Jurnal Teknik Informatika (JUTIF)
Vol. 5, No. 4, August 2024, pp. 601-609

DOI: https://doi.org/10.52436/1.jutif.2024.5.4.2250
p-ISSN: 2723-3863
e-ISSN: 2723-3871

DIGITAL BUSINESS CARD (DiNa) APPLICATION USING CNN ALGORITHM AND OCR TECHNOLOGY AS A FORMAL INTRODUCTION SUGGESTION

Edi Junaedi[*1], Syabina Nur Pajriyanti[2], Muhammad Subali[3], Adrian Maulama Ramadhan[4]

[1,2,3,4] Informatics Engineering, Universitas Cendekia Abditama, Tangerang, Indonesia
Email: [1]edi@cendekia.ac.id, [2]syabinanf25@gmail.com, [3]subali@uca.ac.id, [4]maul@cendekia.ac.id

(Article received: June 7, 2024; Revision: June 22, 2024; published: August 21, 2024)

Abstract

The rapid development of technology makes digital business cards increasingly the first choice as a formal introduction tool that is more environmentally friendly, reducing dependence on the use of paper and ink. In addition to serving as a formal means of introduction, digital business cards are also an effective medium for conveying crucial information about an individual or company. The implementation phase of this application involves the utilization of Optical Character Recognition (OCR) as the main feature, with image pre-processing as a key step to improve reading accuracy, including noise reduction, data normalization, and compression. The process of optical scanning and location segmentation is the main foundation in processing data from Business Card images. The next step includes feature representation and extraction using TensorFlow's OCR technique to process the data efficiently. The integration of the OCR model into the API allows Kotlin-based mobile applications to communicate directly with the OCR model, providing real-time character recognition. The first trial aims to evaluate the accuracy and time taken by the OCR feature in recognizing each text on the Business Card. Tensorflow and Easy-OCR models with 41.86% accuracy were used for object detection and optical character recognition, resulting in a system that is efficient, responsive, and allows model updates without interrupting the main functionality of the application. The app successfully combines eco-friendly aspects with advanced technology, creating a modern solution to meet the needs of effective formal introductions. Thus, this Digital Business Card application is not only an eco-friendly alternative, but also realizes efficiency in retrieving identification information directly through a mobile platform.

Keywords: *Android, CNN, Digital Business Card, Green Computing, OCR.*

APLIKASI KARTU NAMA DIGITAL (DiNa) MENGGUNAKAN ALGORITMA CNN DAN TEKNOLOGI OCR SEBAGAI SARAN PERKENALAN FORMAL

Abstrak

Pesatnya perkembangan teknologi membuat kartu nama digital semakin menjadi pilihan utama sebagai alat perkenalan formal yang lebih ramah lingkungan, mengurangi ketergantungan pada penggunaan kertas dan tinta. Selain berfungsi sebagai sarana formal perkenalan, kartu nama digital juga menjadi media yang efektif untuk menyampaikan informasi krusial tentang individu atau perusahaan. Tahap implementasi aplikasi ini melibatkan pemanfaatan Optical Character Recognition (OCR) sebagai fitur utama, dengan pra-pemrosesan gambar sebagai langkah kunci untuk meningkatkan akurasi pembacaan, termasuk pengurangan noise, normalisasi data, dan kompresi. Proses pemindaian optik dan segmentasi lokasi menjadi fondasi utama dalam mengolah data dari gambar Kartu Nama. Langkah selanjutnya mencakup representasi dan ekstraksi fitur menggunakan teknik OCR TensorFlow untuk memproses data secara efisien. Integrasi model OCR ke dalam API memungkinkan aplikasi mobile berbasis Kotlin berkomunikasi langsung dengan model OCR, memberikan pengenalan karakter secara real-time. Uji coba pertama bertujuan untuk mengevaluasi akurasi dan waktu yang dibutuhkan oleh fitur OCR dalam mengenali setiap teks pada Kartu Nama. Model Tensorflow dan Easy-OCR dengan akurasi 41.86% digunakan untuk deteksi objek dan pengenalan karakter optik, menghasilkan sistem yang efisien, responsif, dan memungkinkan pembaruan model tanpa mengganggu fungsi utama aplikasi. Aplikasi ini berhasil menggabungkan aspek ramah lingkungan dengan teknologi canggih, menciptakan solusi modern untuk memenuhi kebutuhan perkenalan formal yang efektif. Dengan demikian, aplikasi Kartu Nama Digital ini tidak hanya menjadi alternatif ramah lingkungan, tetapi juga mewujudkan efisiensi dalam pengambilan informasi identifikasi secara langsung melalui platform mobile.

