ade Gafar Abdullah, M.Si** (Universitas Pendidikan Indonesia),
- Co-Host universities: Universitas Al-Ghifari, Universitas Hamzanwadi, Universitas PGRI Semarang, Institut Teknologi Nasional Malang, Universitas Ma Chung, Universitas Bhinneka PGRI, Universitas PGRI Adi Buana Surabaya, IKIP PGRI Jember,
- All presenters and participants, and
- The committee members for the commitment, effort, and hard work in accomplishing the conference and proceeding.

We wish you all a fruitful gathering and see you on the next conference.

The Editors,

Prof. Dr. Ade Gafar Abdullah, M.Si.
Asst. Prof. Ayu Liskinasih, M.Pd.
Asst. Prof. Muhammad Nur Hudha, M.Pd.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

LIST OF COMMITTEE

Conference Chair:
Asst. Prof. Ayu Liskinasih, M.Pd.

Co-Conference Chair:
Asst. Prof. Muhammad Nur Hudha, M.Pd.

Advisory Boards:
Prof. Dr. Duran Corebima Aloysius, M.Pd. - Universitas PGRI Kanjuruhan Malang
Prof. Suhadi Ibnu, Ph.D. - Universitas PGRI Kanjuruhan Malang
Prof. Laurens Kaluge, M.A., Ph.D. - Universitas PGRI Kanjuruhan Malang
Prof. Dr. Soedjijono, M.Hum. - Universitas PGRI Kanjuruhan Malang
Prof. Dr. Azlinda Azman - Universiti Sains Malaysia
Prof. Reevany bin Bustami, Ph.D. - Universiti Sains Malaysia
Prof. Dr. Mustafa bin Mamat - UNISZA
Assoc Prof. Helen Creese, Ph.D. - University of Queensland
Dr. Sam Wane - Harper Adams University
Assoc Prof. Pieter Sahertian, M.Si. - Universitas PGRI Kanjuruhan Malang
Assoc Prof. Dr. Sudi Dul Aji, M.Si. - Universitas PGRI Kanjuruhan Malang
Assoc. Prof. Dr. Muhdi, S.H., M.Hum. - Universitas PGRI Semarang
Assoc Prof. Dr. Ir. Hj. Sitti Rohmi Djalilah, M.Pd. - Universitas Hamzanwadi
Assoc. Prof. Dr. Murphin Joshua Sembiring, M.Si. - Universitas Ma Chung
Assoc Prof. Dr. H. Didin Muhafidin, M.Si. - Universitas AL-Ghifari
Assoc Prof. Dr. Ir. Kustamar, M.T. - Institut Teknologi Nasional Malang
Assoc Prof. Dr. Imam Sujono, S.Pd., M.M. - Universitas Bhinneka PGRI
Assoc Prof. Dr. M. Subandowo, M.S. - Universitas PGRI Adi Buana
Prof. Dr. H. M. Rudy Sumiharsono, M.M. - IKIP PGRI Jember

Scientific Committee:
Prof. Dr. Ade Gafar Abdullah, M.Si. - Universitas Pendidikan Indonesia
Assoc. Prof. Dr. Isma Widiaty, M.Pd. - Universitas Pendidikan Indonesia
Prof. Dr. Anna Permanasari, M.Si. - Universitas Pendidikan Indonesia
Asst. Prof. Muhammad Nur Hudha, M.Pd. - Universitas PGRI Kanjuruhan Malang
Asst. Prof. Ayu Liskinasih, M.Pd. - Universitas PGRI Kanjuruhan Malang

Organizing Committee:
Secretary and Moderator:
Asst. Prof. Riza Weganofa, M.Pd. - Universitas PGRI Kanjuruhan Malang
Treasurer:
Asst. Prof. Ati Retna Sari, S.E., Ak., M.SA. - Universitas PGRI Kanjuruhan Malang
Program Committee and Information Technology:

- Asst. Prof. Arief Rahman Hakim, M.Pd. - Universitas PGRI Kanjuruhan Malang
- Asst. Prof. Hestiningtyas Yuli Pratiwi, M.Pd. - Universitas PGRI Kanjuruhan Malang
- Asst. Prof. Tri Ida Wahyu Kustyorini, S.Pt., M.P. - Universitas PGRI Kanjuruhan Malang
- Imam Ariffudin, M.Pd. - Universitas PGRI Kanjuruhan Malang
- Ajeng Intan Nur Rahmawati, M.Pd. - Universitas PGRI Kanjuruhan Malang
- Akhmad Zaini, S.Kom., M.T. - Universitas PGRI Kanjuruhan Malang
- Heri Santoso, M.Kom. - Universitas PGRI Kanjuruhan Malang

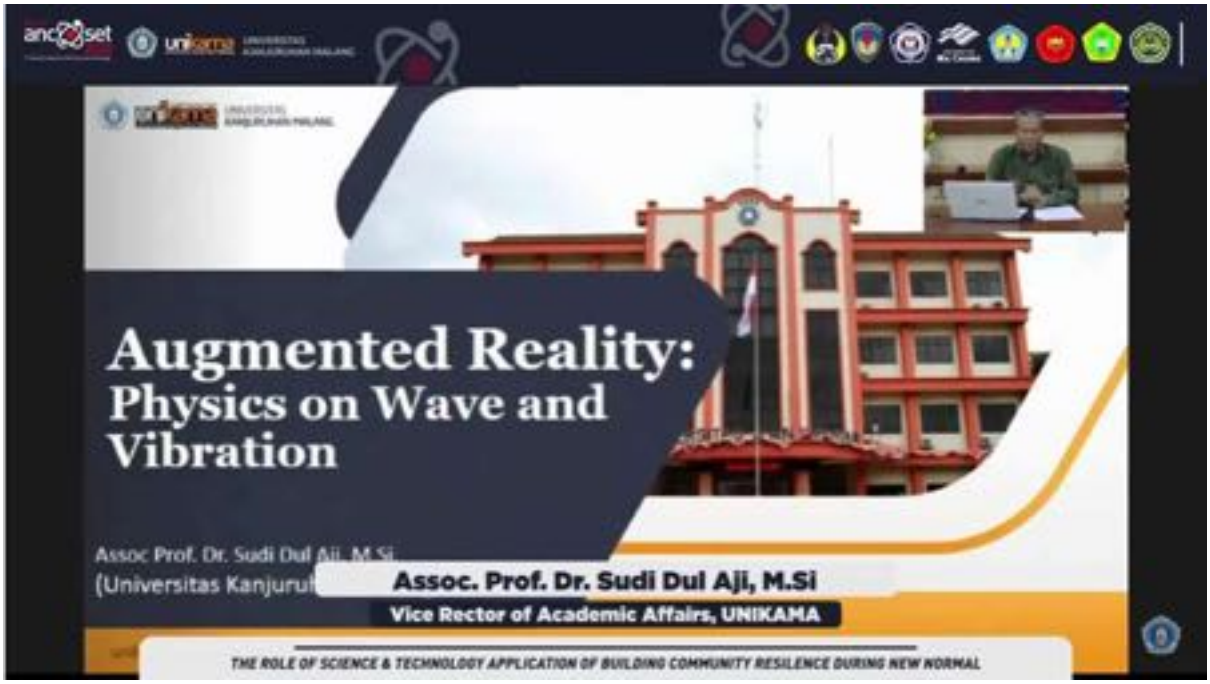
VIRTUAL CONFERENCE DOCUMENTATION

ANCOSET 2020 ~ 2nd Annual Conference of Science and Technology

Ayu Liskinasih, M.Pd
Chair of the 2nd Ancosh & Ancoset 2020
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILENCE DURING NEW NORMAL

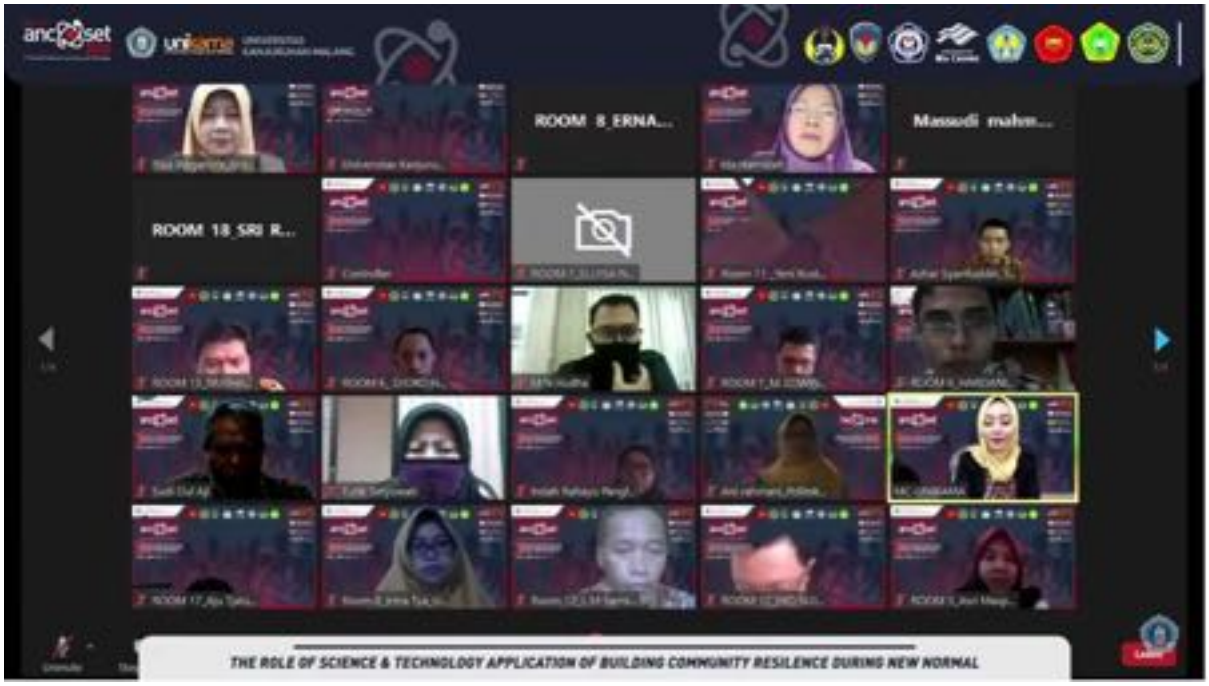
UNIVERSITAS KANJURUHAN MALANG
ancoset
unikama
RUMAH
appi
Oktavia Widiastuti, M.Pd
MC
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILENCE DURING NEW NORMAL

