

VERIFAI.

id verification **done right**

Verifai's **AI-powered OCR-technology**

Overview

There is an increasing demand for robust identification methods in a more digital world. Verifai offers a unique identity verification service platform that allows identity document verification at high accuracy and high speed with use of optical character recognition. This whitepaper explains how Verifai uses artificial intelligence in its optical character recognition system for identity verification. Furthermore, this paper explains the current challenges in optical character recognition, and how to ensure accurate identity verification of the user by the use of different optional checks.

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Introduction

Throughout the last two decades, automatic identification and data capture systems have been developed to assist in the movement of information between systems¹. Traditionally, data enters the system through the use of a keyboard. The main disadvantage of such an arrangement is the reliance on data input by the user (i.e. the human being). While the keyboard is still considered a revolution in the digital era, it may not always be the optimal option for personal data entry or movement. Data entry using keyboards is often time-consuming, unreliable, and inefficient. As a result, the demand for other, mostly faster ways of data identification increased¹. These automatic identification methods mostly had different applications, e.g. transcription software, barcode scanners, QR-codes and optical character recognition².

Firms have become increasingly digitized over the past decades. Physical locations are rapidly closing, while doing business and tasks over the internet has increased significantly over the years³. This gave rise to serious new challenges in proving someone's identity. While someone can prove their identity by entering a physical location and showing their identity document, this is not possible over the internet. Furthermore, someone's identity on the internet is not always certain. Fraud and identity theft is not uncommon in the digital world. In the United States alone, there were 16.7 million victims of identity fraud in 2017⁴. This raises questions on whether you can trust information provided by the user without verifying the user first. There is, therefore, a strong need for a robust digital identity infrastructure that takes into account the current limitations. At the same time, this infrastructure should be compliant with current privacy regulations (i.e. GDPR), as privacy awareness has increased significantly throughout the years and will continue to increase in the coming years⁵.

At Verifai, we are aware of the current challenges of

digital identity verification. We developed an identity verification service platform that verifies identity documents using the camera of the user. What separates Verifai from other parties, is its privacy-first approach: data processing is only performed on the device of the user and is not stored on our servers. That also means that Verifai is fully GDPR compliant⁶.

This paper mainly focuses on the use of optical character recognition systems and its application by Verifai. The main topics that are discussed are the definition of optical character recognition, the implementation of OCR at Verifai, the challenges of identity verification using OCR, how Verifai addresses these challenges, and the use of artificial intelligence in the OCR-based system.

¹Smith, A. D., & Offodile, F. (2002). Information management of automatic data capture: an overview of technical developments. *Information Management & Computer Security*, 10(3), 109-118.

²<https://www.nr.no/~eikvil/OCR.pdf>

³<https://hbr.org/2016/04/a-chart-that-shows-which-industries-are-the-most-digital-and-why>

⁴Pascual, A., Marchini, K., & Miller, S. (2018). 2018 identity fraud: Fraud enters a new era of complexity. Javelin Strategy & Research.

⁵Vervier, L., Zeissig, E. M., Lidynia, C., & Ziefle, M. (2017). Perceptions of Digital Footprints and the Value of Privacy. In *IoTBDs* (pp. 80-91).

⁶Full information about Verifai and GDPR is given on <https://www.verifai.com/en/dpa/>

Optical Character Recognition

What is OCR?

Optical character recognition is a way to process handwritten and printed characters digitally. Performance of such systems heavily depends on the quality of the text and the system itself. The very first releases of OCR-based systems were only able to recognize certain OCR-focused fonts⁷. Later, these fonts were no longer necessary and systems were developed that could process all types of fonts and text with a higher level of accuracy. Over the years, the technology advanced and the costs of these systems decreased significantly, resulting in a higher adoption rate throughout the world³. Nowadays, the use of machine learning techniques has opened up a whole new set of opportunities in the OCR field^{8, 9}. Neural networks have the ability to localize text or symbols, and to understand and detect the characters. In conventional OCR systems, the decision-making is in the hands of the system engineers. In machine learning OCR systems, decisions are made by neural networks that mimic the analytical part of the human brain. These networks are developed using large data sets. In general, the higher the quality (i.e. representativeness) and quantity of data, the better the model.

