Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development

Muhammad Nawaz Tunio · Angeles Sánchez ·
Yasmin Moanis Latif Hatem · Ayman M. Zakaria *Editors*

Sustainability in Creative Industries

Sustainable Entrepreneurship and Creative Innovations—Volume 1

IEREK RESEARCH & KNOWLEDGE ENRICHMENT

Springer

Advances in Science, Technology & Innovation

IEREK Interdisciplinary Series for Sustainable Development

Advances in Science, Technology & Innovation (ASTI) is a series of peer-reviewed books based on important emerging research that redefines the current disciplinary boundaries in science, technology and innovation (STI) in order to develop integrated concepts for sustainable development. It not only discusses the progress made towards securing more resources, allocating smarter solutions, and rebalancing the relationship between nature and people, but also provides in-depth insights from comprehensive research that addresses the **17 sustainable development goals (SDGs)** as set out by the UN for 2030.

The series draws on the best research papers from various IEREK and other international conferences to promote the creation and development of viable solutions for a **sustainable future and a positive societal** transformation with the help of integrated and innovative science-based approaches. Including interdisciplinary contributions, it presents innovative approaches and highlights how they can best support both economic and sustainable development, through better use of data, more effective institutions, and global, local and individual action, for the welfare of all societies.

The series particularly features conceptual and empirical contributions from various interrelated fields of science, technology and innovation, with an emphasis on digital transformation, that focus on providing practical solutions to **ensure food, water and energy security to achieve the SDGs.** It also presents new case studies offering concrete examples of how to resolve sustainable urbanization and environmental issues in different regions of the world.

The series is intended for professionals in research and teaching, consultancies and industry, and government and international organizations. Published in collaboration with IEREK, the Springer ASTI series will acquaint readers with essential new studies in STI for sustainable development.

ASTI series has now been accepted for Scopus (September 2020). All content published in this series will start appearing on the Scopus site in early 2021.

Muhammad Nawaz Tunio · Angeles Sánchez ·
Yasmin Moanis Latif Hatem · Ayman M. Zakaria
Editors

Sustainability in Creative Industries

Sustainable Entrepreneurship and Creative Innovations—Volume 1

A culmination of selected research papers from the International Conference on Sustainability in Creative Industries (SCI), Universitas Ciputra 2022

Springer

Editors
Muhammad Nawaz Tunio
Department of Business Administration
University of Sufism and Modern Sciences
Bhitshah, Pakistan

Yasmin Moanis Latif Hatem
Department of Architecture
College of Engineering
Delta University for Science and Technology
Mansoura, Egypt

Angeles Sánchez
Department of Applied Economics
Faculty of Economics
University of Granada
Granada, Spain

Ayman M. Zakaria
Department of Architecture
Faculty of Fine Arts
Minia University
Minia, Egypt

ISSN 2522-8714 ISSN 2522-8722 (electronic)
Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development
ISBN 978-3-031-48452-0 ISBN 978-3-031-48453-7 (eBook)
https://doi.org/10.1007/978-3-031-48453-7

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Paper in this product is recyclable.

Scientific Committee

Muhammad Nawaz Tunio, University of Sufism and Modern Sciences, Bhitshah, Pakistan
Ghazala Shaukat, University of Sindh, Jamshoro, Pakistan
Erum Shaikh, Shaheed Benazir Bhutto University, Sanghar Campus, Pakistan
Faisal Sultan, KASBIT, Karachi, Pakistan
Saeed Siyal, Greenwich University, Karachi, Pakistan
Stephanie Black, Texas A&M University-San Antonio, USA
Leon Tan, Institute of Technology, Auckland, New Zealand
Ranti Rachmaw, Telkom University, Indonesia
Saimir Shtylla, Barleti University, Albania
Antonio Luis Pérez Corral, University of Granada, Spain
Angel Fernández Pérez, University of Granada, Spain
Angeles Sánchez, University of Granada, Spain
Soheir Abdelrheem Abo Eloyoun, University of Minia, Egypt
Saleh Abd Rabu Ali, University of Minia, Egypt
Amal El Deberky, University of Minia, Egypt
Raymond Sutjiadi, Institut Informatika Indonesia, Surabaya, Indonesia
Ariel Kristianto, Institut Informatika Indonesia, Surabaya, Indonesia
Hassan Shaban, University of Minia, Egypt
Waleed Makram Mohamed, University of Minia, Egypt
Mai Abdelsalam Soliman, Getinform School, Qatar
Fatmaelzahraa Hussien, Curtin University, Australia
Sara Mohamed Sabry, Delta University for Science and Technology, Egypt
Shimaa Fathy Ashour Mohamed, Higher Institute of Engineering and Technology, Egypt
Haider Shah, Bahria University, Islamabad, Pakistan
Muhammad Asif Qureshi, Mohammad Ali Jinnah University, Karachi, Pakistan

The Editors warmly thank all the Reviewers who have contributed their authority to the double-blind review process, to ensure the quality of this publication.

Preface

The massive impact of digital technology is transforming every industry. During the last 20 years, the narrower concept of creative industries (referred to arts and cultural industries) has evolved into the idea of creative economy. Creative economy envelops a multitude of fields, such as music and artistic expression, food and gastronomy, publishing, software, advertising and design, packaging, fashion and textile manufacturing, photography and videography. The ability to create and circulate intellectual capital has the potential to generate wealth and employment and, at the same time, promoting social inclusion, cultural diversity and environmental respect. That is, the creative economy can contribute effectively to the achievement of the Sustainable Development Goals.