Kata kunci: Android, CNN , Kartu Nama Digital, Komputasi Hijau, OCR.

INTRODUCTION

Technological developments have encouraged a shift in the use of business cards, from conventional business cards to digital business cards as a means of formal introduction, business cards can be used to convey information about a person or company. [1] More and more people are using digital media to promote themselves and their businesses along with the rapid development of technology. [2]

Digital business cards (DiNa) can enable people to share their contact information online, and it is one of the most popular methods. In addition, digital business cards are also very environmentally friendly [3] so that they can reduce the use of paper, as people are increasingly aware of the importance of protecting the environment.[4] Conventional business card making using paper and ink has become a huge source of waste and can damage the environment. Ink and paper are also limited resources, and the manufacturing process produces greenhouse gases. Based on this, a solution is needed to solve problems in handling waste and environmental problems. Through this research, the creation of the DiNa application is a scientific solution in solving environmental problems so that it can provide convenience for nature to be preserved and also humans in making and distributing digital business cards. [5]

The DiNa application can also be used as storing their contact information and can also create such as phone numbers, email addresses, social media profiles, and so on. Based on the background explanation above, the researcher wants to design an application with the title "Digital Name Card Application (DiNa) Using Cnn Algorithma And Ocr Technology As Formal Marriage Advice". Through this research, it will be able to minimize dependence on the use of paper and ink so that digital business cards can reduce waste and greenhouse gas emissions generated by the conventional business card manufacturing process. Along with the increasing awareness of the importance of protecting the environment, the demand for environmentally friendly solutions such as digital business card applications continues to increase. In addition, the utilization of Optical Character Recognition (OCR) technology [6] and CNN algorithm [7] opens up new opportunities in the development of this application, allowing the use of more advanced and responsive features in text recognition.

The result of this research is a mitigation model for solving the problem of paper and ink waste through the DiNa application, through the DiNa application it can make information exchange faster and easier data management so that the DiNa application becomes an effective and efficient alternative for formal introductions.[8]

1. RESEARCH METHOD

1.1 Method of Collecting Data

The data collection techniques that researchers use in research are as follows:

1.1.1 Questionnaire

Questionnaire, which is a data collection technique carried out by providing a set of questions related to the object under study, given one by one to respondents who are directly related to the object under study [10]. The distribution of questionnaires can be done in writing (directly submitted to respondents) and can also be digital, one of which is through google form.

1.1.2 Literature Study

Literature Study, data collection is carried out directly from other sources such as journals, theses, guidebooks related to this research and based on the knowledge gained during lectures related to the research problem being carried out.

1.1.3 Field study

Field study, is a data collection technique by conducting direct research and review of the problems taken [12]. In this research, field studies are conducted directly in the community environment, which is directly involved.

1.2 CNN and OCR Algorithm Model Design Method.

The method in this study uses OCR (Optical Character Recognition) and CNN algorithms, the training of the model begins by receiving and reading the alphabet image dataset. After that, the dataset is divided into two parts: training data (train) and test data (test). The training data will be used to train or teach the Convolutional Neural Network (CNN) during the model building process. Meanwhile, the test data will be used as evaluation material to measure the performance of the model that has been formed.[9] Model performance evaluation can be analyzed through Confusion Matrix and Classification Report.

Figure 1. Flowchart of CNN Model Testing

1.2.1 Pre-processing

The first step is image pre-processing to improve the image quality and prepare it for the character recognition process. This may include operations such as sharpening, conversion to grey scale, and noise removal. Preprocessing of the image is done with the aim of smoothing the image with a large amount of noise, so that the image can be detected properly. In addition, this process includes the application of normalisation so that the image gets a uniform size, tilt and rotation.

