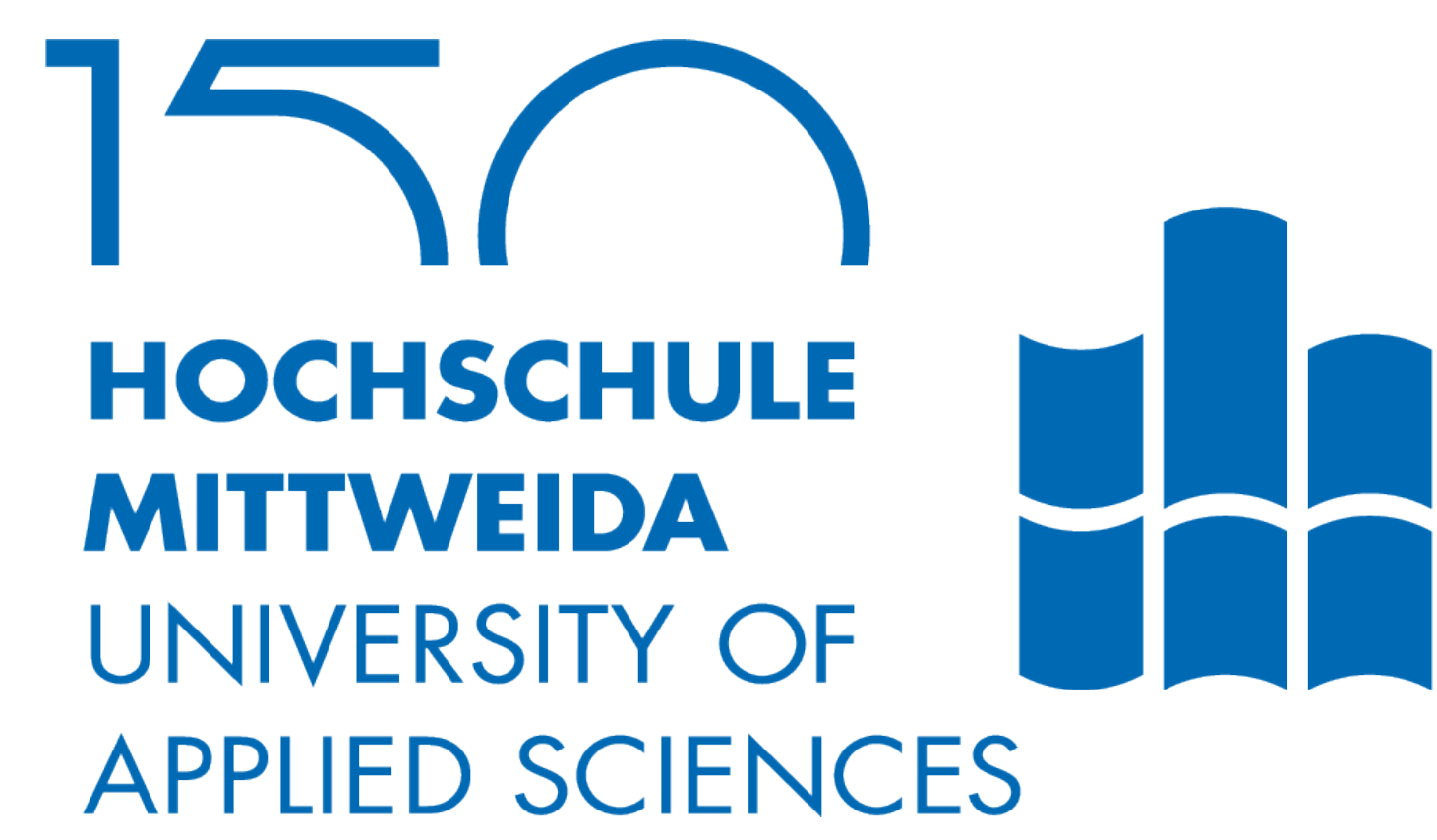


Development of a mobile annotation tool for the evaluation of banknotes

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INTRODUCTION

Banknotes are subject to constant wear (dirt, cracks, etc.) and therefore require regular replacement. From a cost-efficient point of view, however, only those banknotes are to be exchanged which can no longer be assessed as acceptable for circulation. In addition, the quality of a banknote, which is essential for the exchange, is differently perceived in various currency areas. The cooperation partner involved, CI Tech Components AG, manufacturer of banknote validation machines, currently uses classic image processing methods for automated rejection, which have to be modified when introducing new banknotes. In a research project, therefore, the use of convolutional neural networks for automated fitness testing using banknote processing devices is to be investigated. However, the ground truth necessary for the training of these networks was not yet available. This work therefore deals with the creation of a tool for the targeted creation and annotation of training sets. In order to enable different test persons from different currency areas to annotate the fitness of the banknotes, it was necessary to develop a portable system. The basis of the system is a tablet application developed in Swift [7], which allows the creation of annotated and classified images and the transfer to a web service.

RESULT AND DISCUSSIONS



Figure 1: System environment of the Fitness-Voter-App

Figure 1 shows a system overview of the resulting application, which was implemented as a distributed application. The web server provides the test decks to be processed (information about the banknote, e.g. position of the serial number, filter parameters, etc.) of the iPad app. The banknotes are annotated on the iPad. The user places the banknote within the camera area and then starts the annotation process. The annotation process includes the automatic scanning of the banknote, the reading of the serial number and the manual annotation of the banknote wear. After completion of the test set, the recorded data is transferred to the web service and stored persistently.

Banknote exemption

In order to be able to use the app for a wide variety of currencies, the area for recording the banknote was chosen to be sufficiently large. This has the consequence that the banknote images are taken with background. The creation of a valid ground truth therefore requires the banknote to

be released from the background in order to avoid overfitting the CNN to the background. For this purpose, an edge detection based on a binary image was implemented using a RANSAC algorithm. [1, 5] Since the necessary currency-dependent filter parameters can be determined in advance in the app. The currency-related filter parameters required for this can be determined in the app in advance and then specified in the web service when creating a test deck. (Figure 2)