Considering all these reasons, the celebration of the first International Conference "Sustainability in Creative Industries", organized by IEREK, has become an ideal forum to share ideas and experiences on this topic from different countries. This book includes a selection of papers presented at that conference, after passing a review process. The studies presented in this book volume have been carried out using a great variety of methods and techniques.

The book is structured in three parts. The first part "Sustainable Entrepreneurship: Characterization, Analysis, and Impacts" consists of five chapters. Chapter "The Key Characteristics of Sustainable Entrepreneurs" is focused on the study of the personal traits and skills that shape sustainable entrepreneurs. Key characteristics of sustainable entrepreneurs are identified: altruistic, innovativeness, the ability to balance values, probity and self-compassion. Chapter "Analysis of Factors Affecting Entrepreneurial Intention Among Undergraduates" shows that perceived desirability, locus of control, self-efficacy and entrepreneurial education are factors affecting entrepreneurial intention among undergraduates from Indonesia. The study in Chapter "The Influence of Entrepreneurial Alertness on New Venture Performance with Networking Capability as a Moderator at Start-Up in Surabaya", by using Partial Least Square, finds a significant association between entrepreneurial alertness and the new venture performance, where the moderating variable networking capability acts as a predictor of moderation. Chapter "Fashionpreneur: Sustaining Traditional Batik Craft Through Entrepreneurship Activity Among Students at Universiti Malaysia Kelantan (UMK)" presents the main results of the project "Fashionpreneur" in Malaysia with the objective of tracking how many students from this project will venture into the batik business after graduating. Finally, Chapter "Mascot and Brand Sustainability in Pandemic Era: Systematic Literature Review" aims at presenting the results of a systematic literature review on the utilization of mascots for place branding from 2020 to 2022.

In both creative and non-creative industries, probably the most valued skill of a worker is their creativity. To do this, from the academic field, activities and evaluation systems must be designed to encourage students' creativity. The second part of this book, with eight chapters, focuses on "Innovative Approaches to Teaching and Pedagogy in Creative Design Education". Chapter "Explorative Learning Space for Developing Motoric Skills in the Early Childhood Stage" shares the experience of the construction of a multi-function space designated for children to support the growth and development of their motoric skills. Following the Vitruvius design principles, this design allows integrating both activities of playing and learning in one space to encourage the spirit of learning in children. Chapters "Utilizing

Virtual Reality to Support Teaching the Design Principles of the Life-Safety System" and "Virtual Personal Branding Education Workshop for GenIUS School Students Using Framework for Innovation Participatory Design Method" discuss the advantages of using virtual learning methods in architecture studios and in a private school in the context of the pandemic, respectively. Following the survey method, Chapter "The Impact of a Connectivist Learning Environment on Indonesian Design Students' Learning Experiences Through MOOC" analyzes the satisfaction of undergraduate students in Indonesia with MOOC as a methodology to foster the learning process during the COVID-19 pandemic and, more importantly, for the after-pandemic period in an increasingly digitized education context. Results show that this method is very well evaluated by the students. Dealing with a radical vision of education for sustainability, Chapter "Competences, Capabilities, and Skills in Teaching and Learning Fashion Design for Sustainability" illustrates the definition of competencies, capabilities, and acquired skills in teaching and learning fashion design for sustainability through a holistic approach based on the sustainability pillars: environment, economy, society and culture. Chapter "Project-Based Learning (PBL): Student Creativities in the Upcycling Projects" presents the results of the project-based learning focused on increasing student's creativity in project upcycling for fabric waste. Positive outcomes of the project are improvements in student creativity in the products made, originality in describing problems, and creativity in finding solutions. Chapter "Upcycling the Abandoned Students Artwork with Bateson's Type of Learning in Entrepreneurship Course" describes the results of a practical experience with artworks by students from the entrepreneurship course in a private university in West Java, Indonesia. Specifically, they reused and recycled previous assets from their colleagues or themselves and explored the possibility of making them suitable for certain targets using Gutman's Means-End theory. Finally, Chapter "Student Perception and Behavioral Changes in Blended Learning Implementation" investigates students' behavior and attitude toward blended learning by comparing first-time and second-time users.

The third and last part of this book, with five chapters, is focused on "Technological Advancements and Sustainability-Based Innovations in Creative Industries". Chapter "The Collaboration Between Academic and Industry in Creative Industry and Sustainability-Based Programs: The Academic Perspective" highlights the advantages of the collaboration between academic and creative industry in Indonesia based on sustainability programs. Chapters "Sound Visualization Based on Font Modification Using the Sound of Angklung" and "The Implementation of Deep Learning Technique in Mobile Application as a Preservation and Learning Media of Javanese Letter" show the application of technological advances such as artificial intelligence to foster the conservation of local heritages. More specifically, Chapter "Sound Visualization Based on Font Modification Using the Sound of Angklung" presents the sound visualization-based font modification, using the Sound of Angklung difficulty. In Chapter "The Implementation of Deep Learning Technique in Mobile Application as a Preservation and Learning Media of Javanese Letter", mobile application is developed using deep learning technique with VGG-16 convolutional neural network architecture, as the cutting-edge method of artificial intelligence, to recognize Javanese letter and convert it into Latin alphabet. Chapters "Web-Based Human Resource Information System Design AT PT. Cakra Mandala Sakti Surabaya", "User Experience Toward Sustainable Choice: Case Study ZALORA Indonesia" and Chapter "Web-Based Human Resource Information System Design AT PT. Cakra Mandala Sakti Surabaya" conduct case studies of creative innovations that foster economic sustainability. Chapter "Web-Based Human Resource Information System Design AT PT. Cakra Mandala Sakti Surabaya" presents a Web-based human resource information system to optimize the operational management process. Chapter "User Experience Toward Sustainable Choice: Case Study ZALORA Indonesia" explains a technique of automotive modelmaking that uses waste wood. Finally, Chapter "User Experience Toward Sustainable Choice: Case Study ZALORA Indonesia" aims at studying the intervention needed on the user experience aspect that could encourage more conscious shopping through the Zalora Earth Edit platform.