1.2.2 Segmentation

According to Abdul kadir, object segmentation is a technique in separating one or more objects from the background, especially objects that overlap or overlap[6] So in this step, the image is separated into parts that contain individual characters. For business cards, this would include separating the text from the background and other elements on the card.

1.2.3 Collection Of Character Images

Each segmented character then has its features extracted. These may include properties such as the shape, thickness, and orientation of the character. Next, the successfully isolated characters from the segmentation process are collected into a character image set

1.2.4 Classification Of CNN Models

The next step is the classification stage by the CNN model, where the set of character images is classified using the CNN model in order to recognise the characters. The results of this classification are then rearranged into a character set.

CNN (Convolutional Neural Network) is a type of artificial neural network that is often used to analyze visual images. In a CNN, not all neurons in one layer are connected to neurons in other layers, which aims to prevent overfitting. This process results in fewer preprocessing requirements compared to other image classifier algorithms [5]. In CNN, the input is processed through a convolution layer to produce a feature map.

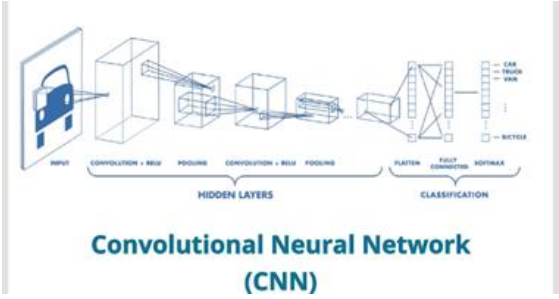

Figure 2. CNN Algorithm Architecture

The Convolutional Neural Network (CNN) architecture follows a series of stages involving convolution, pooling, and operations on recurrent layers. The first stage in the CNN architecture is convolution, where a kernel is used to process the input from the previous layer. This is the main operation that forms the basis of the CNN architecture. The convolution operation is a mathematical process in which a function is applied to the output of another function repeatedly. In CNNs, convolution is applied to the input image using a kernel or filter. This kernel serves to extract features from the input image and produce a feature map as output. The convolution process can be represented as:

$$\boldsymbol{s(t)} = (\boldsymbol{x} * \boldsymbol{t})(\boldsymbol{t}) = \sum \boldsymbol{x(a)} * \boldsymbol{w(t-a)} \quad (1)$$

where s(t) is the output of the convolution operation, x is the input, w is the kernel or filter, α is the index and * is the convolution operation.

This convolution process is cumulative, and is calculated by performing matrix multiplication between the input image and the kernel. To calculate the output size of the convolution operation, hyperparameters such as input volume size (W), filter size (F), padding value (P), and stride size (S) are used. The spatial size of the output volume can be calculated by Eq:

$$\frac{(W-F+2P)}{(S+1)} \quad (2)$$

Where W is the input volume size, F is the filter size, P is the padding value, S is the stride size. Thus, the CNN architecture consists of layers that have filters with specific dimensions (length, width, and number). Each filter is shifted through all parts of the image, and each shift performs a dot operation between the input and the filter value to produce an output called activation map or feature map.

1.2.5 Character Merging

Character merging, where the characters that have been recognized by the CNN model are merged together to form a digital text. Finally, the final result of the this character recognition process is the successfully generated digital text of the namecard.

1.3 System Development Method

The application development method we use is the RAD method, which is very efficient and also in accordance with the criteria that researchers need to design and build applications. The Rapid Application Development (RAD) method is an object-oriented software development approach [21]. RAD is also suitable for short-term projects [8].

Figure 3: RAD

The following stages are carried out in the RAD method:

- Requirement Planning At this stage, planning is carried out to build a software.
- User Design: The design stage can be seen with the architectural design of application use. Starting with the admin through the login stage to the application and directly processing consumer data, house data and house marketing data.
- Implementation & Testing: This stage includes optimizing for the stability of the application, improving the interface, to performing maintenance and compiling documentation. The point of this stage is that this last step is done before handing over the application to the client.