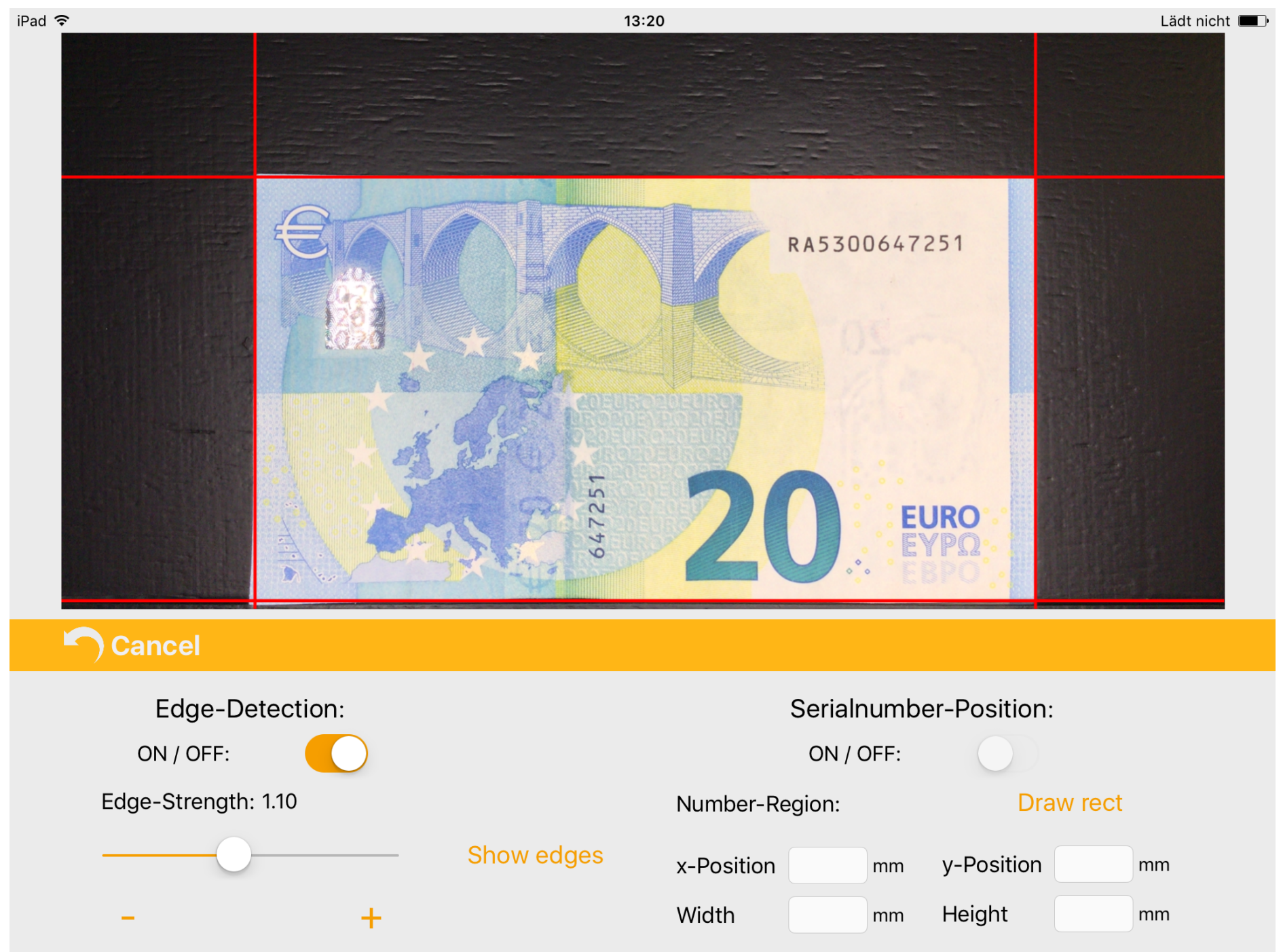


Figure 2: System environment of the Fitness-Voter-App

Serial number detection

Furthermore, the serial number of the banknote must be logged for later identification. Various image processing algorithms and the OCR Tesseract were used for this purpose. [3, 2] In many banknotes, the serial numbers are located within samples and images of the banknote, which makes text detection much more difficult. Furthermore, banknotes are subject to a change in size during their useful life. Therefore, the rough positions of the serial numbers of the app are provided by the test deck. As can be seen in Figure 3, the app then uses these rough position ranges and tries to capture the exact position of the serial number by pattern recognition.