Granada, Spain Angeles Sánchez

Acknowledgments We extend our gratitude to the authors of the research papers which were selected to be included in this book. We also express our appreciation to the reviewers who generously shared their expertise and provided valuable feedback, contributing to the overall quality of the manuscript. We would like to acknowledge the editors of this book for their insightful organization of the volume and their dedicated efforts in editing it professionally. Additionally, we would like to thank the IEREK team for their support in facilitating the publication of the outstanding research papers submitted to the conference.

Contents

The Implementation of Deep Learning Technique in Mobile Application as a Preservation and Learning Media of Javanese Letter

Raymond Sutjiadi, Timothy John Pattiasina, and Peter Santoso

Abstract

Indonesia as the largest archipelagic country in the world has many local heritages. One of the valuable heritages is local language, which is 718 local languages in total from 37 provinces in Indonesia. Javanese language is a local language used by many people in Java Island, the most crowded mainland in Indonesia. This language has specific form of letter, differ from Latin alphabet. Because of that, nowadays people rarely learn how to write Javanese letter because of its difficulty. In this research, mobile application is developed using deep learning technique with VGG-16 convolutional neural network (CNN) architecture, as the cutting-edge method of artificial intelligence, to recognize Javanese letter and convert it into Latin alphabet. By using this application, younger generation can learn Javanese letter easily and in attractive way. Three main features are provided, i.e., scanning the letter, writing the letter, and converting the letter. Users are able to learn how to read and write Javanese letter, also receive feedback score from the system. This application is aimed as a preservation and learning media for those who want to learn Javanese letter using information technology. Based on testing result, this application has 89% of accuracy to recognize Javanese letter.

Keywords

Deep learning · Convolutional neural network · Artificial intelligence · Mobile application · Javanese letter

R. Sutjiadi (✉) · P. Santoso
Informatics Department, Faculty of Information Technology, Institut Informatika Indonesia Surabaya, Surabaya, Indonesia
e-mail: raymond@ikado.ac.id

T. J. Pattiasina
Information System Department, Faculty of Information Technology, Institut Informatika Indonesia Surabaya, Surabaya, Indonesia
e-mail: temmy@ikado.ac.id

1 Introduction

Indonesia is the largest archipelagic country located in South East Asia with more than 272 million population and inhabit more than 1.9 million square kilometer area (BPS, 2022). Based on the census data in 2010 held by Center of Statistics Bureau, Indonesia comprises more than 300 groups of ethnic (Sari et al., 2018). This factor makes Indonesia rich of traditional cultures as the invaluable heritage that need to be preserved in this modern era. Every ethnic possesses specific traditional culture in form of traditional apparel, house, song, and language. Some of them have already been recognized as world heritage by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Indonesia owns 718 local languages in total (Kwary, 2019) from 37 provinces in Indonesia.

One of the biggest ethnics in Indonesia is Javanese, which settles in most part of Java island (Central Java, Special District of Yogyakarta, East Java), and some of them also migrate in other parts of Indonesia island (Muttaqien et al., 2018). This ethnic has many specific traditional cultures, and most of them still exist until now. Javanese has their own specific letter, differs from Latin alphabet, as a written communication medium since the mid-fifteenth century called Javanese letter or sometimes also called as Hanacaraka, Carakan, and Dentawyanjana (Suria, 2018). This letter consists of 20 basic characters represent vowel sound called Aksara Nglegena as seen in Fig. 1. Besides Aksara Nglegena, there are additional characters called Aksara Murda (Fig. 2), Aksara Mahaprana (Fig. 3), Aksara Swara (Fig. 4), and Aksara Ganten (Fig. 5). Javanese letter has similar format with the letter of Balinese and Sundanese because those letters are descended from Aksara Kawi, the older letter used in the era of Sriwijaya Kingdom (Zurbuchen, 1976).

On the other side, nowadays younger generation is exposed by many modern cultures from other countries via

M. Nawaz Tunio et al. (eds.), *Sustainability in Creative Industries*,
Advances in Science, Technology & Innovation, https://doi.org/10.1007/978-3-031-48453-7_16

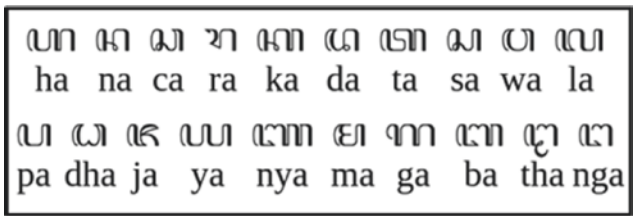


Fig. 1 Twenty characters of Aksara Nglegena

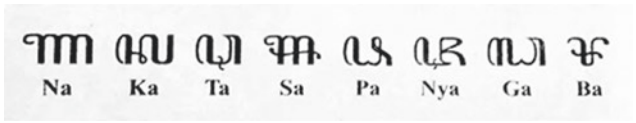


Fig. 2 Eight characters of Aksara Murda

Fig. 3 Four characters of Aksara Mahaprana

Fig. 4 Seven characters of Aksara Swara

Fig. 5 Two characters of Aksara Ganten

television program, music, and other media. Foreign culture is more appreciated, instead of Indonesian local culture itself, because it can be accessed easily via electronic device, such as computer, smartphone, and tablet, which in general already owned by younger generation. The content is more enjoyable, so many people idolize them, for example, Anime, Manga, and J-pop from Japan. It is spreading quickly online, and as more people are exposed to and aware of this Japanese popular culture, the influence will be even more profound (Bangsa & Sihombing, 2022). This factor becomes an impediment to introducing local traditional culture to the younger generation and further, it will eliminate the actors who preserve the Indonesian culture.