2. RESULTS

2.1 Requirements Data Analysis

2.1.1 Collecting Namecard

This stage is a pre-processing stage that is optimized to improve reading accuracy. At this stage, researchers reduce noise in the image (noise reduction), data normalization, and compression. Compression aims to shrink the image data so that OCR processing does not consume too many computer resources. It should be noted that the compression process is lossless, which means that important data and necessary details will not be lost even if the size is reduced.

2.1.2 Getting Accuracy and Speed Information from OCR

This stage is the stage of processing the image detector until it becomes a character that can be recognized by OCR. This stage consists of the following steps:

- Optical Scanning

At this stage, objects are captured in the form of digital images using a webcam. The captured images are converted to gray scale, making detection easier for computers. The researchers collected Business Cards and divided the data into training data and test data. After collecting the appropriate data, pre-processing is carried out to create images that will be used in subsequent tasks.

- Location Segmentation

The next step is to extract the text area to determine the character area to be taken. The researchers specified the kernel as desired. At this stage, the program detects any location in the image that has text. The program marks the image so that unmarked areas are skipped when recognizing letter patterns. Location segmentation is useful for reducing errors and preventing programs from reading objects other than text, such as images or logos. Text area extraction and segmentation is carried out to determine the area that will be extracted automatically.

- Segmentation

This segmentation is different from location segmentation. The area marked in the location segmentation will be segmented again at this stage. This segmentation aims to separate each letter from all the text in the marked area. This separation helps the program recognize letters because the program only needs to focus on one letter rather than the entire text. Image segmentation is used to determine the portion of text that will be retrieved. In this research, the parts taken involve the characters Email, cellphone number and name.

- Representation

Representation refers to taking a picture of the result segmentation process and displays the results in a simpler format. This step is done to reduce program complexity while increasing accuracy.

- Feature extraction

The researchers used the TensorFlow OCR technique to extract features from images. There are eight characters in the picture. Components in the photo, such as curves, curved angles, multiple curves, and other features, are taken for processing at the next stage. In the final step, OCR is used to predict the characters on the Business Card.

2.2 Character Training And Familiarization

This stage is the main stage of the OCR method. At this stage, the features The extracted data is analyzed so that the program can determine the letters in the picture. Processing Best Results in Accuracy and Speed This stage is the final stage of OCR. In general, this stage aims to clean the data that has been processed from spelling and detection errors. This data can also be used as a new dataset that can be combined with machine learning methods to collect business card images using a webcam and files with various lighting conditions and orientations, and label these images using labeling.

The first trial of this application aims to evaluate the accuracy and time required by the OCR feature to recognize each image text from the personal data/biodata on the business card taken. Test this out involves a number of predefined measurement variables, allowing comparison and analysis of results to obtain information on how to achieve optimal results when using the OCR feature in his application. In terms of object detection and optical character recognition, two Main models used: Tensorflow for object detection and Easy-OCR for optical character recognition. Tensorflow model is used for training special dataset in identity card detection using images 320x320 pixels in size, set with 500 epoch training and batch size 8 to

achieve good accuracy. Meanwhile for character recognition, Easy-OCR was chosen due to its similarity to the human eye, enabling optimal OCR results depending on the ease of separating characters from the background, improving OCR smoothness, and source image quality.

The implementation was carried out using the Python programming language and the Tensorflow learning library version 2.0 [6], [3], [7]. A laptop machine with an Intel i5 microprocessor and 8GB RAM was used to run the implemented code. The results of the collected data can be seen in Figure 3

Figure 4. Example output from detecting business cards using OCR with the Python programming language

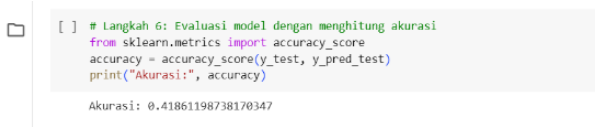

Figure 5. OCR-accuracy score

From Figure 5. shows that the results obtained from 20 experimental photos are letters, words, and sentences on identity cards that can be read by OCR, including Name, Email and Mobile Number, then there are 20 samples of business card photos used in the trial. The researchers provided several visualizations of identity card detection and got an accuracy of 41.86%.

