CoreID JOURNAL

Vol. 3 No. 2, July 2025 (79-86)
ISSN: 2987-6990
DOI: https://doi.org/10.60005/coreid.v3i2.141

Implementation of Template Matching Algorithm in Detecting Student Identification Numbers to Improve Student Services

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Article Info

Article history:

Received April 10, 2025
Revised May 12, 2025
Accepted July 19, 2025

Keywords:

Template Matching
Student Identification Number
Image Processing
Pattern Recognition
Academic Service Automation

ABSTRACT

The rapid progression of technological advancements, particularly in the digitalization of image data, has significantly facilitated numerous sophisticated applications, including pattern recognition. A prominent example can be observed within the education system of UIN Sunan Gunung Djati Bandung, where the Student Identification Number (NIM) constitutes a pivotal component in a wide range of academic service operations. At present, processes such as the verification of scholarship documentation, updating of PD DIKTI data, and the borrowing of library materials are predominantly executed through manual means, frequently resulting in operational inefficiencies and the occurrence of human errors. To address these challenges, this study investigates the application of the template matching algorithm for recognizing the NIM on the Student Identity Card (KTM). This study is conducted to systematically evaluate the implementation of template matching for NIM recognition, assess the performance of the proposed method, and ascertain its impact on enhancing student services. The experimental findings reveal that the template matching algorithm demonstrates variable success rates across three trials (9/20, 8/20, and 8/20 instances correctly identified). The detection accuracy is determined to be influenced by factors including, but not limited to, template values, the presence of noise, variations in lighting conditions, and the parameter settings of the Canny edge detection process. The results substantiate the potential of the template matching algorithm to significantly improve the efficiency of student services by automating the NIM recognition process. Nonetheless, several technical limitations, particularly those impacting detection accuracy, necessitate further refinement to optimize its performance. This research highlights the critical importance of enhancing the algorithm to establish a robust and effective system for academic service delivery.

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1. INTRODUCTION

Advances in image data digitization technology including pattern recognition have significantly contributions to various fields. Sunan Gunung Djati State Islamic University (UIN) Bandung utilizes the Student Identification Number (NIM) as a unique identity in the academic administrative service process, including Single Tuition Fee (UKT) payments, Study Plan Card (KRS) contracts, library book loans, and

others. Although the administration system has been integrated through SALAM (academic service administration system), several service processes are still carried out manually, such as verification of scholarship documents and data updates on PDDIKTI, which have the potential to cause inefficiency and human error.

Student ID Card (KTM) is used as an identification tool that has attributes of student ID number, full name, department, and faculty. It's not yet equipped with modern technology such as barcodes or magnetic cards can automatic recognition of NIM is a strategic step to improve service efficiency. In this case, the template matching algorithm utilizes the similarity of pixel values between the template image and the test image, has effectiveness for objects with patterns that remain relevant to the design of the last five years of KTM in terms of attribute position, this is a relevant and effective solution to detect attributes on KTM, especially NIM. Based on these problems, this study is entitled "Implementation of Template Matching Algorithm to Detect Student ID Number on Student ID Card in Improving Student Service Effectiveness".

2. METHOD

This study follows several sequential stages, including data collection, image preprocessing, template matching implementation, evaluation, and deployment.