UNIVERSITAS KANJURUHAN MALANG
ancoset 2020
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION ON BUILDING COMMUNITY RESILIENCE DURING NEW NORMAL
unikama
RUMAH
appi
Riza Weganofa, M.Pd
MODERATOR
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILIENCE DURING NEW NORMAL


Augmented Reality:
Physics on Wave and Vibration
Assoc. Prof. Dr. Sudi Dul Aji, M.Si
Vice Rector of Academic Affairs, UNIKAMA
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILIENCE DURING NEW NORMAL

Personalized Learning: A Humble Proposal of an Integrated Big Data, AI, IoT, and Security
UUM
Universiti Utara Malaysia
Presentation Annual Conference of Science and Technology (Ancoset) 2020
ancoset
Assoc. Prof. Dr. Massudi Mahmuddin
Universiti Utara Malaysia
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILENCE DURING NEW NORMAL

ANCOSET 2020
Lithium-Ion
Supercapacitor
Biomass-based supercapacitor for electrical energy storage system
IDA HAMIDAH
UNIVERSITAS PENDIDIKAN INDONESIA
Prof. Dr. Ida Hamidah, M.Si
Universitas Pendidikan Indonesia
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILENCE DURING NEW NORMAL


ROOM 8_ERNA...
Masudi mahm...
ROOM 18_SRI R...
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILENCE DURING NEW NORMAL

Anisa Fatwa
Room 16_Prisk...
ROOM 19_SUSD...
THE ROLE OF SCIENCE & TECHNOLOGY APPLICATION OF BUILDING COMMUNITY RESILENCE DURING NEW NORMAL

Journal of Physics: Conference Series

Table of contents

Volume 1503
2021
Previous issue Next issue
2nd Annual Conference of Science and Technology (ANCOSET 2020), 28 November 2020, Makeng, Gambang, Malaysia
Accepted papers received: 18 March 2021
Published online: 30 April 2021

Open all abstracts

Preface

OPEN ACCESS — 01501
Preface
View article PDF View article

OPEN ACCESS — 01502
Peer review declaration
View article PDF View article

Chemistry

OPEN ACCESS — 012001
Utilization of chitosan-clam bioadsorbents as a coagulant for processing electroplating waste
Nur Ain Nadzirah Mohamad Zakaria and Ahmad Zaki Ab Ghani
View article PDF View article

OPEN ACCESS — 012002
Comparison of phenolic, flavonoid, and tannin contents from ethanol extract of Kratom stem (Mitragyna speciosa Korth.), and tamiyam flower (Melastoma malabathricum L.)
Ade Sofiyan and Nurfitri Badrie
View article PDF View article

OPEN ACCESS — 012003
Crude leaf ethanol extract (Syzygium aromaticum L. Merr. and Perr.) is formulated as antiseptic liquid soap
S Sarjuni, T Kartina and A Widiasari
View article PDF View article

OPEN ACCESS — 012004
Antibacterial activity of Sandfordia fancsia caught in East Java and Bali waters
L Sardiana, J Jumaiyah, D Kusuma and R Ilhamdy
View article PDF View article

OPEN ACCESS — 012005
The effect of different storage times at 0°C on the quality of yogurt with the addition of local tea: search for antioxidant and antibacterial activity
F S Fatimahwati, S Rizqiah, L Fadhilah, F Ulfah and N Ulfah
View article PDF View article

OPEN ACCESS — 012006
Bioactivity of Jambu air (Syzygium aqueum) leaves extract against Escherichia coli
Nurul Ilmi and Ade Sofiyan
View article PDF View article

OPEN ACCESS — 012007
Targeted discovery of glycosidic hydrolases from enzymes reservoir of digestive gland Achatina fulica through functional metagenomics
M Kurniawan, A Yunus, H Yu, S Sukiman and D Ratnasari
View article PDF View article

OPEN ACCESS — 012008
Chemical analysis and organoleptic properties of bandea kimoserto (Moss parasitaceae) as filler for catfish (Clarias sp) fish nugget
M N Ferdiana, M Ghufran, D E Sukly, S Zakiyatun, D Kabayani and A Chasanah
View article PDF View article

OPEN ACCESS — 012009
Antibacterial activity of leaf extract of Kaduk (Piper sarmentosum) against Escherichia coli
S Y Wahyu, A Yunus and R Ilhamdy
View article PDF View article

OPEN ACCESS — 012010
Bioactive compounds of leaf extract from Acacia farnesiana (Acacia mangium WILL) against gastro-intestinal pathogenic bacteria
Ade Sofiyan and Nurfitri Badrie
View article PDF View article

OPEN ACCESS — 012011
Effects of vacuolin/cytochalasin on anthracycline cytotoxicity and yield of various red blood cell preparations under aerobic-anaerobic systems
Y Ahmad, A Ali, S M Kaya and N M Ali
View article PDF View article

OPEN ACCESS — 012012
Toxicity of essential oils from orange (Citrus sinensis L. Osbeck) and kemangan (Cymbopogon nardus L. Rendle) on Aedes aegypti L. and Culex quinquefasciatus Say larvae
N Ayuniah, M Ghufran, M Kosing, J Jumaiyah and I Hanafi
View article PDF View article

OPEN ACCESS — 012013
Antibacterial activity of Kaduk (Piper sarmentosum) against Escherichia coli
S Y Wahyu, A Yunus and R Ilhamdy
View article PDF View article

OPEN ACCESS — 012014
Cytotoxicity of Kaduk (Piper sarmentosum) against Vero cell
A Yunus, R Ilhamdy and S Wahyu
View article PDF View article

OPEN ACCESS — 012015
The study of structural properties and photocatalytic activity of ZnO prepared by ultrasonic assisted precipitation method
D Sanuji, S Widiyati, N D Hatmi, S D Arta, S Sakroni, A Wafi, Z F Fadhoilatunisa, H L Hariyati and D D Sunari
View article PDF View article

OPEN ACCESS — 012016
Antibacterial activity of endophytic microorganisms in vitro lychi from Kambang, Bumiaking and Garut West Java
A Ashshaf, P R Widyaparaga and R Widyastuti
View article PDF View article

OPEN ACCESS — 012017
Toxicity of essential oils from orange (Citrus sinensis L. Osbeck) and kemangan (Cymbopogon nardus L. Rendle) on Aedes aegypti L. and Culex quinquefasciatus Say larvae
N Ayuniah, M Ghufran, M Kosing, J Jumaiyah and I Hanafi
View article PDF View article

OPEN ACCESS — 012018
Antibacterial activity of Kaduk (Piper sarmentosum) against Escherichia coli
S Y Wahyu, A Yunus and R Ilhamdy
View article PDF View article

OPEN ACCESS — 012019
Cytotoxicity of Kaduk (Piper sarmentosum) against Vero cell
A Yunus, R Ilhamdy and S Wahyu
View article PDF View article

OPEN ACCESS — 012020
Using PEST analysis to learning the concept of acid-base
E Nurlaila, S S Alwi, I Hidayat and S Bahriah
View article PDF View article

OPEN ACCESS — 012021
Investigating the potency of bioactive compounds from Rice religious as anti-inflammatory agent
A Ashshaf, P R Widyaparaga, T Ramadhan, F Ulfah, F Widyastuti and R Widyastuti
View article PDF View article

OPEN ACCESS — 012022
The technology development in thermoplasmonic materials
R Widayat, S Sudirman and A Chandrawati
View article PDF View article

OPEN ACCESS — 012023
Synthesis and sodium ion minimally invasive decomposition for surgical treatment of neural compression in lumbar spinal stenosis
R Widiati, S A Wibowo and H Syaifudin
View article PDF View article

OPEN ACCESS — 012024
Synthesis of nickel-doped protein metallation electrolyte modules by the PDF professional application
T Sapitri, T Kartasasmita and R Ronaldi
View article PDF View article

OPEN ACCESS — 012025
Developing the Computer Based Test (CBT) on the basic chemistry throughout a web-based application
T Kartasasmita and Ronaldi
View article PDF View article

OPEN ACCESS — 012026
Effect of ethanol of white turmeric extract against antibacterial properties in edible film sweet potato starch and whey protein
Y Ahmad, Y R Abbaga, S Sanjaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012027
Utilization of a module in polymer synthesis based on chemistry to improve student high level thinking
D D Jusuf, S Ramadhan, T Sapitriyanto and D J Sujatan
View article PDF View article

OPEN ACCESS — 012028
Antibacterial activity of leaf extract of Kaduk (Piper sarmentosum) against Staphylococcus aureus
S Y Wahyu, A Yunus and R Ilhamdy
View article PDF View article

OPEN ACCESS — 012029
Cytotoxicity of Kaduk (Piper sarmentosum) against Vero cell
A Yunus, R Ilhamdy and S Wahyu
View article PDF View article

OPEN ACCESS — 012030
Effect of cooking time on the quality of silk-spun loyal (Crassocheilus interbrissus)
I D Chandi, P A Ferdinandus and A Yuliu
View article PDF View article

OPEN ACCESS — 012031
Synthesis and ethanol levels of red dragon fruit wine (Hylocereus costaricensis) with the treatment of sugar and fermentation time
M Sidharta, H Widyasari, N Ariyani, D Ekaputra, F Fadhilah and A A M Nasution
View article PDF View article

OPEN ACCESS — 012032
Antibacterial activity of Z. Zerumbaceae (gaint rosscamber) protein cells M. Arthi and co. raw material for typhoid disease detection kit
Z Zulkifli, Z Nasrin, F F Jauhar, S Widiyanti, S Aqbarini and A H Ali
View article PDF View article

OPEN ACCESS — 012033
Variation in experimental protein production volume of the E. coli/pET-28a system by a low material for typhoid detection kit at different temperatures
Z Nasrin, F F Jauhar, T Widiyanto, S Widiyanti, S Aqbarini, A Ayuniah and A H Ali
View article PDF View article