After obtaining the results of the training and validation losses analysis, the next step is to integrate the approved model and dataset into an API. This API is designed to allow direct connection between the trained OCR model and the Kotlin-based mobile application. This integration aims to provide easy access and use of the character recognition model on mobile platforms.

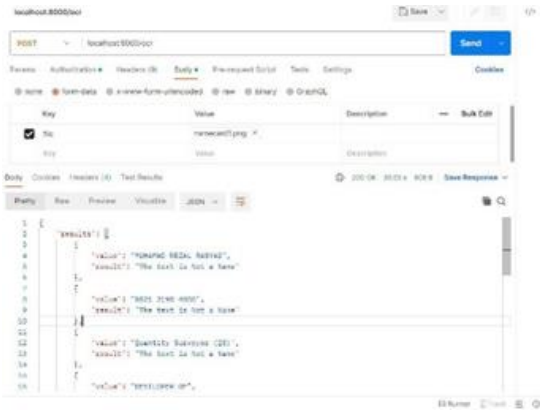

Figure 6. Postman Tests Rest API OCR

With the API, the Kotlin mobile application can easily communicate with the OCR model and send Business Card images to the API. The model will perform a realtime character recognition process on the received image, and the results will be sent back to the mobile application. This allows the application to display information from the Business Card instantly, improving the efficiency and speed of obtaining data from identification documents.

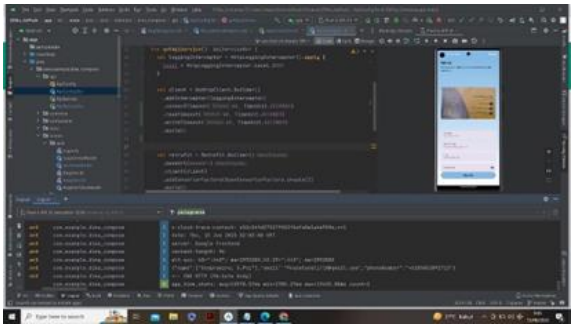

Figure 7. Example of integration between Kotlin and the Tensorflow OCR model which has been made into an API

From Figure 6 , the integration of the OCR model into the API also allows for periodic updates of the model without disrupt the main function of the mobile application. Thus, the application can continue to update its character recognition capabilities without the need to update directly on the user's device. to update directly on the user's device. This integration creates an efficient and responsive system in processing identification information from ID card images directly in the Kotlin-based mobile application. Kotlin-based mobile application.

2.3 Flowchart Activity User

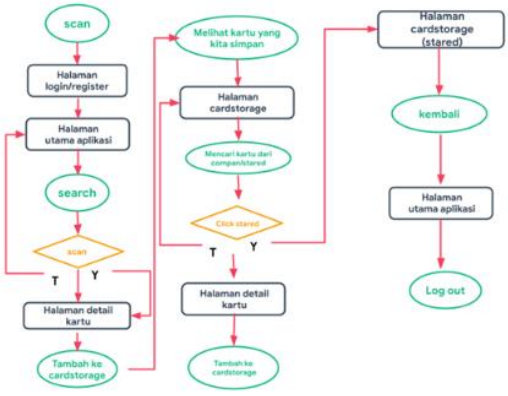

Figure 8. Userflow

Based on this User Activy Flowchart, it explains that the first thing the user does is scan, after which the user is directed to the authentication page. After being authenticated, the user enters the main page of the digital namecard application, then searches for other users by search / scan then the user is directed to the card details page then saves it

to the cardstora- ge (company / all). If you want to save the card with star, you can click start then it will be directed to the cardstorage page in the stared section and the star icon becomes stared. After that, return to the main page and exit the application or logout.