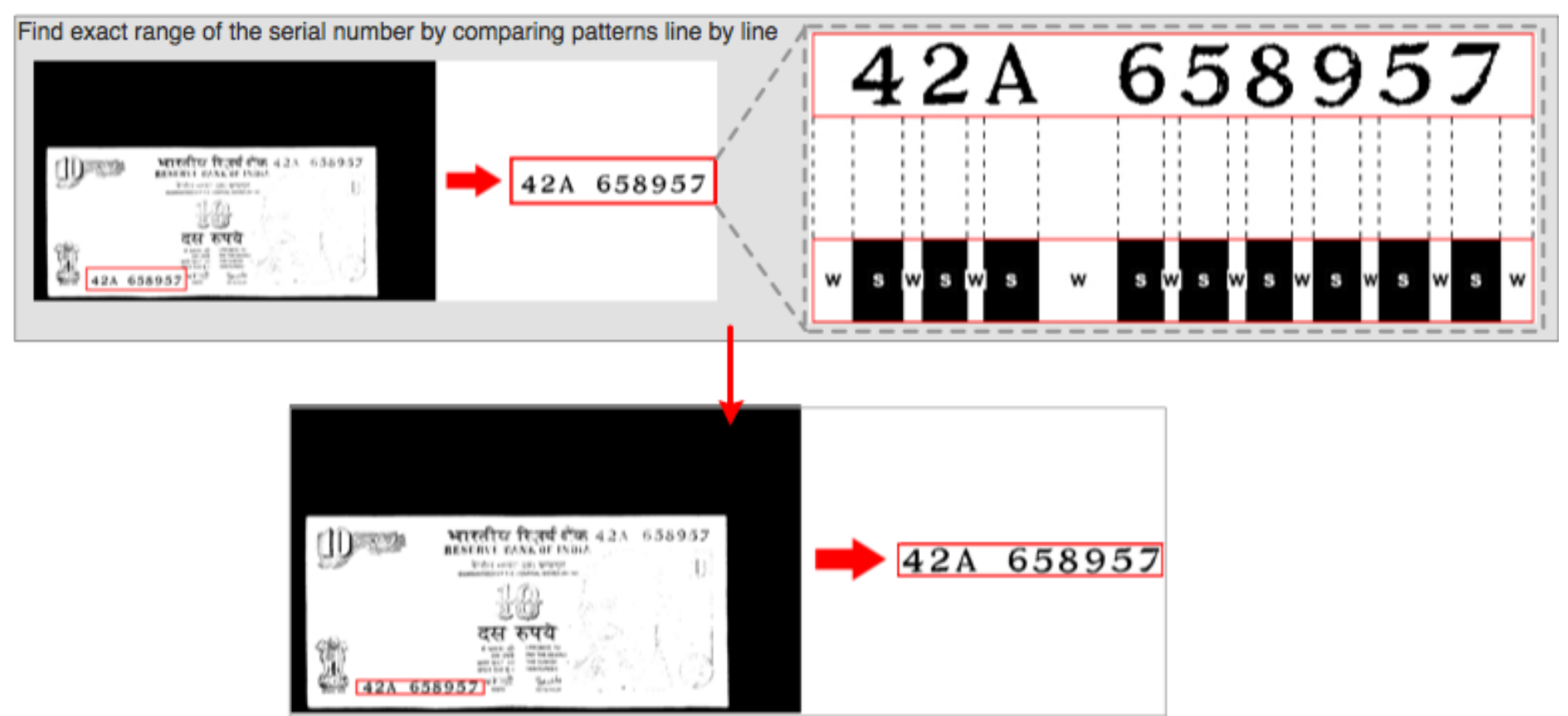


Figure 3: Exact determination of the serial number range by comparison of patterns

The serial number is then performed with several differently binarized images. Based on the probability values of the OCR, only recognized characters > 85% are accepted. For multiple OCR measurements, the serial number is formed based on the highest probabilities. Furthermore, the serial numbers are checked syntactically and, if available, against the second serial number that is to be read out. If no serial number could be determined, the user is prompted to enter the number manually.

Annotation of the banknote

Figure 4 shows the annotation of the banknotes by the user. For this purpose, the user has 10 evaluation parameters to choose from. If the user does not select any of these parameters, the banknote is annotated as "Fit", otherwise as "unfit", specified by selected valuation parameters.