OPEN ACCESS — 012034
Development of mobile learning integration with scientific approaches on electrolyte solution and redox reaction
U Cahyana, D Hasan and M Ulfah
View article PDF View article

OPEN ACCESS — 012035
Development of mobile learning integration with scientific approach in stoichiometry
U Cahyana, F Hadiprayitnawati and D Lestari
View article PDF View article

OPEN ACCESS — 012036
Effect of spacing on growth and yield of local brown beans soybean varieties (Glycine max L. Merrill)
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan F Y Hasanuddin
View article PDF View article

OPEN ACCESS — 012037
Application of nanoze layer in breeding several varieties of chili (Capsicum frutescens L.)
M D Valentia, A A A Wulanja, M A Q Zamzami and T D Wiwoseno
View article PDF View article

OPEN ACCESS — 012038
Utilization of commercial quail laying ration with substitution of fermentation waste bean sprouts
S A Sholeha, U U Kaltsum and N Ardiyati
View article PDF View article

OPEN ACCESS — 012039
Utilization of fermented cassava and rattan as carcass weight and percentage of broiler carcass
S A Sholeha, U U Kaltsum and N Ardiyati
View article PDF View article

OPEN ACCESS — 012040
Application of yeasts isolated from fermented cocoa beans for biocontrol of pathogenic mold in chocolate food
D Sukmawati, E Arman, R Hamdani, N Nasir, A Nurhayati, T Widiyati, R Dian, E Sayekti, S R Pratiwi, S N Rosa et al
View article PDF View article

OPEN ACCESS — 012041
Environmentally safe technology with the conversion of used cooking oil into soap
D Nasrul, A T Hardiyati, A Ardie, S R Fitriani, S Yayan, H Utari and S Syafitri
View article PDF View article

OPEN ACCESS — 012042
Effect of spacing on growth and yield of local brown soybean varieties (Glycine max L. Merrill)
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan F Y Hasanuddin
View article PDF View article

OPEN ACCESS — 012043
Application of nanoze layer in breeding several varieties of chili (Capsicum frutescens L.)
M D Valentia, A A A Wulanja, M A Q Zamzami and T D Wiwoseno
View article PDF View article

OPEN ACCESS — 012044
Utilization of commercial quail laying ration with substitution of fermentation waste bean sprouts
S A Sholeha, U U Kaltsum and N Ardiyati
View article PDF View article

OPEN ACCESS — 012045
Utilization of fermented cassava and rattan as carcass weight and percentage of broiler carcass
S A Sholeha, U U Kaltsum and N Ardiyati
View article PDF View article

OPEN ACCESS — 012046
Application of yeasts isolated from fermented cocoa beans for biocontrol of pathogenic mold in chocolate food
D Sukmawati, E Arman, R Hamdani, N Nasir, A Nurhayati, T Widiyati, R Dian, E Sayekti, S R Pratiwi, S N Rosa et al
View article PDF View article

OPEN ACCESS — 012047
Environmentally safe technology with the conversion of used cooking oil into soap
D Nasrul, A T Hardiyati, A Ardie, S R Fitriani, S Yayan, H Utari and S Syafitri
View article PDF View article

OPEN ACCESS — 012048
Integration of mobile learning and biology-chemistry mapping and its effect on the growth and yield of salacha plants
I Ardiyanto, F Hadiprayitnawati and D Lestari
View article PDF View article

OPEN ACCESS — 012049
Integration dilemma: Issues in STEM project at school
Y Ahmad, A Ali, S M Kaya and N M Kosasyah
View article PDF View article

OPEN ACCESS — 012050
Assessing the feasibility of chemical laboratory safety videos
D Fatul, D Hasan, U A Kaltsum, A Ardiyanto and N Ramdhani
View article PDF View article

OPEN ACCESS — 012051
Utilization of the waste (cladophora fodica) seedlings on compost and urea fertilizer dose treatment
U A Kaltsum, U U Kaltsum, N Ardiyati, R Ilhamdy and T Widiyanto
View article PDF View article

OPEN ACCESS — 012052
The effect of brewing time on pH values, polyphenols content, and antioxidant activities of coffee husk tea (Leonard Kopi)
E Sakkiyah, I Wuntawati, L Nafisyah and A Ustadiyah
View article PDF View article

OPEN ACCESS — 012053
Isolation and evaluation of antioxidant activity in menthol leaves
A S Sayuti, R A Kawaidi and R Kuli
View article PDF View article

OPEN ACCESS — 012054
Molecular docking study of inclusion complex between aromatic amino and Cellulose analogs
A L Lamsari
View article PDF View article

OPEN ACCESS — 012055
Physicochemical characteristics of fermented Virgin Coconut Oil (VCO) on Soft addition
N Hidayat, N Widiastuti and I Nafi
View article PDF View article

OPEN ACCESS — 012056
Antioxidant activity of Jawa pelandeh No. 1
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012057
Computational modeling of inclusion complex between aromatic amino and cellulose analogs using Semiempirical Quantum Method (SQM)
A L Lamsari
View article PDF View article

OPEN ACCESS — 012058
Bacteriocin antimicrobial isolation in fish soy sauce
M Ed Sanwani, E S Edi and D A R Fauzan
View article PDF View article

OPEN ACCESS — 012059
Effect of spacing, antihypoxic extract mahkonia as a sensitizer pill cancer compound
I Sapitri, A Hidayat, T Ramadhan, A Ardie and D H Sari
View article PDF View article

OPEN ACCESS — 012060
Physicochemical characteristics of fermented Virgin Coconut Oil (VCO) on Soft addition
N Hidayat, N Widiastuti and I Nafi
View article PDF View article

OPEN ACCESS — 012061
Integration dilemma: Issues in STEM project at school
Y Ahmad, A Ali, S M Kaya and N M Kosasyah
View article PDF View article

OPEN ACCESS — 012062
Assessing the feasibility of chemical laboratory safety videos
D Fatul, D Hasan, U A Kaltsum, A Ardiyanto and N Ramdhani
View article PDF View article

OPEN ACCESS — 012063
Utilization of the waste (cladophora fodica) seedlings on compost and urea fertilizer dose treatment
U A Kaltsum, U U Kaltsum, N Ardiyati, R Ilhamdy and T Widiyanto
View article PDF View article

OPEN ACCESS — 012064
The effect of brewing time on pH values, polyphenols content, and antioxidant activities of coffee husk tea (Leonard Kopi)
E Sakkiyah, I Wuntawati, L Nafisyah and A Ustadiyah
View article PDF View article

OPEN ACCESS — 012065
Isolation and evaluation of antioxidant activity in menthol leaves
A S Sayuti, R A Kawaidi and R Kuli
View article PDF View article

OPEN ACCESS — 012066
Molecular docking study of inclusion complex between aromatic amino and Cellulose analogs
A L Lamsari
View article PDF View article

OPEN ACCESS — 012067
Bacteriocin antimicrobial isolation in fish soy sauce
M Ed Sanwani, E S Edi and D A R Fauzan
View article PDF View article

OPEN ACCESS — 012068
Effect of spacing, antihypoxic extract mahkonia as a sensitizer pill cancer compound
I Sapitri, A Hidayat, T Ramadhan, A Ardie and D H Sari
View article PDF View article

OPEN ACCESS — 012069
Detection of metal-detectors ankle indicators Couple Plastic Electronic Jumbo ballik waste and shoes as Muslim education
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012070
Antibacterial activity of Ulva ceylanica (Ulvaceae) against pathogenic bacteria
L SARI, N Hayati and A Syukur
View article PDF View article

OPEN ACCESS — 012071
Bioactive antibacterial isolation in wet media processing
A Ahmad,Kusumaningsih, R Kuli, R Widayat, R Hidayat, T Widiyanto, T Jakaria, A Jurnawan and S L Wiyanpada
View article PDF View article

OPEN ACCESS — 012072
Molecular docking simulation of interaction between insulin and silica nanoparticle
A Ahmad and Y Ahmad
View article PDF View article

OPEN ACCESS — 012073
Kaolin-based ceramic membrane for wastewater treatment
R Widayat, S Sudirman and A Chandrawati
View article PDF View article

OPEN ACCESS — 012074
Bioactive antibacterial isolation in wet media processing
A Ahmad,Kusumaningsih, R Kuli, R Widayat, R Hidayat, T Widiyanto, T Jakaria, A Jurnawan and S L Wiyanpada
View article PDF View article

OPEN ACCESS — 012075
Molecular docking simulation of interaction between insulin and silica nanoparticle
A Ahmad and Y Ahmad
View article PDF View article

OPEN ACCESS — 012076
Kaolin-based ceramic membrane for wastewater treatment
R Widayat, S Sudirman and A Chandrawati
View article PDF View article

Computer Science

OPEN ACCESS — 012077
Scale and digital better applications involving the behavior of children applying the health protocols
H D Jokopurno, Y I Gani, H Supangat and N Ferry
View article PDF View article

OPEN ACCESS — 012078
Analysis of the composition patterns of drug alone with Apriori Algorithm
Ayuna, A Sabarita, M Ikhsan and P Tarigan
View article PDF View article

OPEN ACCESS — 012079
Autonomous car using CNN deep learning algorithm
A Santoso and Ginardi Hendro Gunawan
View article PDF View article

OPEN ACCESS — 012080
Comprehensive study of DR Leading SLT trajectory for software testing
J L Ali, N Kapsi and N Ahmad
View article PDF View article

OPEN ACCESS — 012081
Rapid identification of rice green leaves using Fluorescence satellite image and artificial intelligence
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012082
The development of thematic modules based on Strengthening Character Education (PPK) and Quick Response (QR) code
Y Ardiyanto, E S P Widayanti, D D Chrisyanto and I Lestariningsih
View article PDF View article

OPEN ACCESS — 012083
Rapid identification of rice green leaves using Fluorescence satellite image and artificial intelligence
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012084
Scale and digital better applications involving the behavior of children applying the health protocols
H D Jokopurno, Y I Gani, H Supangat and N Ferry
View article PDF View article