2.4 Activity Diagram

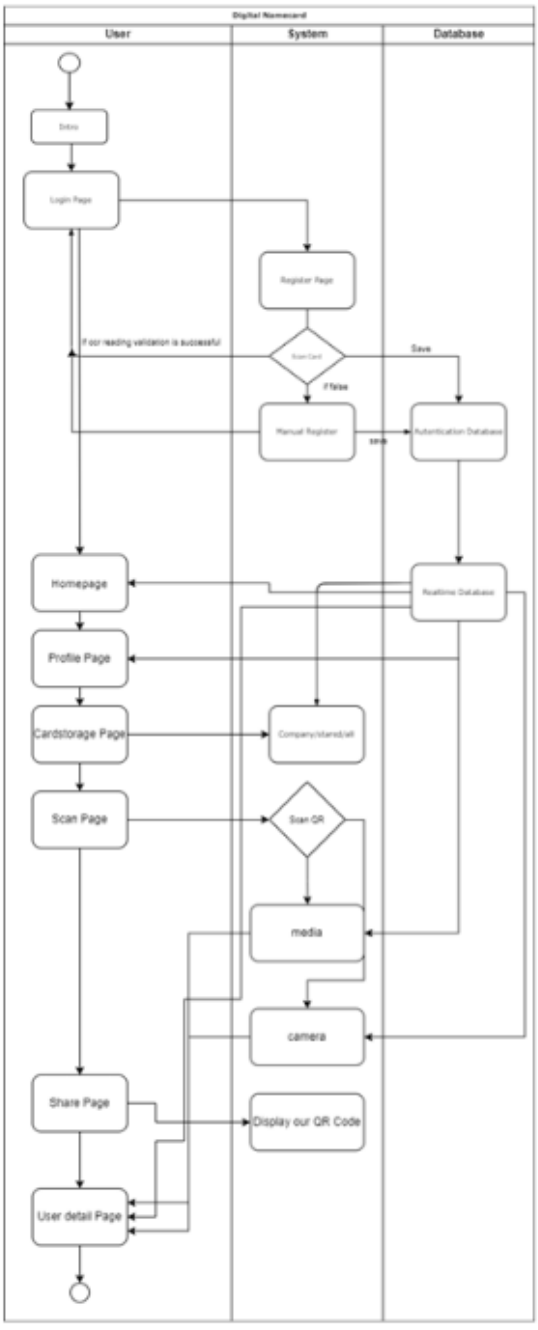

Figure 9. Activity Diagram

The author utilizes an Activity Diagram to depict the workflow scenarios and interactions within the system. The Activity Diagram aids in visualizing the workflow and processes within the system in a more structured manner. [1] With this approach, system development can be carried out more efficiently according to user needs and expectations.

2.5 Use Case Diagram

In this case there are 2 users who want to connect to each other through the DiNa application. Where User 1 is a new user who wants to connect with User 2 who already has an account and namecard in the DiNa application. So that User 1 must register himself either by OCR or manually and then log in to be authenticated and directed to the application page so that he can share his namecard with User 2. Then User 2 scans the qr code and saves user 1. And finally they are connected to each other with a namecard.

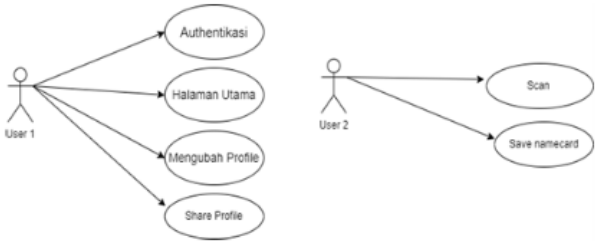

Figure 10. Use Case Diagram

2.6 Interface Design

At this stage the author designs the User Interface design.

2.6.1 Login Screen / Authentication

Authentication here is useful as a link between the de- sign page and the database so that if the user has not been authenticated the page in the application will not appear because every user who creates an account will automatically have a bearer token.