Applications

There are many applications for optical character recognition systems¹⁰. A couple of examples include:

- **Handwriting recognition**
OCR makes it possible to transform handwritten text (both optical and digital) into digital characters.
- **Indexation of legal documents**
OCR is used to digitize legal documents that then become indexed and searchable by entering keywords.
- **Cheque processing**
OCR helps the banking industry process cheques without human intervention, decreasing the processing time in banks.
- **Digital archiving in healthcare**
OCR helps healthcare institutions with the digital archiving of patient files, so information can be obtained with ease when needed.
- **Number plate recognition**
Law enforcement is able to use OCR to obtain number plate characters, which can be used for toll purposes, or to fine drivers that go over the speeding limit.
- **Validation of optical documents**
OCR helps digital firms archive their documents digitally, and check the validity of optical documents (e.g. passports, invoices and bank statements).

⁷These fonts were called OCR-A and OCR-B and were developed to facilitate OCR operations. For background, see <https://myfonts.wordpress.com/2006/09/18/typographic-abbreviations-series-1-ocr/>.

⁸Coates, A., Carpenter, B., Case, C., Satheesh, S., Suresh, B., Wang, T., ... & Ng, A. Y. (2011, September). Text Detection and Character Recognition in Scene Images with Unsupervised Feature Learning. In ICDAR (Vol. 11, pp. 440-445).

⁹Breuel, T. M., Ul-Hasan, A., Al-Azawi, M. A., & Shafait, F. (2013, August). High-performance OCR for printed English and Fraktur using LSTM networks. In 2013 12th International Conference on Document Analysis and Recognition (pp. 683-687). IEEE.

¹⁰Hamad, K. A., & Kaya, M. (2016). A detailed analysis of optical character recognition technology. International Journal of Applied Mathematics, Electronics and Computers, 4(1), 244-249.

Issues, challenges and solutions

Conventional OCR systems are very advanced: text accuracy is generally high, processing speed is also high, and results are generally reliable. This is only the case if the image that needs to be processed is of high quality and if the character font complies with the predefined standards. However, the main problem with conventional, non-AI, OCR systems is optimization for various scenes and environments. Accuracy of the OCR in the verification process heavily depends on the setting and conditions of the scene and camera. Verifai either uses the camera of the user, or allows the user to upload a photo or scan of the identity document. This way, the user determines the context of the identity verification process. Some constraints, challenges, and solutions are shown in Table 1.

Privacy concerns with OCR

As some firms or institutions do not require all the sensitive data included on identity documents, extracting entire documents might result in privacy concerns. For example, photos or social security numbers on identity documents are often not required. Verifai adds the ability to mask sensitive regions using so-called privacy filters. During the preprocessing phase, Verifai automatically adds these masks, so the firm or institution is never able to obtain this personal data.

	Constraint	Challenge	Solution
Scene complexity	The camera may capture unnecessary details in the image that may hinder the text recognition process.	Separate textual parts from non-textual parts in the image.	Use artificial intelligence to remove the complex background from the image.
Lighting and glare	Dark lighting conditions make the text less readable; Glare results in excessive brightness spots in the image that makes the text difficult to extract.	Make sure the camera captures all details effectively so that all the data can be extracted.	Use machine learning and (if possible) multiple image frames to address lighting and glare issues
Rotation and tilting	The identity document may be somewhat tilted when captured and should be corrected.	Perspective distortion causes difficulty in the OCR process	Use computer vision techniques to detect tilting and correct the image.
Blur and document degradation	Unfocused cameras cause blurry images; Document degradation may result in less readable text and unknown outcomes.	Address blurriness and document degradation in the preprocessing part of OCR.	Use machine learning and (if possible) multiple image frames.
Web verification	The web version allows only the use of one image or scan, instead of a video stream which is possible in the app.	Extract all the required data from one image, preventing any complexities.	Provide feedback to user during the process, perform checks, use artificial intelligence.

Table 1. Constraint examples, the challenges and their solutions

Identity confirmation using OCR

Identity confirmation entails all the steps to ensure someone's identity. The first stage in identity confirmation is identity verification, i.e. whether the identity data is associated with an individual. Verifai's OCR technology is very intelligent in extracting the required characters from identity documents. OCR helps Verifai in (1) checking and verifying the MRZ on the identity document, and (2) gaining access to the NFC chip inside the identity document. OCR is then used as a key to gain access to this NFC chip, as this chip is protected for security reasons.