The preservation of Javanese letter becomes a tough challenge, not only for government institutions, but also for educators. The Indonesia government via the Ministry of Education, Culture, Research, and Technology issues a policy where Javanese language and literature become a local course curriculum in school located in Central and East Java (Rahadini & Nurhayati, 2022). This effort is to increase the number of people who understand the Javanese language, including how to write Javanese letter. But in practice, this subject is often considered less important than other courses, and students' interest in learning Javanese language is still low comparable to the other languages (Nurmasari et al., 2017), like English and Mandarin.

Based on the above situation, it needs innovative way how to introduce Javanese letter to younger generation. In this research, mobile application based on Android is developed as a media to learn Javanese letter. Not only for educational purpose, this application is also implemented the artificial intelligence to recognize Javanese letter and convert it into Latin alphabet characters. So by using this application, younger generation is able to learn Javanese letter in more fun and enjoyable way.

2 Research Methodology

This research uses some methodologies to build the application. Rapid application development (RAD) is a robust methodology for developing mobile applications rapidly. Convolutional neural network (CNN) as a deep learning method is implemented for the intelligent system to support the recognition features. This research also adopted VGG-16 as a CNN model that has proven to be used as an image recognition engine.

2.1 Rapid Application Development (RAD)

To develop this application, it will be used rapid application development (RAD) methodology as a software development life cycle (SDLC). RAD model is a prototyping-based method and develop iteratively without specific planning involved (Fatima et al., 2018). RAD also focuses on users requirements by building prototyping model, which developed iteratively based on suggestions and testing from users. Different from waterfall methodology, which states that software developer teams should have a detailed roadmap for the project, RAD does not have complicated planning. Basically, RAD methodology aims to develop the applications faster. Continuous feedback analysis and frequent interactions are needed to achieve good result. RAD supports quick program design progression and makes without question transport on adjusted time (Yashod, 2021). Figure 6 shows RAD processes, where every phase will be continued by the next phase until finish. This continuous phase will be repeated until prototypes fulfill all system objectives and requirements.

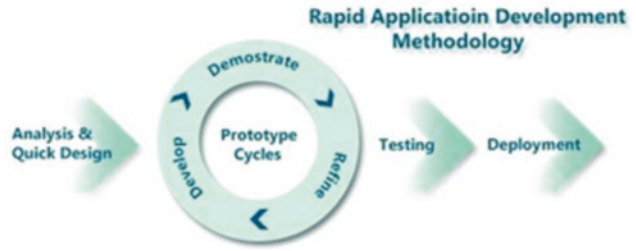


Fig. 6 Rapid application development (RAD) methodology

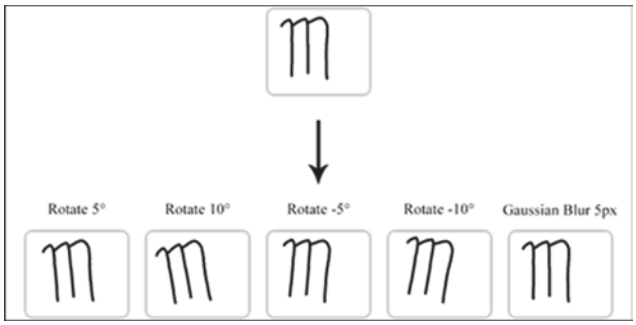


Fig. 7 Dataset image preprocessing

The first phase of the RAD is to gather all the information related to the system requirements. In this phase, developer should do system requirement analysis by interviewing the users, distributing questionnaire, studying the literatures (books or journals), or observing the business process. Based on the result of system requirement analysis, developer then creates quick design of the application. The second phase is the repetitive stage for prototyping development phase. During this phase, developer will implement quick design into product prototype. This product prototype should be expanded by accommodating user needs. Developer should demonstrate this prototype to the users and refine it based on user feedback. The third phase is testing the prototype. In this phase, product prototype is already mature and ready to be tested for final deployment. The last phase is deployment in the actual environment after all system functionalities have been validated.

This application comprises into two modules, and each module is separated into five stages of development (Sasmito et al., 2020), i.e.,

(a) Module for dataset training and testing, written using Python programming language, TensorFlow framework, and Keras library. This module results data model which will be used by the Android application and becomes an important part to recognize Javanese letter accurately based on artificial intelligence training process.

- Business modeling: In this first stage, dataset is collected by gather hand written samples of Javanese letter from some people. Dataset used to build a data model consists of 250 vector images per 20 characters of Aksara Nglegena only. So, the total dataset is 5000 vector images.
- Data modeling: In this stage, collected sample data is preprocessed to be fitted to the required specification to optimize the data training results. To generate dataset and maximize the variant of the image, every image data is entering preprocessing stage where there are image binarization process and other five image processing methods (apply image rotating and Gaussian filter) as shown in Fig. 7. The objective of this process is to minimize the overfitted data model.
- Process modeling: In this stage, final dataset is uploaded to the Kaggle platform and openly published to be used by other developers.
- Application generation: This is the main stage, where this module is developed using Python programming language in Kaggle environment system.
- Testing: the last stage where resulted data model is optimized by tuning hyperparameter to search the most optimum accuracy value. The final data model then will be hosted on the cloud server as a source of knowledge for Android application to recognize Javanese letter and convert it into particular Latin alphabet characters.