OPEN ACCESS — 012085
Analysis of the composition patterns of drug alone with Apriori Algorithm
Ayuna, A Sabarita, M Ikhsan and P Tarigan
View article PDF View article

OPEN ACCESS — 012086
Autonomous car using CNN deep learning algorithm
A Santoso and Ginardi Hendro Gunawan
View article PDF View article

OPEN ACCESS — 012087
Comprehensive study of DR Leading SLT trajectory for software testing
J L Ali, N Kapsi and N Ahmad
View article PDF View article

OPEN ACCESS — 012088
Rapid identification of rice green leaves using Fluorescence satellite image and artificial intelligence
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012089
The development of thematic modules based on Strengthening Character Education (PPK) and Quick Response (QR) code
Y Ardiyanto, E S P Widayanti, D D Chrisyanto and I Lestariningsih
View article PDF View article

OPEN ACCESS — 012090
Rapid identification of rice green leaves using Fluorescence satellite image and artificial intelligence
Y Ahmad, A Ali, S M Kaya, N M Kosasyah and A Jurnawan
View article PDF View article

OPEN ACCESS — 012091
"Tess of the d'Ubervilles" sentiment analysis using Plutchik's Wheel of Emotions
Y Ardiyanto, E S P Widayanti, D D Chrisyanto and I Lestariningsih
View article PDF View article

OPEN ACCESS — 012092
Classification of diabetes disease using decision tree algorithm (C4.5)
N C Pertiwa, S Hidayat, Y Ardiyanto, Y Susanto and Y Suryanto
View article PDF View article

OPEN ACCESS — 012093
Development of a tablet activity application using the Model View Controller (MVC) concept
A D Cahyo, D Kusumaningsih, Y Jumaryadi and L Lukmanul
View article PDF View article

OPEN ACCESS — 012094
Crude-novel sentiment analysis of Indonesian language and Javanese language using convolutional neural network
Y Ardiyanto, E S P Widayanti, D D Chrisyanto and I Lestariningsih
View article PDF View article

OPEN ACCESS — 012095
A review of deep learning methods in MPM based customer segmentation
H Susilo, Y H Wibowo and Y Suryani
View article PDF View article

OPEN ACCESS — 012096
Classification of diabetes disease using decision tree algorithm (C4.5)
N C Pertiwa, S Hidayat, Y Ardiyanto, Y Susanto and Y Suryanto
View article PDF View article

OPEN ACCESS — 012097
Classification of diabetes disease using decision tree algorithm (C4.5)
N C Pertiwa, S Hidayat, Y Ardiyanto, Y Susanto and Y Suryanto
View article PDF View article

OPEN ACCESS — 012098
Development of a tablet activity application using the Model View Controller (MVC) concept
A D Cahyo, D Kusumaningsih, Y Jumaryadi and L Lukmanul
View article PDF View article

OPEN ACCESS — 012099
Crude-novel sentiment analysis of Indonesian language and Javanese language using convolutional neural network
Y Ardiyanto, E S P Widayanti, D D Chrisyanto and I Lestariningsih
View article PDF View article

OPEN ACCESS — 012100
A review of deep learning methods in MPM based customer segmentation
H Susilo, Y H Wibowo and Y Suryani
View article PDF View article

OPEN ACCESS — 012101
Understanding and exploiting user behaviours using features of Wikidata data for eLearning usage from performance of Indonesian students
I Ardiyanto, R Hidayatullah and A Nugroho
View article PDF View article

OPEN ACCESS — 012102
Application of data mining for attainment of banks in the library using the Apriori method
R A Maksyakur, M Ikhsan and A Santoso
View article PDF View article

OPEN ACCESS — 012103
Hybrid game Education Jasmine vocabulary
Y Ardiyanto, E S P Widayanti and N Ferwanah
View article PDF View article

OPEN ACCESS — 012104
Augmented reality: Physics on wave and vibration
N Ula, I Nafisyah, S Jumiyati and M Ikhsan
View article PDF View article

OPEN ACCESS — 012105
Design of the adaptive systems of reporting the performance of temporary employees at the rank based office of communication and informations in Minar Regency
Y Ardiyanto, E S P Widayanti, D D Chrisyanto, I Ali, I Ali, T Tedesco and I Gasanty
View article PDF View article

OPEN ACCESS — 012106
Effective unsupervised film Grain noise images to improve machine learning based on DNA sequencing data
M Susanto, D Kristiyanti and N Wibowo
View article PDF View article

OPEN ACCESS — 012107
Rapid identification drug resistance using machine learning based on DNA sequencing data
M Hadiyanto, D Kristiyanti, N Wibowo and A Ardie
View article PDF View article

OPEN ACCESS — 012108
A Research Neighbor Interface for detecting egg quality conditions using Raspberry Pi
A Ardie, D Kristiyanti, N Wibowo, M Hadiyanto, A Santoso and A Ardie
View article PDF View article

OPEN ACCESS — 012109
Rapid tomorrow strategy to increase Mbedlin error reliability
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012110
Rapid tomorrow strategy to increase Mbedlin error reliability
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012111
Design of the adaptive systems of reporting the performance of temporary employees at the rank based office of communication and informations in Minar Regency
Y Ardiyanto, E S P Widayanti, D D Chrisyanto, I Ali, I Ali, T Tedesco and I Gasanty
View article PDF View article

OPEN ACCESS — 012112
Effective unsupervised film Grain noise images to improve machine learning based on DNA sequencing data
M Susanto, D Kristiyanti and N Wibowo
View article PDF View article

OPEN ACCESS — 012113
Rapid identification drug resistance using machine learning based on DNA sequencing data
M Hadiyanto, D Kristiyanti, N Wibowo and A Ardie
View article PDF View article

OPEN ACCESS — 012114
A Research Neighbor Interface for detecting egg quality conditions using Raspberry Pi
A Ardie, D Kristiyanti, N Wibowo, M Hadiyanto, A Santoso and A Ardie
View article PDF View article

OPEN ACCESS — 012115
Rapid tomorrow strategy to increase Mbedlin error reliability
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012116
Rapid tomorrow strategy to increase Mbedlin error reliability
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012117
Servicial and Wellbeing IoT for healthy check academic information system of private university
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012118
Comparative study of regression testing tools feature set and testing
A Wenzayah, R Mahmud and L L Ma
View article PDF View article

Mathematics

OPEN ACCESS — 012119
3D-Print: An Android based for bilingual digital promotion of Indonesian's Batik
Y Ardiyanto, E S P Widayanti, D D Chrisyanto, I Ali, I Ali, T Tedesco and I Gasanty
View article PDF View article

OPEN ACCESS — 012120
Servicial and Wellbeing IoT for healthy check academic information system of private university
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012121
Comparative study of regression testing tools feature set and testing
A Wenzayah, R Mahmud and L L Ma
View article PDF View article

OPEN ACCESS — 012122
3D-Print: An Android based for bilingual digital promotion of Indonesian's Batik
Y Ardiyanto, E S P Widayanti, D D Chrisyanto, I Ali, I Ali, T Tedesco and I Gasanty
View article PDF View article

OPEN ACCESS — 012123
Servicial and Wellbeing IoT for healthy check academic information system of private university
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012124
Comparative study of regression testing tools feature set and testing
A Wenzayah, R Mahmud and L L Ma
View article PDF View article

OPEN ACCESS — 012125
3D-Print: An Android based for bilingual digital promotion of Indonesian's Batik
Y Ardiyanto, E S P Widayanti, D D Chrisyanto, I Ali, I Ali, T Tedesco and I Gasanty
View article PDF View article

OPEN ACCESS — 012126
Servicial and Wellbeing IoT for healthy check academic information system of private university
Y Ardie, A Santoso and M Y Sukarsono
View article PDF View article

OPEN ACCESS — 012127
Comparative study of regression testing tools feature set and testing
A Wenzayah, R Mahmud and L L Ma
View article PDF View article

of planned harvesters
1 Kaushal, 2 Kaushal, 3 Kaushal
• Case Journal • Free article • EPUB Article

Electrical, Electronics and Computer Engineering

01010
OPEN ACCESS
Smart Grid Information System (SIS): Potential mapping of agrifeedstock in Southern part of West Java
1 Nugraha, 2 Sugiyono, 3 Sasongko, 4 Sudiyono, 5 Jusuf, 6 Pribadi
• Case Journal • Free article • EPUB Article

01020
OPEN ACCESS
Decision support system for mapping SMEs with Bangalore Sorting Industry 4.0 using SWAHT method
1 Ramesh, 2 Ramesh, 3 Ramesh, 4 Ramesh
• Case Journal • Free article • EPUB Article

01030
OPEN ACCESS
The utility of image storm assessment in the formation of tree mimic-at-flake structure and nodule in cast iron
1 Ugata, 2 A Ugata, 3 Kanjuna, 4 A Kanjuna
• Case Journal • Free article • EPUB Article

01040
OPEN ACCESS
Effect of the approximation temperature on chinese extraction for iron metal ions adsorption: Case study in Bangka pond in Ujung Kulon
1 Aldy, 2 Ardiansyah, 3 Gabriella
• Case Journal • Free article • EPUB Article

01050
OPEN ACCESS
Optimization and determination of lymphatic filariasis using spatial autocorrelation
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01060
OPEN ACCESS
Prediction on the multiphase energy diagram of Al_2O_3, Mn^{2+} under pressure
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf, 6 Kusuf
• Case Journal • Free article • EPUB Article

01070
OPEN ACCESS
Performance of Cosmos cocubaea (microalgal bar-ra) ness particles coating in the manufacture of Dye Sensitized Solar Cells (DSSC)
1 Kusuf and 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf, 6 Kusuf, 7 Kusuf and 8 Kusuf
• Case Journal • Free article • EPUB Article

01080
OPEN ACCESS
Electric network solution for modelling of Phytoplankton growth
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01090
OPEN ACCESS
Covid-19 in crabs with nontrivial incidence rate
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

Material Engineering

01100
OPEN ACCESS
The effectiveness of using magic book math in Mathematics learning during the Covid-19 pandemic in Senior High School
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf
• Case Journal • Free article • EPUB Article