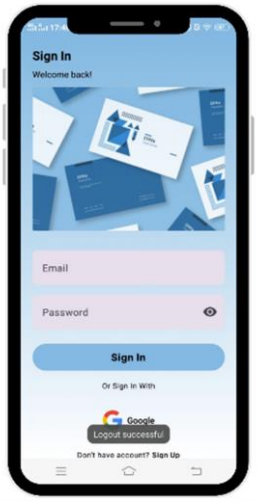

Figure 11. Login Screen

2.6.2 Registration Page

The list page functions for users who do not yet have an account on the DiNa mobile application.

On this page, users can also sign in by selecting "Sign In".

Figure 12. Registration Page

2.6.3 Homepage

On this page, it runs how the design made by researchers with jetpack compose so that it is interactive and also the homepage runs according to the design and is also connected to the database created on the backend so that the two are integrated and then produce a homepage page on the DiNa application. Inside the homepage there is a search to find other users who have not been saved, then after the search there is a card that can be starred and will be stored in the star database, then there is a buttom bar and buttom sheet.

Figure 13. Hompage

2.6.4 Scan Card Page

In the scan page how the application runs a scan of the qr code that has been generated with each user id. Then scan here using MLkit google vision as qr code detection

Figure 14. Scan Card Page

2.6.5 Share Card Page

The share page here runs how the user shares the namecard but has generated the id of each user profile so that it becomes a qr code. To generate a user profile id into a qr code, researchers use the zxing library.

3. CONCLUSIONS

Amidst technological advancements, the development of a Digital Business Card application based on CNN Algorithm OCR offers an effective solution for formal recognition that is environmentally friendly. Through image pre-processing stages, including noise reduction and compression, and integration of OCR into the API, this application achieves high efficiency in character recognition on Business Cards. The test results show that the Tensorflow model and Easy OCR provide 41.86% accuracy and satisfactory speed. In addition, by integrating CNN Architecture in the text detection and recognition process, this application can provide more accurate and efficient results.

The use of this application not only brings formal recognition to a more modern level but also adopts an environmentally friendly spirit. From the results of designing and testing the application, it can be concluded that Digital NameCard (DiNa) is an informative solution for the community, especially for those who have a career. The process of creating DiNa is very simple, making it easy for users to create and store their contact information. In addition, DiNa proves the efficiency and practicality of storing business cards without sacrificing natural resources, especially trees to make paper. Through storage in the application database, DiNa not only minimizes the carbon footprint associated with paper production, but also makes a positive contribution to environmental preservation.

Through storage in an application database, DiNa not only minimizes the carbon footprint associated with paper production, but also makes a positive contribution to environmental preservation. By utilizing OCR technology and CNN Algorithm,

DiNa becomes a modern and environmentally friendly formal recognition tool. thus the application of DiNa can change the paradigm of self-introduction to be more efficient, without leaving responsibility for environmental sustainability.

REFERENCES

[1] M. S. G. S. S. L. S. K. S. P. Khandare Keshav Balu. Digital business card. INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH, 2021.

[2] Ganjar Nugraha, 2023. Mengenal Kartu Nama Bisnis Beserta Fungsinya. (https://www.jurnal.id/id/blog/kartu-nama-bisnis-dan-fungsinya-sbc/ diakses 01 Januari 2024)

[3] Dini Aprilia Kurniawati, 2020 Teknologi Terkini di Bidang Lingkungan. lem fktugm, 11 Agustus: 1

[4] Mengenal Efek Rumah Kaca dan Dampaknya Bagi Kehidupan. 19 November 2020. (https://dlh.semarangkota.go.id/mengenal-efek-rumah-kaca-dan-dampaknya-bagi-kehidupan/diakses 08 Januari 2024)

[5] D. Mustofa. Aplikasi desain kartu nama berbasis android," jurnal responsif. 2022.

[6] Drobac, S., Lindén, K. Optical character recognition with neural networks and post-correction with finite state methods. IJDAR 2020

[7] Heriawan, H. 2023. Penerapan CNN dalam klasifikasi komponen elektronik. Skripsi. Fakultas Sains dan Teknologi, UIN Sunan Gunung Jati Bandung

[8] [Annisa, M.S. 2023. Pengertian Metode RAD ,Tahapan, Kelebihan dan Kekurangan, Fakultas Ilmu Komputer dan Teknologi Informasi UMSU (https://fikti.umsu.ac.id/pengertian-metode-rad-tahapan-kelebihan-dan-kekurangan/ diakses 08 Januari 2024)

[9] Hisham Zargar, Ruba Almahasneh & László T. Kóczy. Automatic Recognition of Handwritten Urdu Characters 2021

[10] Sugiyono. Metode Penelitian Kuantitatif, Kualitatif, dan RD. Alfabeta, 2020.