(b) Module for Android application, written using Java programming language. This application will be used by the users to scan Javanese letter using smartphone camera and convert it into Latin alphabet characters, based on data model created by first module.

- Business modeling: In this first stage, literature study is conducted to search similar research and find state-of-the-art to be developed.
- Data modeling: In this stage, prototyping model is developed by designing user interface to accommodate every feature on application.
- Process modeling: In this stage, final prototyping model is developed by arranging some improvements based on user needs.
- Application generation: This is the main stage, where this module is developed using Java programming language in Android Studio IDE.
- Testing: the last stage where mobile application is ready to be used and tested by the users to find some bugs and optimize its accuracy.

2.2 Convolutional Neural Network (CNN)

Convolutional neural network (CCN) is a popular deep learning algorithm that processes certain input digital images to provide the knowledge to detect the item

categories by giving some important variables (biases and weights) to various characteristics and objects in the image. Convolutional neural network (CNN) has shown excellent performance in many computer vision and machine learning problems (Khan et al., 2020). The development of CNN has had a tremendous influence in the field of computer vision in recent years and is responsible for a big jump in the ability to recognize objects (Voulodimos et al., 2018). This fast achievement has been enabled by increasing the amount of data that available for data training and also supported by the computing power enhancement.

The CNN design has kernels or filters that can find edges or features throughout a digital image. Every digital image on CNN is represented by an array of pixel values for each color channel, which is often an RGB or 3-channel image. More precisely convolutional layers are able to detect patterns on images. A kernels is a collection of weight values in form of matrix which is trained to detect specific features on an image. The fundamental principle of CNN is to spatially convolve the kernel on an input image and determine whether any features have been identified. The spatial translation of the input from a characteristic detection layer will be conveyed to the output unchanged since each filter or kernel seeks to identify a specific characteristic at each input point. A convolution process is performed by computing the dot product of the kernel and the input area where the kernel is overlapped to obtain a value expressing how sure it is that a certain feature is present (Kumar & Kumar, 2018). Figure 8 depicts the fundamental CNN structure (You et al., 2017).

2.3 VGG-16 Architecture Model

VGG-16 is a CNN model developed by Simonyan and Zisserman (2015) from University of Oxford, to classify large-scale image and maintain its peak performance to result good accuracy. This model won as runner-up position in ILSVRC-2014 challenge with less than 7.5% test error. VGG-16 model is good to be used as image classification algorithm because of its robustness.

This model comprises 13 convolutional layers and three fully connected layers as shown in Fig. 9. Max Pooling is used to extract low-level features such as edges and points. Softmax is used as an activation function to calculate the relative probability value between 0 and 1 based on the model confidence correlated to which class the image belong to. In this research, there are 20 classes of Javanese letter (Aksara Nglegena) to be classified as an output. The highest probability value will be taken as a final recognition result. Detailed per layer VGG-16 architecture process is shown in Table 1.

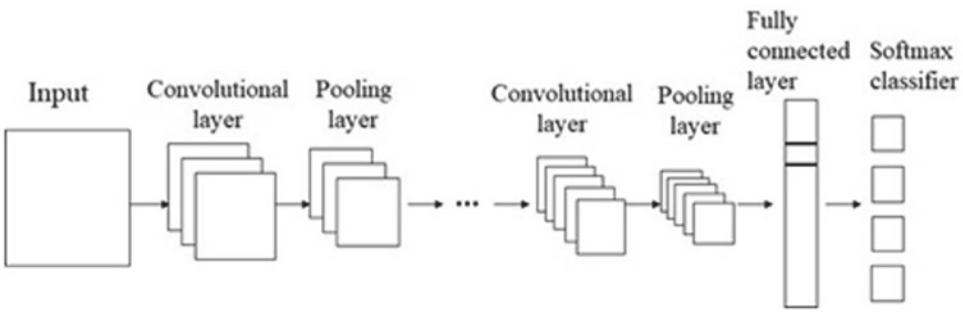
3 Result and Discussion

3.1 Use-Case Diagram

In general, this Andorid mobile application has four features or menus that can be accessed by the users (as shown in Fig. 10), i.e.,

- Scanning: Users can access this menu to scan a letter of Javanese letter (Aksara Nglegena) using smartphone camera, and application will recognize that letter utilizes VGG-16 (CNN) method. The recognition result in form of particular Latin alphabet characters will be shown on screen.
- Learning: Users can learn how to write Javanese letter (Aksara Nglegena) by writing the letter directly via smartphone touch screen. Application will recognize the result and give a score based on artificial intelligence.
- Converting: Users can type the Latin alphabets, and application will convert it into respective Javanese letters (Aksara Nglegena). Also, users are able to copy the characters or share it to another application.
- Setting: Allows users to change the functionality and behavior of an application. Users may access this menu to change some tuning parameters related to the function of the application.