Material Science

01110
OPEN ACCESS
Analysis of prospective Mathematics teacher on graphing function
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01120
OPEN ACCESS
Augmentation time series model and Gabor filter to predict foreign tourist arrivals in East Java
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf, 6 Kusuf
• Case Journal • Free article • EPUB Article

01130
OPEN ACCESS
Dynamical analysis of diphtheria epidemic model with natural immunity rate on exposed individuals
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01140
OPEN ACCESS
Mathematical Profile of creative thinking process of prospective teachers with reflective learning style in proving and solving problems
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf
• Case Journal • Free article • EPUB Article

01150
OPEN ACCESS
Augmented Reality Mobile Application Using Pancasila Ins for Mathematics learning in Elementary School
1 Sugiyanto and 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf, 6 Kusuf
• Case Journal • Free article • EPUB Article

Mathematics

01160
OPEN ACCESS
Bibliometric analysis of research on mathematical literacy in Indonesia
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01170
OPEN ACCESS
Mathematics communication software for mining association rules (market basket analysis) to design product layout solutions
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01180
OPEN ACCESS
Analysis of mathematical problem posing ability
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01190
OPEN ACCESS
3D Graphic application: Mathematical spatial ability
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf
• Case Journal • Free article • EPUB Article

01200
OPEN ACCESS
Implementation of student mathematics learning outcomes through Kahoot learning games application at elementary school
2 Lestari, 3 Saya, 4 Wahi and 5 Kusuf
• Case Journal • Free article • EPUB Article

01210
OPEN ACCESS
Effect of the Mawar Mathematics Project model on mathematical creativity
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf
• Case Journal • Free article • EPUB Article

01220
OPEN ACCESS
Development of mathematic media games education based on e-learning in the Planting of Basic Concepts in Numeracy
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

01230
OPEN ACCESS
Mathematical communications through project based learning toward an ordered
1 Kusuf
• Case Journal • Free article • EPUB Article

01240
OPEN ACCESS
Mathematic connections through scientific pond and lecture inquiry
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01250
OPEN ACCESS
Realistic mathematics education on teaching functions to develop algebraic thinking ability
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01260
OPEN ACCESS
Mathematical understanding of addition and subtraction concept in first grade through utilization of flipped classroom
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01270
OPEN ACCESS
Influence of contextual metacognition on Self-Regulatory Strategies students in math IV
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01280
OPEN ACCESS
Student's problem solving on mathematical proportion
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01290
OPEN ACCESS
3D Graphic application: Mathematical spatial ability
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf
• Case Journal • Free article • EPUB Article

01300
OPEN ACCESS
Implementation of student mathematics learning outcomes through Kahoot learning games application at elementary school
2 Lestari, 3 Saya, 4 Wahi and 5 Kusuf
• Case Journal • Free article • EPUB Article

01310
OPEN ACCESS
Effect of the Mawar Mathematics Project model on mathematical creativity
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf
• Case Journal • Free article • EPUB Article

01320
OPEN ACCESS
Development of mathematic media games education based on e-learning in the Planting of Basic Concepts in Numeracy
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

01330
OPEN ACCESS
Mathematical communications through project based learning toward an ordered
1 Kusuf
• Case Journal • Free article • EPUB Article

01340
OPEN ACCESS
Mathematic connections through scientific pond and lecture inquiry
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01350
OPEN ACCESS
Realistic mathematics education on teaching functions to develop algebraic thinking ability
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01360
OPEN ACCESS
Mathematical understanding of addition and subtraction concept in first grade through utilization of flipped classroom
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01370
OPEN ACCESS
Influence of contextual metacognition on Self-Regulatory Strategies students in math IV
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01380
OPEN ACCESS
Student's problem solving on mathematical proportion
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01390
OPEN ACCESS
Graphic communication in detecting outlier cases in time-column control diagram
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

01400
OPEN ACCESS
Sentiment analysis using tweet analysis in describing Covid-19 crisis outlined in Indonesia
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

01410
OPEN ACCESS
Geogebra application for quadratic functions
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01420
OPEN ACCESS
Long-term sequence of a extension modules
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01430
OPEN ACCESS
Analysis of Average Wheel Models by penalized Lasso in modelling the scores of Indonesian students
1 Kusuf, 2 Kusuf,Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01440
OPEN ACCESS
Household behavior towards shallow groundwater saving in Pekalongan City
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01450
OPEN ACCESS
Estimation of variables in generalized linear mixed model for simplex in Jenda Processes
1 Kusuf, 2 Kusuf,Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01460
OPEN ACCESS
Mathematical communication skills of students through Geoblocks assisted ELPSA approach
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01470
OPEN ACCESS
Equivalence between categories of superinduction
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01480
OPEN ACCESS
Estimation of linear system using gradient vector
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01490
OPEN ACCESS
Some properties of Max Plus algebra and generalized inverses on 3x3 matrices integer models 2
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01500
OPEN ACCESS
The impact of school disasters in Indonesia: How does welfare accumulate and attenuate the loss of people?
1 F E Firmansyah, 2 A S Kurniati and 3 F Hadiyanto
• Case Journal • Free article • EPUB Article

01510
OPEN ACCESS
Quantifying SMEs and GO impact to schools in Indonesia based on Heterogeneous Cobweb-Map (HCM)
1 F E Firmansyah, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01520
OPEN ACCESS
Analysis skill of critical thinking on Newton Law Topics using Argument Based Science Inquiry (ABSI) model
1 F Fitriani, 2 Sudarisman, 3 Setiawan, 4 S Ayu, 5 M Ikhsan, 6 Ru and 7 Kusuf
• Case Journal • Free article • EPUB Article

01530
OPEN ACCESS
Mathematical Modeling of Ecosystem Dynamics
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01540
OPEN ACCESS
Mathematical communication skills of students through Geoblocks assisted ELPSA approach
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01550
OPEN ACCESS
Equivalence between categories of superinduction
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01560
OPEN ACCESS
Estimation of linear system using gradient vector
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01570
OPEN ACCESS
Some properties of Max Plus algebra and generalized inverses on 3x3 matrices integer models 2
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01580
OPEN ACCESS
The impact of school disasters in Indonesia: How does welfare accumulate and attenuate the loss of people?
1 F E Firmansyah, 2 A S Kurniati and 3 F Hadiyanto
• Case Journal • Free article • EPUB Article

01590
OPEN ACCESS
Quantifying SMEs and GO impact to schools in Indonesia based on Heterogeneous Cobweb-Map (HCM)
1 F E Firmansyah, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01600
OPEN ACCESS
Analysis skill of critical thinking on Newton Law Topics using Argument Based Science Inquiry (ABSI) model
1 F Fitriani, 2 Sudarisman, 3 Setiawan, 4 S Ayu, 5 M Ikhsan, 6 Ru and 7 Kusuf
• Case Journal • Free article • EPUB Article

01610
OPEN ACCESS
Mathematical Modeling of Ecosystem Dynamics
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01620
OPEN ACCESS
Development of a classifying system of Gamma-ray Burst Spectra using Kohonen Self-Organizing Map
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01630
OPEN ACCESS
Game based learning for the mastery of HOTS in prospective physics teachers in digital electronics courses
1 Kusuf, 2 Kusuf and 3 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01640
OPEN ACCESS
Distance and displacement concept: Comprehension shifting of students on learning process
1 Kusuf, 2 F Ag, 3 S Widhiati, 4 Ardiyana, 5 Kusuf, 6 Sukaesih and 7 S Hidayat
• Case Journal • Free article • EPUB Article

01650
OPEN ACCESS
Mathematics Module based on STEM-problem based learning on newton's motion law material for senior high school
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01660
OPEN ACCESS
Mathematics Module based on STEM-problem based learning on newton's motion law material for senior high school
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01670
OPEN ACCESS
Development of a classifying system of Gamma-ray Burst Spectra using Kohonen Self-Organizing Map
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01680
OPEN ACCESS
Game based learning for the mastery of HOTS in prospective physics teachers in digital electronics courses
1 Kusuf, 2 Kusuf and 3 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01690
OPEN ACCESS
Distance and displacement concept: Comprehension shifting of students on learning process
1 Kusuf, 2 F Ag, 3 S Widhiati, 4 Ardiyana, 5 Kusuf, 6 Sukaesih and 7 S Hidayat
• Case Journal • Free article • EPUB Article

01700
OPEN ACCESS
The relationship between accounting and the economic shock in the equivalent of rapidly rotating neutron stars
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01710
OPEN ACCESS
Classification students' misconception using four-tier diagnostic test on Newton Law subject
1 Sudargono, 2 A P Ayu, 3 F Fitriani, 4 S Ru, 5 Ikhsan and 6 A Kusuf
• Case Journal • Free article • EPUB Article

01720
OPEN ACCESS
Physics undergraduate students' perceptions of online learning during the transition period to the new normal era
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01730
OPEN ACCESS
How to learn oscillation and wave in Covid19 Environment?
1 D Ula, 2 L Ichsan, 3 D Widha, 4 N Kusuf,Kusuf, 5 F Fitriani, 6 Sudargono and 7 A Yulia
• Case Journal • Free article • EPUB Article

01740
OPEN ACCESS
Analysis of the responses of the Newton Friction delay zone raised under longer conditions in Indonesia
1 Kusuf, 2 F Ridwanto and 3 Kusuf
• Case Journal • Free article • EPUB Article

01750
OPEN ACCESS
Low carbon learning: Logical framework in learning process at elementary schools
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf, 6 Kusuf, 7 Kusuf and 8 Kusuf
• Case Journal • Free article • EPUB Article

01760
OPEN ACCESS
Differential equations, Solving the oscillation system
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

Physics

01770
OPEN ACCESS
Development of scientific literacy based physics learning module on direct current circuit material
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01780
OPEN ACCESS
Analysis of cotton weight of the stuck in a winding cone thermosuccinic refrigerator
1 N Kusuf,Kusuf, 2 Kusuf and 3 N Tangguh
• Case Journal • Free article • EPUB Article

01790
OPEN ACCESS
Infiltration of producing hinges from heat waste in enamel bondgender at thermoplastic temperature
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01800
OPEN ACCESS
Chronostratigraphy of Geoblocksjuda hotpot carrots in Central Kalimantan open forests
1 Kusuf,Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf and 6 Kusuf
• Case Journal • Free article • EPUB Article