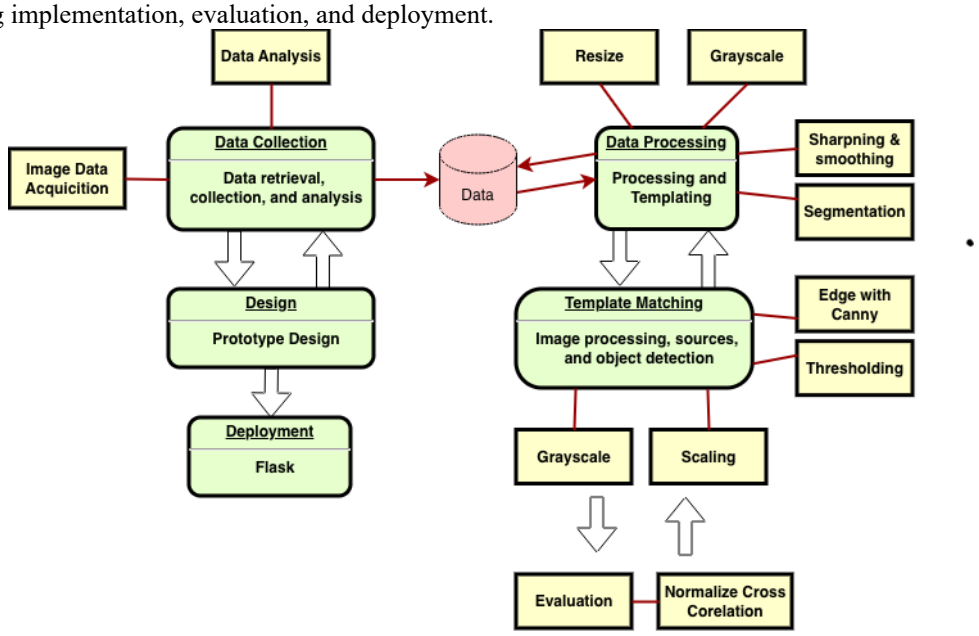

Figure 1. Research Method

a. Data Collection

The process carried out is to acquire images from data available at the Academic UIN Sunan Gunung Djati Bandung using an OPPO A74 camera with 48 MP + 2 MP + 2 MP and take data from the ICT Training Division of UIN Sunan Gunung Djati Bandung which was acquired by primary sources, namely students, conduct observations and analysis of the object. Image acquisition is converted into JPG (Joint Photographic Expert Group) format and the image is resized by changing the resolution size to 180 x 60 for the template image and 850 x 550 for the test image. Data exploration starts by examining the format of the student registration number in the form of numbers, with a character length of 10, and identification of variables in the form of a student registration number that has attributes of name, department, and faculty.

b. Image Preprocessing

Resize

The template matching method uses a template approach that requires an aspect ratio so that the resizing process will determine the aspect ratio of the image. This resizing helps avoid image distortion by preventing loss of detail and image clarity and lightening the template matching process.

Grayscale

Converting the test image color to grayscale which will be used in the image binarization process and helps eliminate unnecessary color information.

Sharpening and Smoothing

Sharpening the image aims to clarify the edges of objects in the image by passing the image through a high-pass filter. Sharpening is done to highlight fine details in the image, remove blur, and edges high filter sharpening is based on differentiation which measures the rate of change of a function.

Segmentation

This process uses a discontinuity approach segmentation which partitions the image if there is a large change in intensity (edge -based).

c. Template Matching
The application of the template matching method can be done with the following main steps:
Grayscale
Removes unnecessary color information from detected objects.
Edge with Canny
Implementation of the canny operator to binarize images into 0 and 1 with a threshold of 50 – 200 which will separate objects from the background.
Scaling
Avoid differences in image size and the original if the template dimensions do not match the dimensions of the image area.
Template Matching
The stages in template matching are load test image, templateand input test image below template image then compare, the results obtained are compared with the threshold (threshold), if the result is greater than the threshold it will be marked as detected.

d. Evaluation
To determine the level of similarity between the template image and the test image using NC calculations (Normalized Cross Correlation). Percentage the larger of NC value is approaching 100%, the more suitable the comparison results between the template image and the test image are, adjusting to the method used in the template matching, namely TM_CCOEFF_NORMED [6].

e. Deployment

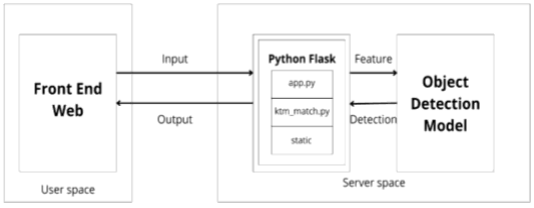

Figure 2. Deployment Design

Integrating object detection models, especially template matching, into the Flask application allows users (service officers) to upload KTM images and process them to detect student ID numbers.