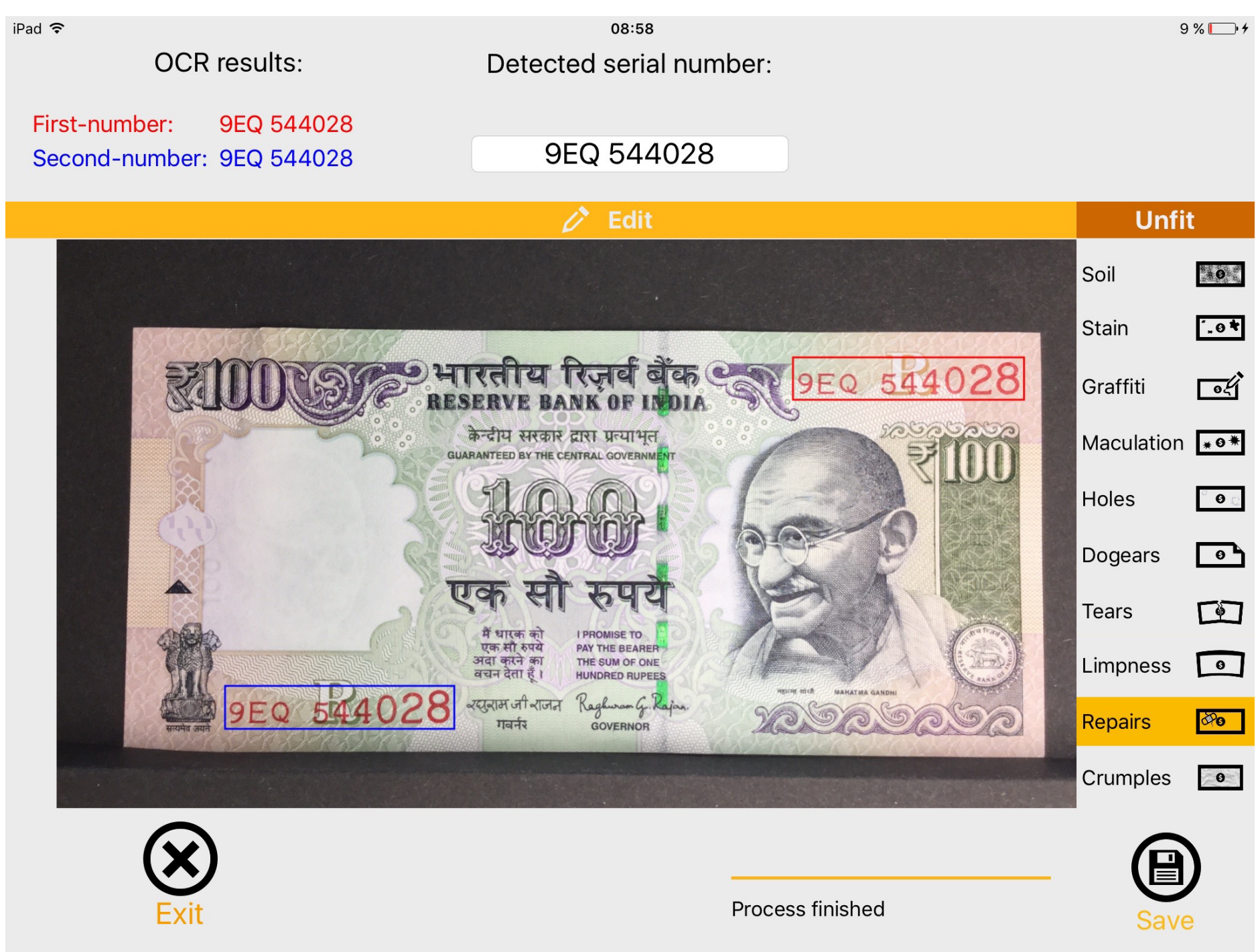


Figure 4: Annotation of a banknote

Webservice

Based on the MVC framework Laravel a basic web service with a MySQL database was developed. The web service enables the creation and management of test decks, the provision of test decks in JSON format for the app and the persistent storage of annotated data sets. The open source framework Laravel follows the development pattern Model View Controller (MVC) and is licensed under MIT. Laravel offers multiple components in the standard installation, which can be used by developers for larger and more complex developments. [4, 6]

SUMMARY AND CONCLUSIONS

The result is an iPad app that allows you to create annotation data sets of international currencies. These annotated data sets can then be used to train convolutional neural networks. In addition to the software implementation, a transportable annotation structure for placing the tablet and the banknote was also developed. Due to its portability, the FitnessVoter app could already be used in the Indian currency area. For the further development, annotations are planned by manually marking the affected areas on the banknote. In addition, the web service should also be used for annotation tasks. In this case, the user should perform annotation of digital banknote images directly in the web browser.

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