01810
OPEN ACCESS
An optical microwave wavelength in physics class
1 F E Firmansyah, 2 S Yuliyanti, 3 S Ayuningtyas, 4 A Kusuf, 5 Sugiyanto and 6 Kusuf
• Case Journal • Free article • EPUB Article

01820
OPEN ACCESS
Measurement of winding on radiation electromagnetic field on the tests coil
1 Kusuf,Kusuf, 2 Kusuf, 3F Kusuf, 4 Kusuf, 5 Kusuf and 6 F Kusuf
• Case Journal • Free article • EPUB Article

01830
OPEN ACCESS
Development of an inquiry-based practicum lab based on academic literacy to explain Newton's second law
1 Kusuf, 2 F Yuliati, 3F Kusuf, 4 Kusuf, 5 Kusuf, 6 Kusuf, 7 Kusuf and 8 Kusuf
• Case Journal • Free article • EPUB Article

01840
OPEN ACCESS
Multimedia Blog as an explanation activity for estimating moto cost density using the correlation of ceramic diameter and ceramic density
1 F Ag 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01850
OPEN ACCESS
The development of harmonic oscillation e-module based on problem based learning (pbl) for helping improvement of students' critical thinking ability
1 Z Kusuf, 2 Ichsan and 3 Kusuf
• Case Journal • Free article • EPUB Article

01860
OPEN ACCESS
Energy efficiency analysis for various type of electric cooker
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01870
OPEN ACCESS
Enhancing science literacy capabilities of prospective primary school teachers through the STEM-Project Learning Model
1 Kusuf, 2 A Ulfah and 3 Kusuf
• Case Journal • Free article • EPUB Article

01880
OPEN ACCESS
Analysis of the ability of student concept in environmental physics
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01890
OPEN ACCESS
Distribution and abundance of macroplankts at Bali estuary, South Sumatera, Indonesia
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01900
OPEN ACCESS
Development of web-based learning media for physics materials using Moodle in high school
1 Aldy, 2 Kusuf, 3 Yani, 4 Ardiyansyah and 5 Kusuf
• Case Journal • Free article • EPUB Article

01910
OPEN ACCESS
Implementation of problem-based learning media to increase student's motivation in learning physics
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01920
OPEN ACCESS
Moodle Open Online Simulation (MOOS) of physics concepts microscopes for improving creative thinking
1 Kusuf, 2 Kusuf and 3 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01930
OPEN ACCESS
Structural, magnetic and microwave absorption properties of natural iron sand
1 Kusuf,Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01940
OPEN ACCESS
Distribution and abundance of macroplankts at Bali estuary, South Sumatera, Indonesia
1 Kusuf and 2 Kusuf
• Case Journal • Free article • EPUB Article

01950
OPEN ACCESS
Development of web-based learning media for physics materials using Moodle in high school
1 Aldy, 2 Kusuf, 3 Yani, 4 Ardiyansyah and 5 Kusuf
• Case Journal • Free article • EPUB Article

01960
OPEN ACCESS
Implementation of problem-based learning media to increase student's motivation in learning physics
1 Kusuf,Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

01970
OPEN ACCESS
Moodle Open Online Simulation (MOOS) of physics concepts microscopes for improving creative thinking
1 Kusuf, 2 Kusuf and 3 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

01980
OPEN ACCESS
Structural, magnetic and microwave absorption properties of natural iron sand
1 Kusuf,Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

01990
OPEN ACCESS
Bibliometric study related based on augmented reality
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

02000
OPEN ACCESS
Bibliometric augmented reality: Display Computer scattering model
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

02010
OPEN ACCESS
Development of statistics particle under one dimensional harmonic oscillator potential
1 J Sampa, 2 Pentasena, 3 Wayayanda and 4 Kusuf
• Case Journal • Free article • EPUB Article

02020
OPEN ACCESS
Energy momentum tensor of scalar field with higher order derivatives
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

02030
OPEN ACCESS
Electric field induced travel mode in ribbon zigzag graphene nanoribbon
1 J Sampa, 2 F Pelpelina and 3 Kusuf
• Case Journal • Free article • EPUB Article

02040
OPEN ACCESS
Development of a model in interpolating classical energy of soliton of sine Gordon equation
1 F Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

02050
OPEN ACCESS
Radiation dose study based on augmented reality
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

02060
OPEN ACCESS
Augmentation of statistics quantum mechanics in radial problems and EOM equations
1 S Hajiyarafiq, 2 M E Jamlaoui and 3 F Mesrouaq
• Case Journal • Free article • EPUB Article

02070
OPEN ACCESS
Energy momentum tensor of scalar field with higher order derivatives
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

02080
OPEN ACCESS
Electric field induced travel mode in ribbon zigzag graphene nanoribbon
1 J Sampa, 2 F Pelpelina and 3 Kusuf
• Case Journal • Free article • EPUB Article

02090
OPEN ACCESS
Development of a model in interpolating classical energy of soliton of sine Gordon equation
1 F Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

02100
OPEN ACCESS
Radiation dose study based on augmented reality
1 Kusuf and 2 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

02110
OPEN ACCESS
Augmentation of statistics quantum mechanics in radial problems and EOM equations
1 S Hajiyarafiq, 2 M E Jamlaoui and 3 F Mesrouaq
• Case Journal • Free article • EPUB Article

02120
OPEN ACCESS
Dynamic analysis of Lumbrokinase Extracellular dipeptidyl Dicarboxylase with ipal gel method for cake salt production
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

02130
OPEN ACCESS
Dynamic analysis of Lumbrokinase Extracellular dipeptidyl Dicarboxylase with ipal gel method for cake salt production
1 Kusuf, 2 Kusuf, 3 Kusuf and 4 Kusuf
• Case Journal • Free article • EPUB Article

02140
OPEN ACCESS
Measurement system development of refractive index, salinity and magnetic field parameters on liquid waste pollutant
1 Kusuf, 2 Kusuf and 3 Kusuf
• Case Journal • Free article • EPUB Article

02150
OPEN ACCESS
Characteristics of narrow diffraction coefficient as a function of energy group in the one-dimensional multi-group diffusion equation using Chebyshev polynomials
1 M I Sadat, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

02160
OPEN ACCESS
Applying differential equations for study magnetohydrodynamic phenomenon on the solar surface
1 Kusuf, 2 Kusuf and 3 Kusuf,Kusuf
• Case Journal • Free article • EPUB Article

02170
OPEN ACCESS
Relationship from dimensional collision second years students using PISAT simulations on momentum and impulse concept
1 Sabrayanto, 2 Ibrahim, 3 Kusuf, 4 Kusuf, 5 Zumbar and 6 Kusuf
• Case Journal • Free article • EPUB Article

Chemistry

02180
OPEN ACCESS
Optimization of extraction and purification of Lipase and Protease of Cattle, pancreatic
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf and 6 Kusuf
• Case Journal • Free article • EPUB Article

02190
OPEN ACCESS
Characterization of Lipase and Protease of Cattle, pancreatic
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

02200
OPEN ACCESS
Optimization of extraction and purification of Lipase and Protease of Cattle, pancreatic
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf, 5 Kusuf and 6 Kusuf
• Case Journal • Free article • EPUB Article

02210
OPEN ACCESS
Characterization of Lipase and Protease of Cattle, pancreatic
1 Kusuf, 2 Kusuf, 3 Kusuf, 4 Kusuf and 5 Kusuf
• Case Journal • Free article • EPUB Article

IOPscience Journals Books About IOPscience Contact us Developing countries access IOP Publishing open access policy

IOP Publishing © Copyright 2021 IOP Publishing Terms & conditions Disclaimer Privacy & cookie policy

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.

Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Photogrammetric stereo image rectification

To cite this article: M E Tjahjadi and F Handoko 2021 *J. Phys.: Conf. Ser.* **1869** 012066

View the article online for updates and enhancements.

This content was downloaded from IP address 180.245.156.107 on 15/08/2021 at 00:07

Photogrammetric stereo image rectification

M E Tjahjadi[1,*] and F Handoko[2]

[1] Department of Geodesy, National Institute of Technology (ITN) Malang, Jl. Bendungan Sigura-gura 2 Malang 65145
[2] Department of Industrial Engineering, National Institute of Technology (ITN) Malang, Jl. Bendungan Sigura-gura 2 Malang 65145

[*]edwin@lecturer.itn.ac.id

Abstract. Today, off-the-shelf digital cameras are hand on tools for conducting visual inspections in surveying and mapping related activities or in structural inspection of industrial objects. Dense point clouds of the inspected object surface are of typical data required and their accuracies are also become more demanding. Deriving these data are off particular interest of this paper instead we work on overlapping images for generating those ones. An imaging geometry of stereo images is exploited further to reveal some drawbacks of the normalized stereo imaging configurations. We utilize a photogrammetric collinearity condition to model physical reality of the imaging process. A sequence of coordinate axes rotations on both images is rearranged as well as preserving normalized images resolutions to be equal to the source ones. Also based upon the prescribed resolutions, an efficient indirect resample is performed to interpolate grey values of the warped images. To ascertain reliability of the mathematically developed method, C++ programming codes were written and implemented in the solution. It reveals that a nuisance such as y-parallax is completely eliminated. Therefore, by using our method, the normalized images can be used in the dense point clouds production in a high quality and efficiency.

1. Introduction

In our ongoing research project conducting aerial and terrestrial photography, there is a need to inspect three dimensional object through stereoscopic viewing [1] for a variety of photogrammetric image processing tasks [2,3]. Stereoscopic viewing is established by rectifying two overlapping images of the same rigid scene undergo projective transformations [4]. Then, a resampling is performed to produce an image pair that has the corresponding epipolar lines coincide and be parallel to x-axis of images. Nonetheless, barely any captured images are ready for viewing geometry due to cumbersome image processing tasks. An alternative method is sought to be more intuitive and simple to make images are geometrically ready for stereoscopic viewing.