3. RESULTS AND DISCUSSION

The number of 400 images were collected from the Academic section and ICT training archives, consisting of 137 images from ICT and 263 images from Academics, taken using a mobile phone camera. After selection, 281 images were eligible for use in the study. Of the many templates, only three templates were selected for the experiment, with 20 KTM images tested on each template.

The results of field observations, the student ID card model for the 2018-2022 intake has the same model, namely as follows:

KTM Model Class of 2018

KTM Model Class of 2019

KTM Models Class of 2020

KTM Models Class of 2021

Figure 3. KTM Models 2018, 2019, 2020, and 2021

3.1 Data Processing Results

a. Grayscale Image

Figure 4. Grayscale Image

The resulting image from image transformation is the image used in the grayscale process where R, G and B are the color intensities at the pixel and y is the grayscale intensity value at the pixel in question.

b. Scaling

Figure 5. Scaling Image

The scaling result is the same size as the source image.

c. Edge segmentation with Canny Operator

Figure 6. Edge Segmentation

Using the functions provided in OpenCV to detect edges in images using the Canny operator.

d. Template Matching Results

In template matching, the template image with attribute 1194050032 is compared with the source image. The system searches for the highest maxVal, and if it exceeds the threshold, the object is detected.

Figure 7. Matching Template Results Phase 1

Figure 7 shows the word 'MAHASISWA', which means that in the source image, the highest correlation is in the word 'MAHASISWA' and will continue to search for the highest maxVal.

Figure 8. Matching Template Results Phase 2

In 4.12 it shows, '1194050032' is detected, meaning that this attribute has the highest maxVal.

Figure 9. Matching Template Results Phase 3

The threshold value of 0.2 has been determined after the highest maxVal is obtained and exceeds the threshold value, and bounding will automatically be detected in that area.

Figure 10. Matching Bounding Template Results

Figure 11. Result of Template Matching Detected

The threshold value of 0.2 was obtained based on experiments from 0.4 and 0.8. The threshold value at 0.2 has the highest percentage.

e. Evaluation

Evaluation using maxVal (maximum correlation coefficient) and maxLoc (detected pixel location). The image is considered correct if maxVal >= 0.2 and the average maxLoc is around ±200.

Table 1. Test 1 with Template 1208040072

Data	Detected	Correlation Value	Max Loc	Recognition Test Results
1195020081	1195020081	0.3259	(218, 270)	Correct
1194050162	1194050162	0.3032	(207, 263)	Correct
1194050032	194050032	0.2631	(447, 489)	Wrong
1208040009	08040009	0.2460	(225, 240)	Wrong

Data	Detected	Correlation Value	Max Loc	Recognition Test Results
1201040090	01040090	0.2591	(206, 247)	Wrong
1201040095	01040095	0.2543	(203, 240)	Wrong
1201060080	01060080	0.2637	(198, 240)	Wrong
1194050160	194050160	0.2868	(239, 245)	Wrong
1195030010	195030010	0.3046	(238, 264)	Wrong
1208040054	1208040054	0.2742	(178, 234)	Correct
1208040072	1208040072	0.2580	(205, 248)	Correct
1201060051	1201060051	0.2606	(169, 232)	Correct
1192010020	1192010020	0.4205	(206, 254)	Correct
1204070025	1204070025	0.2755	(173, 257)	Correct
1204060036	1204060036	0.2385	(172, 233)	Correct
1206000005	1206000005	0.2788	(178, 244)	Correct
1183030060	83030060	0.3170	(239, 269)	Wrong
1194050118	TANGERANG	0.277	(648, 424)	Wrong
1204020115	SG State Islamic University BANDUNG	0.263	(447, 489)	Wrong