Fig. 8 Basic structure of CNN



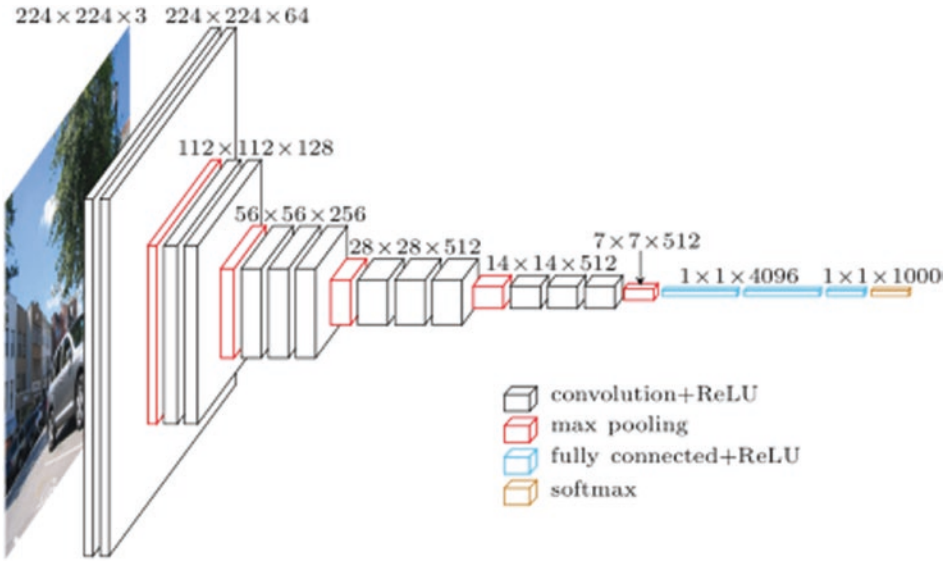


Fig. 9 Architecture of VGG-16

Table 1 List of VGG-16 per layer process

No	Layer	Description
1	Conv3-64	64 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
2	Conv3-64	64 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
3	Maxpool	Max pooling process, matrix 2 × 2, stride 2 × 2
4	Conv3-128	128 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
5	Conv3-128	128 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
6	Maxpool	Max pooling process, matrix 2 × 2, stride 2 × 2
7	Conv3-256	256 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
8	Conv3-256	256 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
9	Conv3-256	256 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
10	Maxpool	Max pooling process, matrix 2 × 2, stride 2 × 2
11	Conv3-512	512 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
12	Conv3-512	512 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
13	Conv3-512	512 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
14	Maxpool	Max pooling process, matrix 2 × 2, stride 2 × 2
15	Conv3-512	512 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
16	Conv3-512	512 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
17	Conv3-512	512 channel convolution layer, 3 × 3 matrix, padding = 'same', ReLU activation rectified
18	FC-4096	Fully connected dense layer of 4096 units, ReLU activation
19	FC-4096	Fully connected dense layer of 4096 units, ReLU activation
20	FC-20	Fully connected dense layer of 20 units, Softmax activation

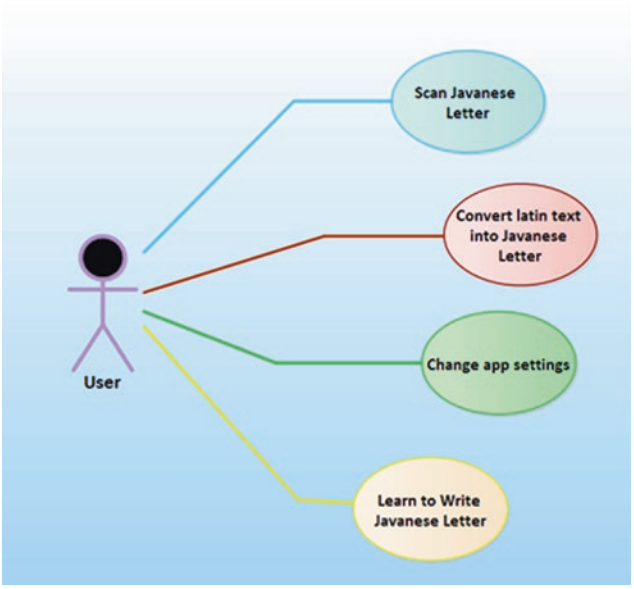


Fig. 10 Use-case diagram

3.2 Architectural Design

Architectural design depicts the relationship between the user and many subsystems related to the application. Based on Fig. 11, it can be seen that user will interact directly to application using Android smartphone device. This application has to access the cloud backend server via Internet connection, where data model hosted and run a Python web service. This web service stand by to receive a sample image from smartphone and process the recognition. In this case, a neural network model that has been trained is needed to be used in the prediction process of scanning a Javanese letter and learning to write in Javanese. The recognition result then will be sent back to the application via Internet connection and inform to the user on display screen.

3.3 User Interface Design

Designing good user interface plays an important part because user will have experience using this application via all features provided in user interface. All menus must be stated clearly about the function to help user operate all features smoothly. Also, user interface design must represent the theme of the application. Because this application is about Javanese culture, user interface uses brown as the main color combined with white color, inspiring from the color of Batik—traditional textile design from Java. There are five pages in this application that can be accessed by the user, i.e.,

- Main page: On this page, user will find four main buttons to access four features provided by the application. Scan menu to access the scanning page, convert menu to access the conversion feature, exercise menu to access the learning feature, and setting menu to access setting page. At the top, there is information of application name written using typography similar to Javanese letter, version number, and the photo of Borobudur temple—historical temple from Java—as the background image. The user interface design for main page is shown in Fig. 12.
- Scanning page: This is the main feature of this application. By accessing this page, application will activate smartphone camera automatically, and user just aims the Javanese letter as the camera focuses. If system recognizes the character, there will be pop up menu to inform the respective Latin alphabet. The user interface design for scanning page is shown in Fig. 13a and b.
- Learning page: By accessing this page, application will show 20 buttons, one button for each Javanese letter (Aksara Nglegena). User has to select one of them, and system will open white drawing space, where user can practice how to write selected Javanese letter using touch screen. After submit it, system will show the result and the similarity score based on artificial intelligence. The user interface design for learning page is shown in Fig. 14a, b, and c.