The epipolar rectification enables disparities between two images is only in the x-axis direction or lie on the same rows. Many algorithms are relied on a homographic or a fundamental matrix [5] to estimate the correspondence point and minimize perspective distortion. A more accurate algorithm using a so called three step image rectification to minimize camera rotations had been invented [6]. Both algorithms use homographic matrices on one or two images to rectify the image, but an undesirable distortion still occurs due to an exclusion of camera lens distortion model.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

A method called normalized images [7] was invented to resample epipolar images with respect to the world or object space reference system. The images are in epipolar geometry with respect to the object space. Following this idea, this paper discusses a modified version of their work by adding additional parameters of systematic errors such as lens distortion. Digital consumer grade cameras are widely known to suffer instabilities in their internal lenses and electronics imaging system [8]. Recently, quite similar works have been reported [9–11], but they use known Ground Control Point coordinates instead of an arbitrary coordinate frame. The next section explains some background knowledge followed by a detailed elaboration of how to obtain an aligned and rectified stereo images with an arbitrary object space coordinate system.

2. Methods

A relationship between the original stereo pair and its normalized pair is established by connecting the perspective centre of the left image and its rectified image (C_1) together with the right image and its rectified one (C_2) respectively (Figure 1). It is assumed that the interior parameters (i.e., x_p, y_p, c), exterior parameters $(X_{C1}, Y_{C1}, Z_{C1})$for the left image and (X_{C2}, Y_{C2}, Z_{C2}) for the right image, as well as camera calibration parameters (i.e., K_1, K_2, K_3, P_1, P_2, a_1, a_2) are known. The epipolar geometry of a stereo pair is the geometry of the intersection of the image planes with the planes containing the baseline $\boldsymbol{B}$. It intersects each original image plane at the left epipole (e_1) and the right epipole (e_2). The baseline vector of $\boldsymbol{Bx}$, $\boldsymbol{By}$, and $\boldsymbol{Bz}$ components intersects each original image plane at the left epipolar line and the right epipolar line respectively. Any point A(X, Y, Z) in the object space appears both on actual images at a'_1 and a'_2 as well as on rectified ones at a_1 and a_2 as depicted in Figure 1.

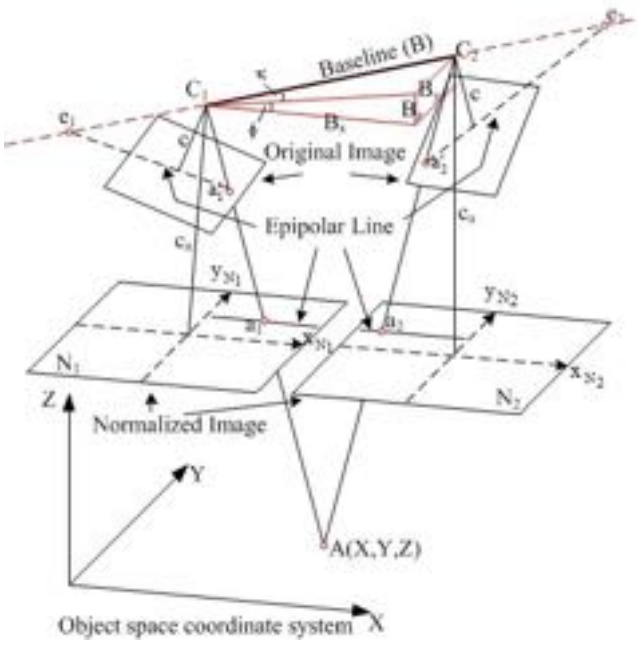


Figure 1. A relationship between original and normalized stereo pair.

Aforementioned parameters above can be computed using an approximate but fast method [12], or by a rigorous methods such space resection [13] or relative orientation [14]. The collinearity condition [13] stated that the object space point A, and its corresponding image as well as normalized one are formed a straight line to the perspective centre C_1 and C_2 of the original images. The equation to relate a point from the original image to the object space and from the normalized image to the object space and their rotational elements are as follows [7]:

$$[x - x_p \quad y - y_p \quad -c]^T = \boldsymbol{R_b R^T}[x_N \quad y_N \quad -c]^T \tag{1}$$

$$[B_x \quad B_y \quad B_z]^T = [X_{c2} - X_{c1} \quad Y_{c2} - Y_{c1} \quad Z_{c2} - Z_{c1}]^T \tag{2}$$

$$\Omega = (\omega_1 + \omega_2).2^{-1}; \;\; \phi = \tan^{-1}(B_z B_x^{-1}); \;\; \mathrm{K} = \tan^{-1}\left(B_y [B_x^2 + B_z^2]^{-0.5}\right) \tag{3}$$

$\boldsymbol{R}_b$ is the rotation matrices normalized images where $\boldsymbol{R}$ is a rotation matrix of original image [13]. The baseline component vectors are required to rotate and align original images to the normalized ones. The process can be viewed as a two steps of rotation. The first steps, the viewing directions of the original images are rotated to a perpendicular with the normal direction of the X-Y axes of the object space plane. This yields a true parallel with Z axis of object space system. The second steps, it makes x-y axes of once rotated image align with the X-Y axes of the object space system. The result is a normalized stereo pairs of N_1 and N_2 which their x axes are parallel with the X axis and their y axes are parallel with the Y axis. A combination of these three elementary rotations into the baseline rotation $\boldsymbol{R}_b$ yields:

$$R_b = R_{\mathrm{K}} R_\phi R_\Omega = \begin{bmatrix} \cos \mathrm{K} & \sin \mathrm{K} & 0 \\ -\sin \mathrm{K} & \cos \mathrm{K} & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\phi & 0 & -\sin\phi \\ 0 & 1 & 0 \\ \sin\phi & 0 & \cos\phi \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\Omega & \sin\Omega \\ 0 & -\sin\Omega & \cos\Omega \end{bmatrix} \tag{4}$$

If those two rotations are combined, it would transform the original image into the normalized position. The transformation must be done twice for a stereo pair with using each of its extrinsic parameter rotation where for the left image $\boldsymbol{R_{N1}} = \boldsymbol{R_b R_1^T}$ and $\boldsymbol{R_{N2}} = \boldsymbol{R_b R_2^T}$ for the right one. If distortion free stereo images are used the value of the resulting y parallax will be zero or negligible. However due to utilization of consumer grades, off-the-shelves cameras, the exhibit lens distortion should be eliminated during the process of stereo rectification. Using equation (1), the relationship between the original and normalized image can be expressed by the modified collinearity equation as [15]:

$$x - x_p - \Delta x = -c(r_{11}x_N + r_{21}y_N - r_{31}c)(r_{13}x_N + r_{23}y_N - r_{33}c)^{-1} \tag{5a}$$

$$y - y_p - \Delta y = -c(r_{21}x_N + r_{22}y_N - r_{32}c)(r_{13}x_N + r_{23}y_N - r_{33}c)^{-1} \tag{5b}$$

$$\Delta x = \bar{x}r^2K_1 + \bar{x}r^4K_2 + \bar{x}r^6K_3 + P_1(r^2 + 2\bar{x}^2) + 2P_2\bar{x}\bar{y} + a_1\bar{x} + a_2\bar{y} \tag{5c}$$

$$\Delta y\Delta = \bar{y}r^2K_1 + \bar{y}r^4K_2 + \bar{y}r^6K_3 + P_2(r^2 + 2\bar{y}^2) + 2P_1\bar{x}\bar{y} + 2P_1\bar{x}\bar{y} \tag{5d}$$

$$\bar{x} = x - x_p; \bar{y} = y - y_p; r = (\bar{x}^2 + \bar{y}^2)^{-0.5} \tag{5e}$$

Both x, y and x_N, y_N are image coordinates in metric unit (i.e. mm), $\Delta x, \Delta y$ are systematic lens distortion errors from optical and electronic components of the camera. Neglecting these terms will cause a projected collinear ray on the image will deviate from its true position. Also, r_{11}, …, r_{33} are the element of $\boldsymbol{R_{N1}}$, or $\boldsymbol{R_{N2}}$. In this paper it is assumed that the focal lengths for all type of images are equal. This equation is applied for each image, and it is usually easier to project the tessellation of the normalized image back to the original image to determine the grey level.

The procedure to rectify according to the epipolar line [7] starts from the transformation T_1 (Figure 2). T_1 enables pixel addresses of the original digital image to be transformed to a camera system and vice versa. T_2 is the projective transformation between the original and rectified images. Equation 1 is used to transform coordinates from an original image to its normalized counterpart or to transform coordinates from the normalized image to the original image by using an inverse process of it. T_3 defines the origin and size of the normalized digital image. First, the four corners of the original digital image ((0, 0), (max column, 0), (max column, max row), and (0, max row)) are transformed to the normalized image coordinates through T_1 and T_2. The origin of the normalized digital image is calculated by determining the maximum y-coordinate, which determines row = 0. The minimum x coordinate defines

column = 0. For the size of the normalized digital image, the maximum coordinate differences, dx_{max} and dy_{max}, in x and y directions are computed.

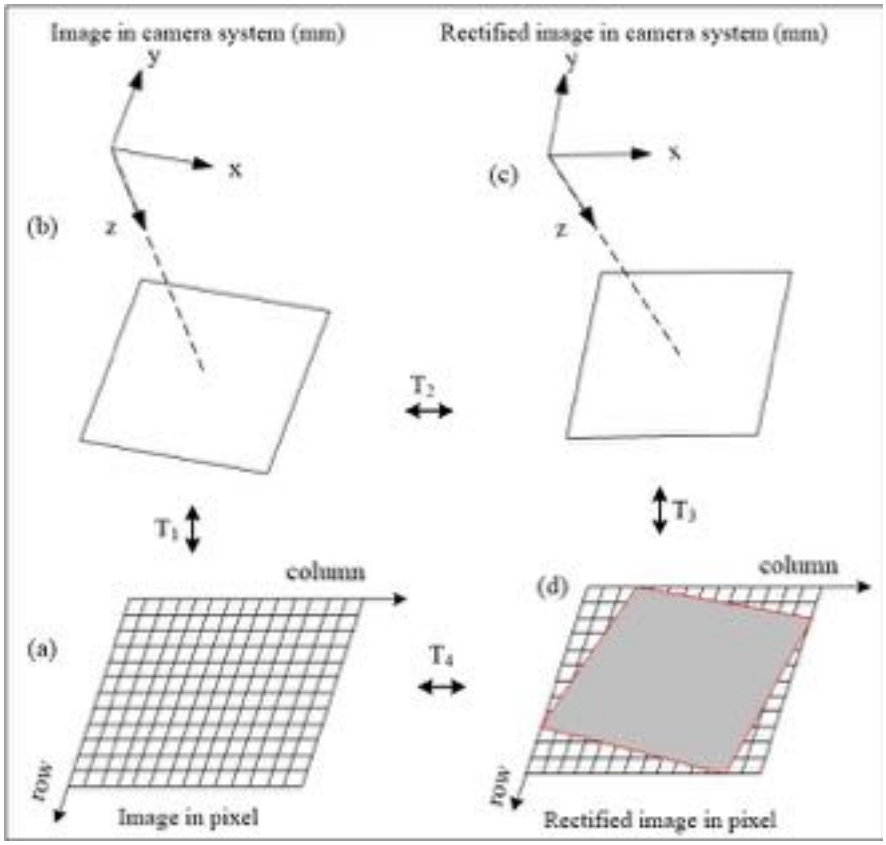


Figure 2. A relationship between the original and normalized stereo pair.