The second stage involves identity authentication, i.e. the process of recognizing the user's identity. This stage is important in fraud prevention. Criminals can be very creative and determined in fraudulent behavior¹¹. Verifai allows several identity authentication methods in determining whether the user is who he or she claims to be. These include the following:

- **NFC**
Biometric passports include a password-protected NFC chip that is readable using the machine readable zone (MRZ) of the ID.
- **Manual Cross Check**
The user has the ability to verify the data from the Machine Readable Zone (MRZ) with the Visual Inspection Zone (VIZ).
- **Liveness check**
The liveness check makes it possible to verify the liveness of the person, i.e. whether the current user is actually using the app at the moment.
- **Security Features**
Enables the user to check the presence of visible and invisible security features of the identity document to improve security and reliability of the document.

Artificial intelligence in OCR

What is AI?

Artificial intelligence (AI) is the ability of computer systems to perform tasks that emulate human intelligence, i.e. systems that are able to think and to act humanly and rationally¹². An AI-powered system is able to correctly interpret, treat, and learn from external data¹³. We can distinguish different types of AI systems in terms of intelligence, which can be seen in Table 2. **Analytical AI** represents the world by using past data to predict future decisions. **Human-inspired AI** involves emotional intelligence (e.g. happiness, sadness, anger) as well as cognition to make future decisions. **Humanized AI** also adds the use of social intelligence in decision-making, which makes the system self-aware and self-assured about the decision the system makes. Verifai uses analytical artificial intelligence for its application in the OCR technology.

	Non-AI	Analytical AI	Human-inspired AI	Humanized AI
Cognition	✗	✓	✓	✓
Emotion	✗	✗	✓	✓
Social	✗	✗	✗	✓

Table 2. Types of AI systems in terms of intelligence¹¹

Application by Verifai

Verifai uses artificial intelligence as a building block for the optical character recognition system. While there are certain standards to the shape and size of identity documents throughout the world, there are many differences in the outside appearance of such cards¹⁴. Different countries use different backgrounds or designs, including different type sizes and fonts, as there are no agreed-upon standards for these characteristics. The machine readable zone (MRZ), however, uses a uniform font on all issued identity cards and passports¹⁵.

Verifai wants its technology to be able to extract text and other data from all types of identity documents, regardless of type, size, or design. To achieve this goal, Verifai uses analytical machine learning to recognize patterns in characters so that it learns to recognize the text characters in identity documents with high accuracy. Much effort is put into the design and functioning of the AI-based system, especially the deep learning model. This model should take into account all the constraints of OCR that have already been mentioned in this paper. Furthermore, the model should be efficient and effective in character recognition, and should be able to work with a variety of mobile devices.

¹¹ For more information, see https://www.hidglobal.com/doclib/files/resource_files/web-fraud-prevention-identity-verification-authentication-guide-2018-2019.pdf

¹² Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited,.

¹³ Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. Business Horizons, 62(1), 15-25.

¹⁴ See https://www.icao.int/publications/Documents/9303_p3_cons_en.pdf

¹⁵ Full explanation is given in ICAO Doc 9303, which is available at <https://www.icao.int/publications/pages/publication.aspx?docnum=9303>

The AI-powered system

The AI-powered system is given one or multiple images or scans of the identity document. If multiple images are provided, these are all used to form an overall best image. Then, the system follows a procedure of **(1) preprocessing**, **(2) segmentation**, and **(3) classification**.

- 1.** Preprocessing entails all the steps that are required to improve the quality of the image, i.e. image scaling, tilt improvement, and noise removal.
- 2.** Segmentation is about the breakdown of the image in parts for further processing.
- 3.** Classification is the recognition of characters in the parts. With Verifai, these steps are supported by a neural network.