Table 2. Test 2 with Template 1201060080

Data	Detected	Correlation Value	Max Loc	Recognition Test Results
1195020081	1195020081	0.3169	(218, 267)	Correct
1194050162	1194050162	0.2849	207, 258	Correct
1194050032	1194050032	0.2459	(218, 257)	Correct
1208040009	POLITICAL SCIENCE	0.2153	(419, 368)	Wrong
1201040090	PSYCHOTHERAPY	0.2476	(370, 337)	Wrong
1201040095	PSYCHOTHERAPY	0.2483	(364, 330)	Wrong
1201060080	STUDENT	0.2154	(418, 136)	Wrong
1194050160	1194050160	0.2562	(226, 242)	Correct
1195030010	1195030010	0.2784	(210, 261)	Correct
1208040054	POLITICAL SCIENCE	0.2188	(382, 362)	Wrong
1208040072	STUDENT	0.2192	(464, 148)	Wrong
1201060051	STUDENT	0.2299	(421, 128)	Wrong
1192010020	1192010020	0.3193	(206, 250)	Correct
1204070025	ID CARD	0.2236	(259, 159)	Wrong
1204060036	STUDENT	0.2127	(403, 144)	Wrong
1206000005	STUDENT	0.2313	(429, 144)	Wrong
1183030060	1183030060	0.2202	(212, 266)	Correct
1194050118	1194050118	0.2720	(217, 249)	Correct
1204020115	SG State Islamic University BANDUNG	0.2242	(450, 483)	Wrong
1203040078	AND THE LAW	0.2381	480, 337	Wrong

Table 3. Test 3 with Template 1204070025

Data	Detected	Correlation Value	Max Loc	Recognition Test Results
1195020081	1195020081	0.2853	(217, 268)	Correct
1194050162	1194050162	0.3125	(208, 258)	Correct
1194050032	022-7800525	0.2617	(647, 101)	Wrong
1208040009	POLITICAL SCIENCE	0.2432	(421, 371)	Wrong
1201040090	PSYCHOTHERAPY	0.2498	(343, 339)	Wrong
1201040095	PSYCHOTHERAPY	0.2445	(337, 331)	Wrong
1201060080	1201060080	0.2280	(177, 239)	Correct
1194050160	1194050160	0.2602	(214, 243)	Correct
1195030010	1195030010	0.2782	(212, 262)	Correct
1208040054	POLITICAL SCIENCE	0.2438	(289, 266)	Wrong
1208040072	MU POLITICS	0.2160	(458, 372)	Wrong
1201060051	STUDENT	0.2128	(413, 132)	Wrong
1192010020	1192010020	0.3514	(207, 252)	Correct

Data	Detected	Correlation Value	Max Loc	Recognition Test Results
1204070025	STUDENT	0.2269	(408, 161)	Wrong
1204060036	STUDENT	0.2526	(406, 147)	Wrong
1206000005	PSYCHOLOGY	0.2400	(167, 371)	Wrong
1183030060	1183030060	0.2290	(210, 267)	Correct
1194050118	1194050118	0.2723	(216, 250)	Correct
1204020115	COMMUNICATION	0.2284	(333, 368)	Wrong
1203040078	AND THE LAW	0.2555	(480, 338)	Wrong

MaxVal will indicate the location where the template matches, meaning maxVal will be linear with the template's maxLoc when plotted in coordinates.

Analysis of test 1 of 20 experimental data, 9 images were successfully detected correctly and 11 images were detected imperfectly. In test 2, 8 of 20 data were detected correctly and in test 3, 8 of 20 data were detected correctly. The analysis of the causes:

1. The template values used, from the three templates, produce different maxVal and maxLoc, some of which are significant and some are not too significant.
2. Noise and lighting in the source image, even though the image resolution is 850 x 550, the resolution is not entirely a parameter for obtaining the appropriate maxLoc value.
3. In the implementation of the canny operation is very important because it will produce an edge image that separates the object from the background, then scaling the test image between 0.5 to 2.0 with 10 iterations. This iteration will be used in template matching where the results of the test image resizing produce a reduced test image (downscaling). The results of this template matching will find the maxVal value.