A change from the normalized image coordinates to normalized pixel coordinates is performed by using the relationship dx_{max} = resolution in x' direction, and dy_{max} = resolution in y' direction. Two options are available to determine the size of the normalized digital image. The first keeps the original resolution. The created normalized digital image will have a different pixel size from the original one. The second retains the original pixel size, but it has a different number of pixels (or different resolutions). T_4 involves epipolar rectification between the original digital image and the normalized one. The transformation is accomplished using indirect differential rectification [16] and each pixel tessellation is calculated through T_3, T_2, and T_1 as illustrated in Figure 2.

3. Results and discussion

Data for the demonstration are two unrectified stereo images (Figure 3) with known interior and exterior orientation parameters. The algorithm above is implemented in C++, developed algorithms are applicable for grey value images only, however they can be extended to input colour images.

After determining the origin and size of the normalized stereo, tessellation grids of these images are ready to be filled in by grey values from the originals which are done through T_4 transformation. Bilinear interpolation is chosen to resample grey values. A pair of the normalized images is created: the preserving resolution pair (Figure 4 left-column) and the preserving pixel size pair (Figure 4 right-column).

There is a possibility of the loss of information on normalized images due to the choice of interpolation method as well as resolutions and pixel sizes. The effect of the loss of information is noticeable. Blurring effects in all patches are caused by employing the bilinear interpolation method.

However, the use of option preserving resolution (Figure 4 left-column) may result in corrupted edge information. It was revealed that the corrupted edges can affect a process of stereoscope viewing. Hence, this option is not recommended. The normalized images from option preserving pixel size (Figure 4 right-column) also have drawbacks. The computational time is much greater than that of the first option. Moreover, the resulting normalized image file size generated using this option is bigger than that from using the other one. However, this option would result the most accurate epipolar line location which can produce a zero y parallax.

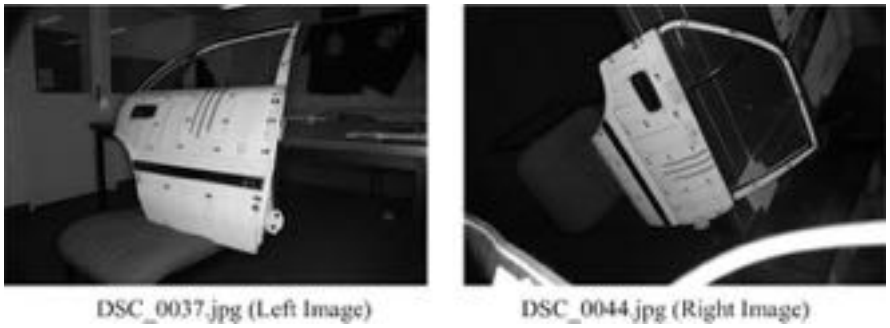


Figure 3. Input stereo pair.

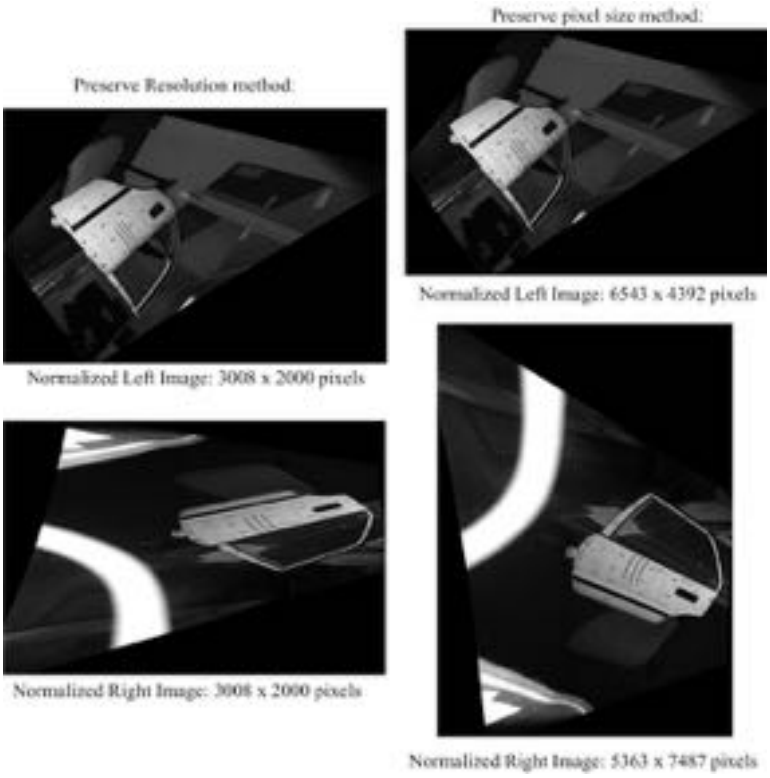


Figure 4. Two methods of normalizing stereo pair.

This method results distortion-less stereo images since it incorporates camera distortion parameters while performing image rectification process. Another improvement of this method is that two different resolutions of stereo image can be produced due to the Ω rotation. A choice of preserving pixel size would result a zero y-parallax and it is the most accurate epipolar line location. Furthermore, this method can align epipolar lines with geodetic reference frame provided that stereo images' exterior orientation parameters are supplied with GPS coordinates.

4. Conclusion

Epipolar rectification of a stereo pair with respect to the object space and by adding systematic errors of lens distortion as well as electronic imaging defect terms is important in the digital image processing. This method can align epipolar lines parallel to the axes of the any reference frame system. This method successful and operational to eliminate the y-parallax and to make the resulted epipolar line truly aligned with the Y axis of the reference system. When the image is rotated, the net area becomes larger. Maintaining the image resolution causes the pixel size larger, but maintaining a constant pixel size requires a higher resolution image. Furthermore, a developed C++ program for precise stereo image rectification is successfully implemented.

Acknowledgments

This work was funded by Ministry of Research, Technology and Higher Education of the Republic of Indonesia.

References

[1] Li S, Ma L and Ngi Ngan K 2013 Anaglyph image generation by matching color appearance attributes *Signal Process. Image Commun.* **28** 597–607
[2] Tjahjadi M E, Handoko F and Sai S S 2017 Novel image mosaicking of UAV's imagery using collinearity condition *Int. J. Electr. Comput. Eng.* **7** 1188–96
[3] Kedzierski M and Delis P 2016 Fast Orientation of Video Images of Buildings Acquired from a UAV without Stabilization *Sensors* **16** 1–16
[4] Herráez J, Denia J L, Navarro P, Rodríguez J and Martín M T 2013 Epipolar image rectification through geometric algorithms with unknown parameters *J. Electron. Imaging* **22** 1–11
[5] Hartley R I 1999 Theory and Practice of Projective Rectification *Int. J. Comput. Vis.* **35** 115–27
[6] Monasse P, Morel J-M and Tang Z 2010 Three-step image rectification *BMVC 2010-British Machine Vision Conference* (BMVA Press) pp 89.1--89.10
[7] Cho W and Schenk T 1992 Resampling Digital Imagery to Epipolar Geometry ed L W Fritz and J R Lucas *Int. Arch. Photogramm. Remote Sens.* **29** 404–8
[8] Wackrow R, Chandler J H and Bryan P 2007 Geometric consistency and stability of consumer-grade digital cameras for accurate spatial measurement *Photogramm. Rec.* **22** 121–134
[9] Liu J, Guo B, Jiang W, Gong W and Xiao X 2016 Epipolar rectification with minimum perspective distortion for oblique images *Sensors (Switzerland)* **16** 1–17
[10] Jannati M, Valadan Zoej M J and Mokhtarzade M 2018 A novel approach for epipolar resampling of cross-track linear pushbroom imagery using orbital parameters model *ISPRS J. Photogramm. Remote Sens.* **137** 1–14
[11] Liansheng S, Jiulong Z and Duwu C 2009 Image rectification using affine epipolar geometric constraint *J. Softw.* **4** 27
[12] Tjahjadi M E 2016 A fast and stable orientation solution of three cameras-based UAV imageries *ARPN J. Eng. Appl. Sci.* **11** 3449–55
[13] Tjahjadi M E and Handoko F 2017 Single frame resection of compact digital cameras for UAV imagery *International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)* vol 4, ed M A Riyadi, M Facta, D Setiawan and H Rahmawan (Yogyakarta: IEEE Computer Society Press) pp 409–13
[14] Tjahjadi M E and Agustina F D 2019 Fast and stable direct relative orientation of UAV-based stereo pair *Int. J. Adv. Intell. Informatics* **5** 24–39
[15] Förstner W, Wrobel B, Paderes F, Fraser C S, Dolloff J, Mikhail E M, Rujikietgumjorn W and McGlone J C 2013 Analytical Photogrammetric Operations *Manual of Photogrammetry: 6th Edition* ed J C McGlone (Bethesda, Maryland: American Society for Photogrammetry and Remote Sensing) pp 785–955
[16] Novak K 1992 Rectification of Digital Imagery *Photogramm. Eng. Remote Sens.* **58** 339–44