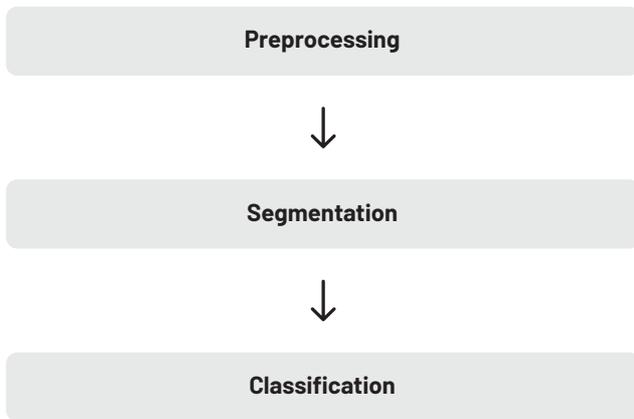


Figure 3. Identity document process

The preprocessing phase entails all the steps that are necessary to adapt the image in such a way that makes it easier to segment. The system needs to make sure that the quality of the input image is improved, as this enhances the output of both the segmentation and classification processes. To prevent blurry parts, glare, or any other challenges mentioned, multiple photos are taken to average out these challenges and to increase the overall visibility of the document. On the web, taking multiple photos is not possible, which is why Verifai assists the user in capturing the best possible photo. In general, steps that may be required are scaling of the image, skew correction, and noise removal.

Next, the segmentation phase includes the extraction of all different characters in the preprocessed document. The image is broken down into parts that may include characters. The most important part of segmentation is determining whether a recognized region or object really is a character. The system needs to ignore any other type of noise. Consequently, the system is able to detect if an MRZ is present and, if so, the location of the MRZ. The technology then focuses on the part of the image within these borders, so the text can easily be extracted with high accuracy.

Finally, the system is guided by an algorithm in character prediction. This is the classification phase of the OCR system. The neural network plays an important role in this phase. The OCR system is trained to predict the characters with high accuracy. This prediction is applied to the recognized regions to detect the corresponding character. The output is then returned, which can be used and verified by Verifai's built-in components, e.g. NFC and security features check.

AI-powered versus conventional OCR

There are some important advantages to using an AI-powered OCR system instead of conventional OCR-technologies. These include the following:

- By using analytical artificial intelligence, the system is trained in its accuracy and reliability. Training data helps the machine learn in the prediction process, which, in this case, is the character recognition. Conventional OCR is not capable of learning, and the user is only able to increase reliability by measuring and monitoring the results. This means that using AI makes OCR much smarter.
- Artificial intelligence is better able to deal with complex environments and its consequences for the input, e.g. glare, rotation, tilting, or blur. The AI-powered system is, for instance, able to combine the results of multiple frames to create a better overall input image. This way, scene complexities can be minimized.
- As identity documents are highly variable between designs and countries, artificial intelligence helps text extraction from all kinds of documents without the need of formats for each type, which is a requirement when using traditional OCR.
- Verifai developed OCR-technology that performs 90% better than open-source alternatives on the market¹⁶.

¹⁶ Compared to Tesseract, internal performance test under different lighting conditions.

Conclusion

Through the years, optical character recognition systems have been developed to extract characters from all types of optical documents. Such systems are used in various industries for different purposes. For example, OCR can be used for handwriting recognition, document archiving, and number plate recognition. Using OCR offers numerous great advantages, including higher data processing speed, higher work efficiency, and higher effectiveness.

Verifai uses OCR as one of the first steps in the identity verification process. This step determines whether the identity data is associated with an individual. Verifai developed an AI-powered OCR-system that is able to extract characters from identity documents (e.g. passports, identity cards, and driver's licenses). To do so, Verifai allows both the use of the camera in someone's smartphone, and the use of a scan or photo of an identity document.

Both methods face certain industry-wide constraints that must be overcome. Scene complexity may hinder the recognition process, and the challenge is to separate textual parts from non-textual parts of the image. Bad lighting results in dark OCR conditions, while glare results in excessive brightness spots in the image. The challenge is to make sure the camera captures all necessary details, or that the provided scan has all the necessary details. Blurry text may hinder the recognition process, so blur must be prevented as much as possible. Moreover, web applications allow only the use of a single image, so the input image must meet all mandatory requirements for OCR to work correctly.

To address these constraints and challenges, Verifai uses AI-powered OCR-technology. This technology is able to (1) detect and preprocess the identity document, especially the MRZ; (2) extract the different characters in the preprocessed document by segmentation; and (3) identify and predict the characters that are segmented by classification. At all stages, artificial intelligence is used. For example, artificial intelligence helps prevent glare by processing multiple frames into a preprocessed image. AI also helps in optical character detection, as this AI-powered system is assisted and trained by a neural network. This way, Verifai ensures identity verification with higher efficiency and effectiveness than traditional OCR systems.

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