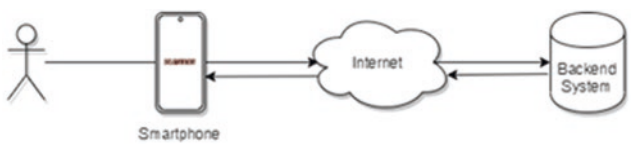


Fig. 11 Architectural design

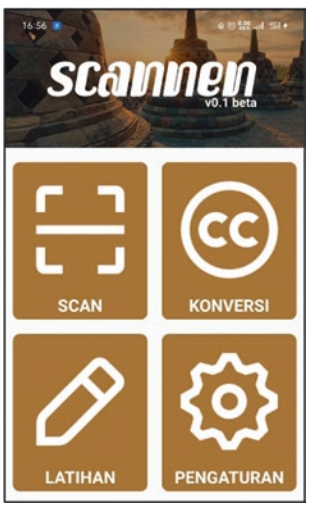


Fig. 12 Main page user interface design

- Converting page: On this page, there are two text boxes, the top for typing Latin alphabet character and the bottom to show the Javanese letter. Also there is copy button, where the user can copy the text and paste it to another application. The user interface design for converting page is shown in Fig. 15.
- Setting page: This is the special page to adjust the application setting. Also in this page user can access the tutorial page, asking question via email, and read the developers identity. The user interface design for setting page is shown in Fig. 16.

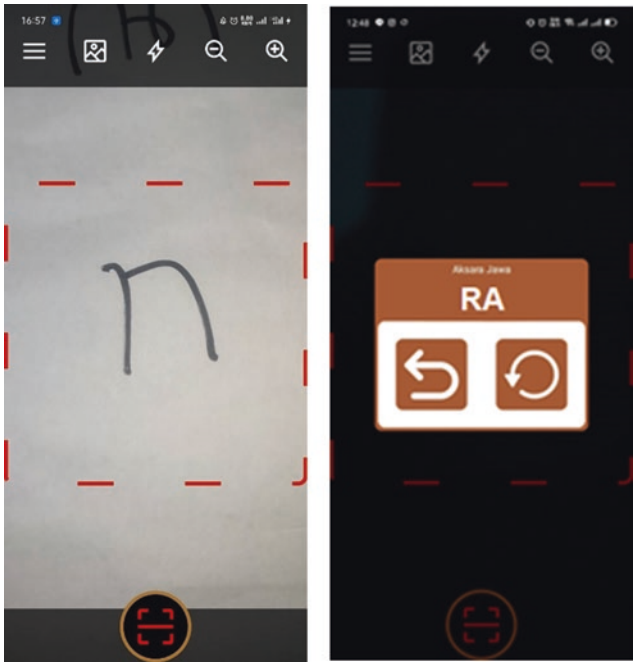


Fig. 13 Scanning page user interface design

3.4 Application Testing

Developing artificial intelligence application must be tested its accuracy to improve user experience. To test the accuracy of recognition feature, the application will be used to scan several handwritten Javanese letters (Aksara Nglegena) as shown in Table 2 Figures a–i. Javanese letter is written on a white paper sheet using black permanent ink with proper thickness. An Android smartphone equipped with back camera is used as a device to install and test the application. The testing conducted in well-lit environment to maximize the image quality. From the result of testing as shown in Table 2, it is found that the system accuracy is 89%.

4 Conclusion

The development of Android application to recognize Javanese letter using deep learning method is able to run all features well. The recognition system also works reliably with 89% accuracy to predict handwritten Javanese letter. By using this application, user can learn how to write Javanese letter as well and get a feedback score using artificial intelligence. This application also has a feature to make it easy to type Javanese letter by using Latin alphabet characters.

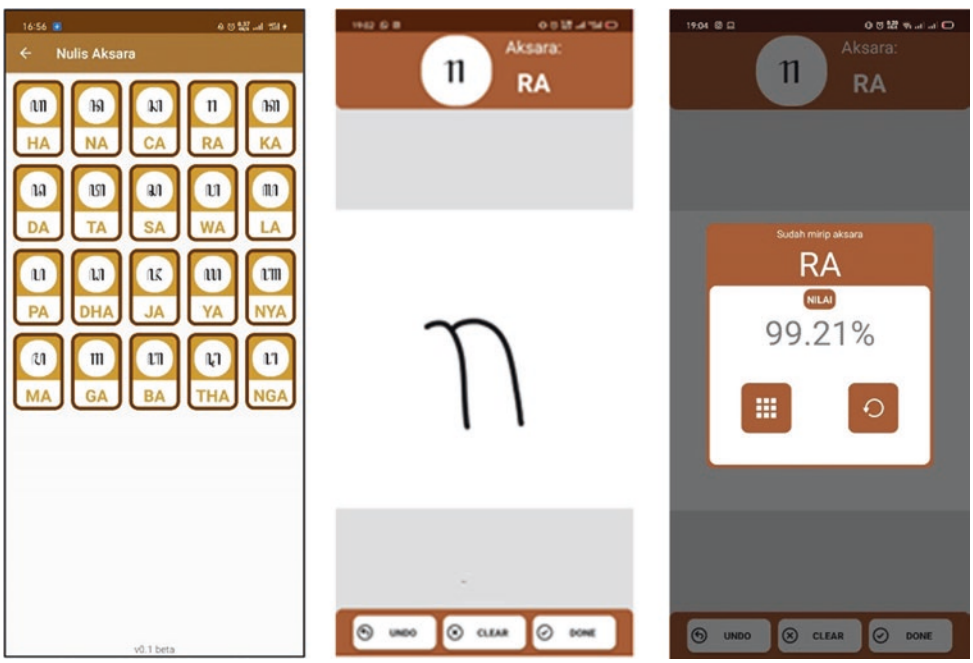


Fig. 14 Learning page user interface design

Fig. 15 Converting page user interface design

Fig. 16 Configuration page user interface design

This application not only functions as a tool, but also works as an innovative educational media to introduce Javanese letter to someone who wants to learn writing Javanese letter. Learning Javanese letter becomes more fun and enjoyable supported by the use of information technology devices and artificial intelligence which is already familiar to the younger generation. Learning Javanese letter is no longer boring, but user may use this application interactively. Furthermore, this application may contribute to the effort of Javanese letter preservation as well.