This positive relationship occurs when an increase in a variable is followed by a decrease in another variable, which explains that the greater the maxVal and maxLoc values are equal to the maxLoc value of the template, the greater the similarity of the matrices being compared.

4. CONCLUSION

Based on the research conducted, it can be concluded that the template matching algorithm was successfully implemented to recognize student identification numbers (NIM) on student identity cards (KTM) by utilizing the maxVal and maxLoc values as indicators of image similarity. Nevertheless, the accuracy of the detection process is strongly affected by factors such as image noise, lighting conditions, and the quality of the template used. The performance evaluation revealed varying levels of detection success, with only 9 out of 20, 8 out of 20, and 8 out of 20 test data correctly detected in different trials. These results indicate that the performance of the algorithm can be further improved through optimization of image preprocessing techniques, including edge detection using the Canny operation and appropriate scaling of the test images. Despite these limitations, the application of image recognition using the template matching method demonstrates significant potential in supporting the automation of manual processes, particularly in student data verification, thereby improving the efficiency of student services. However, further enhancements in accuracy and robustness are required before the system can be fully relied upon for practical implementation at UIN Sunan Gunung Djati Bandung.

REFERENCES

[1] M. Sigala, A. Beer, L. Hodgson, and A. O'Connor, *Big Data for Measuring the Impact of Tourism Economic Development Programmes: A Process and Quality Criteria Framework for Using Big Data*. 2019.

[2] G. Nguyen *et al.*, "Machine Learning and Deep Learning frameworks and libraries for large-scale data mining: a survey," *Artif. Intell. Rev.*, vol. 52, no. 1, pp. 77–124, 2019, doi: 10.1007/s10462-018-09679-z.

[3] C. Shorten and T. M. Khoshgoftaar, "A survey on Image Data Augmentation for Deep Learning," *J. Big Data*, vol. 6, no. 1, 2019, doi: 10.1186/s40537-019-0197-0.

[4] R. Vinayakumar, M. Alazab, K. P. Soman, P. Poornachandran, A. Al-Nemrat, and S. Venkatraman, "Deep Learning Approach for Intelligent Intrusion Detection System," *IEEE Access*, vol. 7, pp. 41525–41550, 2019, doi: 10.1109/ACCESS.2019.2895334.

[5] K. Sivaraman, R. M. V. Krishnan, B. Sundarraj, and S. Sri Gowthem, "Network failure detection and diagnosis by analyzing syslog and SNS data: Applying big data analysis to network operations," *Int. J. Innov. Technol. Explor. Eng.*, vol. 8, no. 9 Special Issue 3, pp. 883–887, 2019, doi: 10.35940/ijitee.I3187.0789S319.

[6] A. D. Dwivedi, G. Srivastava, S. Dhar, and R. Singh, "A decentralized privacy-preserving healthcare