[11] Afdholudin. Rancang bangun alat pembaca data e-ktp menggunakan library google vision berbasis raspberry pi. Universitas Jambi (Published), 2021.

[12] A. Anendya. Kotlin sebagai bahasa pemrograman. 2023.

[13] Hestia. Kartu nama, pengertian, manfaat dan jenisnya,. 2020.

[14] R. D. S. R. . Z. R. Kaban. Penerapan metode rapid application development (rad) dalam perancangan sistem informasi penjualan berbasis web. JURNAL INFORMATIKA DAN PERANCANGAN SISTEM (JIPS), vol. 4(2), pp. 1-7, 2022.

[15] M. S. G. S. S. L. S. K. S. P. Khandare Keshav Balu. Digital business card. International Journal Of Advance Scientific Research, 2021

[16] Arindam et al Chaudhuri. Optical Character Recognition System for Different Languages with Soft Computing, Studies in Fuzziness and Soft Computing. Springer, 2017.

[17] Bambang Satrio. Implementasi virtual business card berbasis android. Jurnal Teknologi Informasi dan Ilmu Komputer (JTIIK), 2019.

[18] Muhammad Fauzan Adli Muttaqien. Perancangan program aplikasi kartu nama digital. JOM FTEKNIK, 2021.

[19] Sheilly Padda. Green computing. IJCSN - International Journal of Computer Science and Network, 2019.

[20] H. I. A. S. R. Z. . W. A. A. A. S. Faqih. Desain aplikasi manajemen kunjungan pelanggan barbershop squad corporation (a. k.-s.q.u.a.d.) desain aplikasi manajemen kunjungan pelanggan barbershop squad corporation (a. k.-s.q.u.a.d.). IJSE Indonesian Journal on Software Engineering, 2019.

[21] B. Fajar R. Fikri M. O. Pratama, W. Satyawan and H. Hamzah. indonesian id card recognition using convolutional neural networks. Int. Conf. Electr. Eng. Comput. Sci. Informatics vol. 2018-Octob pp. 178â181, 2018.

[22] Junaedi E, Wulandari F. *Pengembangan Metode Pembelajaran Huruf Hijaiyah Dengan Smartphone Android*. 2021;15(1). Available from: https://journal.uniku.ac.id/index.php/ilkom

[23] R. W. A. A. N. A. N. S. S. D. Rully Pramudita. "penggunaan aplikasi figma dalam membangun," jurnal buana pengabdian, vol. 3, p. 2, 2021.

[24] Junaedi E, Wulandari F, Icha I. Development of Virtual Reality Applications as a Media for Digitizing Cultural Heritage in the Historic Building of the Banten Caringin Mosque. JURNAL SISFOTEK GLOBAL. 2022 Sep 30;12(2):126

[25] Jurnal Informatika Dan Perancangan Sistem (JIPS) vol. 4(2) pp. 1-7 2022. R. D. S. R. . Z. R. Kaban, "Penerapan Metode Rapid Application Development (RAD) dalam Perancangan Sistem Informasi Penjualan Berbasis Web.

[26] T. Pettersson R. Oucheikh. Product verification using ocr classification and mondrian conformal prediction. Expert Syst. Appl., vol. 188, p. 115942, 2022.

[27] N. Regita. Android studio. 2021.
[28] O. P. Sihombing. Penerapan green computing dan strategi keberlanjutan layanan ti/si,. Academia.
[29] N.N.; Lyakhov P.A.; Valuev G.V.; Valueva, M.V.; Nagornov and N.I Chervyakov. Application of the residue number system to reduce hardware costs of the convolutional neural network implementation. 2021.