The user interface is designed by bringing the characteristic of Javanese cultures. The dominant color adopts the color of Batik, typography style uses font character that resembles Javanese letter, and background image uses Borobudur temple, one of the Javanese pride cultures. This makes application feeling closer to Javanese people.

Table 2 Application testing

Input image	Expected result	Recognition result	Conclusion
	DHA	THA	False
	GA	GA	True
	JA	JA	True
	KA	KA	True
	LA	LA	True
	NGA	NGA	True
	RA	RA	True
	THA	THA	True
	YA	YA	True

There are recommended suggestions for application improvement in the future. This application can be leveraged to recognize Javanese letter other than Aksara Nglegena. Also this application can be added the spelling sound of Javanese letter. So users not only learn writing Javanese letter, but also learn how to spell it. On the other hand, this application could be improved by adding some features to learn and recognize other languages that have particular type of letter, like Mandarin Chinese, Japanese, and Russian.

References

Bangsa, B. P. & Sihombing, L. H. (2022). The impact of Japanese popular cultures to Indonesian younger generation: A case study of PUNICO. *Humaniora, 13*(3), 241–246. https://doi.org/10.21512/humaniora.v13i3.8131

BPS. (2022). *Statistical yearbook of Indonesia 2022*. Badan Pusat Statistik.

Fatima, F., Javed, M., Amjad, F., & Khan, U. G. (2018). An approach to enhance quality of the RAD model using agents. *Journal of American Science, 14*(9), 47–55. https://doi.org/10.7537/marsjas140918.08

Khan, A., Sohail, A., Zahoora, U., & Qureshi, A. S. (2020). A survey of the recent architectures of deep convolutional neural networks. *Artificial Intelligence Review, 53*, 5455–5516. https://doi.org/10.1007/s10462-020-09825-6

Kumar, S., & Kumar, M. (2018). A study on the image detection using convolution neural networks and tenser-flow. In *International Conference on Inventive Research in Computing Applications (ICIRCA)* (Vol. 2, pp. 1080–1083).

Kwary, D.A. (2019). A corpus platform of Indonesian academic language. *SoftwareX*, 202–106.https://doi.org/10.1016/j.softx.2019.01.011

Muttaqien, A., Sologon, D., & O'Donoghue, C. (2018). Earnings polarization, ethnicity, and regional perspective in Indonesia. In *WIDER Working Paper 2018/106 United Nations University* (pp. 1–23).

Nurmasari, L., Subiyantoro, S., & Fadhilah, S. S. (2017). Primary school students' barriers on learning Javanese language: A case study in central Java, Indonesia. In *International Conference on Teacher Training and Education 2017 (ICTTE 2017)* (Vol. 158, pp. 436–444).

Rahadini, A. A., Nurhayati, E., & Suwarna. (2022). Teachers' beliefs about Javanese learning materials on local wisdom curriculum in Indonesia. *Journal of Language and Linguistic Studies, 18*(Special Issue 1), 348–358.

Sari, B. T., Vijver, F. J. R., Chasiotis, A., & Bender, M. (2018). Contextualized bilingualism among adolescents from four different ethnic groups in Indonesia. *International Journal of Bilingualism, 23*(6), 1469–1482. https://doi.org/10.1177/1367006918803678

Sasmito, G. W., Wibowo, D. S., & Dairoh, D. (2020). Implementation of rapid application development method in the development of geographic information systems of industrial centers. *Journal of Information and Communication Convergence Engineering, 18*(3), 194–200. https://doi.org/10.6109/jicce.2020.18.3.194

Simonyan, K., & Zisserman, A. (2015). Very deep convolutional networks for large-scale image recognition. In *The 3rd International Conference on Learning Representations (ICLR2015)*. https://doi.org/10.48550/arXiv.1409.1556

Suria, O. (2018). Development of word game algorithm for learning Javanese script. *CommIT (Communication and Information Technology) Journal, 12*(2), 73–86. https://doi.org/10.21512/commit.v12i2.4792

Voulodimos, A., Doulamis, N., Doulamis, A., & Protopapadakis, E. (2018). Deep learning for computer vision: A brief review. *Computational Intelligence and Neuroscience, 2018*, 1–13. https://doi.org/10.1155/2018/7068349

You, W., Shen, C., Guo, X., Jiang, X., Shi, J., & Zhu, Z. (2017). A hybrid technique based on convolutional neural network and support vector regression for intelligent diagnosis of rotating machinery. *Advances in Mechanical Engineering, 9*(6), 168–176.

Yashod, R. (2021). Overview of System Development Life Cycle Models. *Journal of Management and Science, 11*(1), 12–22. https://doi.org/10.26524/jms.11.3

Zurbuchen, M. S. (1976). *Introduction to old Javanese language and literature: A Kawi prose anthology*. University of Michigan Center for South and Southeast Asian Studies.