blockchain for IoT," *Sensors (Switzerland)*, vol. 19, no. 2, pp. 1–17, 2019, doi: 10.3390/s19020326.
[7] F. Al-Turjman, H. Zahmatkesh, and L. Mostarda, "Quantifying uncertainty in internet of medical things and big-data services using intelligence and deep learning," *IEEE Access*, vol. 7, pp. 115749–115759, 2019, doi: 10.1109/ACCESS.2019.2931637.
[8] S. Kumar and M. Singh, "Big data analytics for healthcare industry: Impact, applications, and tools," *Big Data Min. Anal.*, vol. 2, no. 1, pp. 48–57, 2019, doi: 10.26599/BDMA.2018.9020031.
[9] L. M. Ang, K. P. Seng, G. K. Ijemaru, and A. M. Zungeru, "Deployment of IoV for Smart Cities: Applications, Architecture, and Challenges," *IEEE Access*, vol. 7, pp. 6473–6492, 2019, doi: 10.1109/ACCESS.2018.2887076.
[10] B. P. L. Lau *et al.*, "A survey of data fusion in smart city applications," *Inf. Fusion*, vol. 52, no. January, pp. 357–374, 2019, doi: 10.1016/j.inffus.2019.05.004.
[11] Y. Wu *et al.*, "Large scale incremental learning," *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, vol. 2019-June, pp. 374–382, 2019, doi: 10.1109/CVPR.2019.00046.
[12] A. Mosavi, S. Shamshirband, E. Salwana, K. wing Chau, and J. H. M. Tah, "Prediction of multi-inputs bubble column reactor using a novel hybrid model of computational fluid dynamics and machine learning," *Eng. Appl. Comput. Fluid Mech.*, vol. 13, no. 1, pp. 482–492, 2019, doi: 10.1080/19942060.2019.1613448.
[13] V. Palanisamy and R. Thirunavukarasu, "Implications of big data analytics in developing healthcare frameworks – A review," *J. King Saud Univ. - Comput. Inf. Sci.*, vol. 31, no. 4, pp. 415–425, 2019, doi: 10.1016/j.jksuci.2017.12.007.
[14] J. Sadowski, "When data is capital: Datafication, accumulation, and extraction," *Big Data Soc.*, vol. 6, no. 1, pp. 1–12, 2019, doi: 10.1177/2053951718820549.
[15] J. R. Saura, B. R. Herraez, and A. Reyes-Menendez, "Comparing a traditional approach for financial brand communication analysis with a big data analytics technique," *IEEE Access*, vol. 7, pp. 37100–37108, 2019, doi: 10.1109/ACCESS.2019.2905301.
[16] D. Nallaperuma *et al.*, "Online Incremental Machine Learning Platform for Big Data-Driven Smart Traffic Management," *IEEE Trans. Intell. Transp. Syst.*, vol. 20, no. 12, pp. 4679–4690, 2019, doi: 10.1109/TITS.2019.2924883.
[17] S. Schulz, M. Becker, M. R. Groseclose, S. Schadt, and C. Hopf, "Advanced MALDI mass spectrometry imaging in pharmaceutical research and drug development," *Curr. Opin. Biotechnol.*, vol. 55, pp. 51–59, 2019, doi: 10.1016/j.copbio.2018.08.003.
[18] C. Shang and F. You, "Data Analytics and Machine Learning for Smart Process Manufacturing: Recent Advances and Perspectives in the Big Data Era," *Engineering*, vol. 5, no. 6, pp. 1010–1016, 2019, doi: 10.1016/j.eng.2019.01.019.
[19] Y. Yu, M. Li, L. Liu, Y. Li, and J. Wang, "Clinical big data and deep learning: Applications, challenges, and future outlooks," *Big Data Min. Anal.*, vol. 2, no. 4, pp. 288–305, 2019, doi: 10.26599/BDMA.2019.9020007.
[20] M. Huang, W. Liu, T. Wang, H. Song, X. Li, and A. Liu, "A queuing delay utilization scheme for on-path service aggregation in services-oriented computing networks," *IEEE Access*, vol. 7, pp. 23816–23833, 2019, doi: 10.1109/ACCESS.2019.2899402.
[21] G. Xu, Y. Shi, X. Sun, and W. Shen, "Internet of things in marine environment monitoring: A review," *Sensors (Switzerland)*, vol. 19, no. 7, pp. 1–21, 2019, doi: 10.3390/s19071711.
[22] M. Aqib, R. Mehmood, A. Alzahrani, I. Katib, A. Albeshri, and S. M. Altowaijri, *Smarter traffic prediction using big data, in-memory computing, deep learning and gpus*, vol. 19, no. 9. 2019.
[23] S. Leonelli and N. Tempini, *Data Journeys in the Sciences*. 2020.
[24] N. Stylos and J. Zwiegelaar, *Big Data as a Game Changer: How Does It Shape Business Intelligence Within a Tourism and Hospitality Industry Context?* 2019.
[25] Q. Song, H. Ge, J. Caverlee, and X. Hu, "Tensor completion algorithms in big data analytics," *arXiv*, vol. 13, no. 1, 2017.