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IMPLEMENTATION AND TESTING OF TEXT RECOGNITION ALGORITHM ON MOBILE DEVICES

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Abstract:

A large number of people every day are faced with a situation where they need to transfer the text from the image or various documents to digital format. This is a routine work that requires a lot of time, care and effort. In most cases, a mobile phone, unlike a scanner, is always there. The mobile application will allow you to quickly transfer the necessary documents to the digital version, and the format of the created document, DOC will allow you to immediately start working with it, without losing additional time to convert the file to an available format for editing. The aim of the work is to develop a mobile application for text recognition from a graphic image for Android devices. This program is implemented in object-oriented programming language Java, using the development environment Android Studio. The analysis was done of the existing API and existing methods of text recognition. The most suitable methods were selected and integrated into the application.An algorithm for creating and storing a file in the memory of a mobile device was developed and implemented, as well as an algorithm that will allow you to get the files created by the application from your mobile phone. The ability to send files is implemented too. An application interface was developed and implemented. The application was tested.

Keywords:

Image recognition, program, application.

ACM Computing Classification System:

Distributed systems organizing principles, software functional properties, specialized application languages

Introduction

The development of a mobile application based on the Android OS, for text recognition from a graphic image is an actual topic. This is due to the fact that a large number of people daily face a situation where they need to transfer text from an image or various documents to a digital format [1].

This is a routine work that requires a lot of time, care and effort. In most cases, a mobile phone, unlike a scanner, is always there.

The mobile application will allow you to quickly transfer the necessary documents to the digital version, and the format of the created document, DOC, will allow you to immediately start working with it, without losing any additional time to convert the file into an accessible format for editing.

The DOC document format is a feature of this application, since almost all analogues allow you to save files in PDF format, which is not convenient, since this format is not suitable for editing.

The goal is to develop a mobile application for text recognition from a graphic image for Android devices.

To implement the application, the following tasks were set:

1. Analyze and disassemble existing text recognition methods.
2. Analyze and parse existing APIs. Choose the most suitable and integrate it into the application.
3. Develop and implement an algorithm for creating and storing a file in the memory of a mobile device.
4. Develop and implement an algorithm that allows you to receive files created by the application from a mobile phone and realize the possibility of sending them.
5. Develop and implement an application interface.

1 Installing the Application

In order to use the application, you must first install it. The installation file permits APK, it is standard for all versions of the Android operating system [2]. The name of the installer Document_reader_1.0, an example in (Fig.1). The application icon is currently standard. It is presented in the form of a square image with the logo of the Android OS.

To start the installation, you must click on the icon of this application. The system will automatically start the installation process and a window will open before the user informing you that this application does not require special permissions and asking: Do you really want to install it?

An example of this item is in (Fig.2). If the user clicks the "Cancel" button, the installer will close and the application will not be installed. If, at this stage, click the "Install" button, the installation program will automatically redirect the user to the next page of the installer.

Fig.1. Installer file.

The second page of the installer displays the installation progress itself. The system unpacks files and registers them in the telephone system for further use.

The installation step is displayed as a green bar in the center of the screen, which symbolizes the remaining and elapsed time, an example in (Fig.3).

To complete the installation, the user simply needs to wait until the bar is completely full.

The waiting time is always individual, depending on the processor that is installed in the mobile device, the amount of RAM and the write speed of the internal or external drive, depending on which one is being installed.

Most often, the installation takes about 2-3 minutes, in some cases, the time may be longer, due to the reasons described earlier.

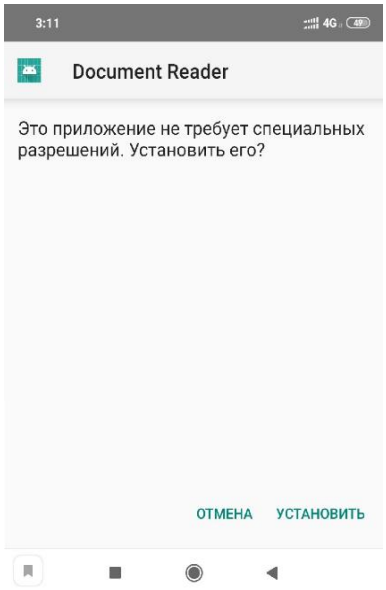


Fig.2. Installation Initial Page: information, button cancel and install.

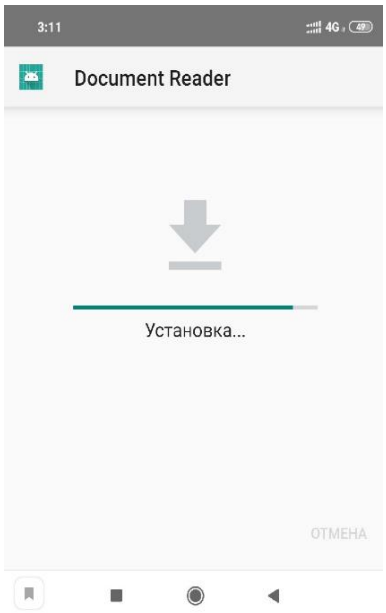


Fig.3. Installation Process.

After the installation process is completed, if the user has the built-in antivirus installed, the system will start checking the installed files, an example is shown in (Fig.4). This test also takes some time and depends on the same conditions as the installation. It allows you to protect the user's device from malicious programs, confirms that the installation was performed correctly and the application will work correctly.

If the user does not want to wait, he can click the "Cancel" button, the check will stop, but the application will be installed. This action poses a security risk and is not recommended. If the user just waits, the system upon completion of the check will display a new page that informs him about the successful check, an example is shown in (Fig.4). On this page, you must click the "Finish" button and proceed to the operation of a successfully installed and verified program.

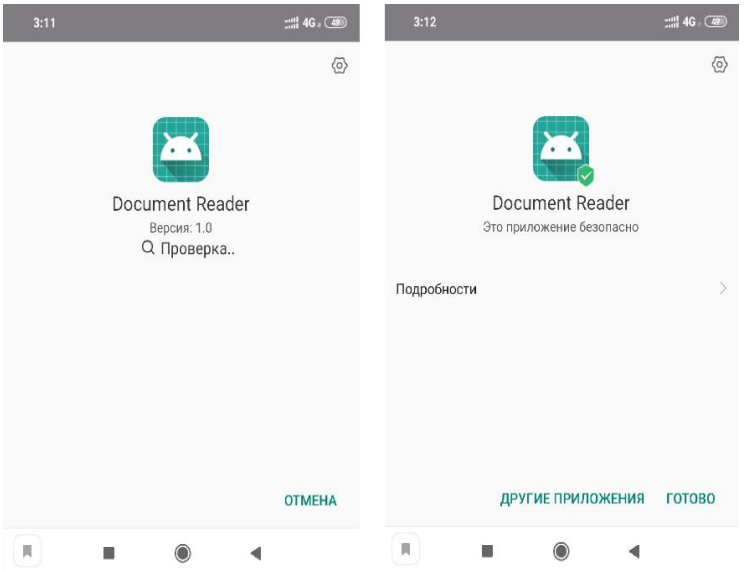


Fig.4. The beginning and the end of the test.

2 Application Operation

After the application is installed, a shortcut will appear on the desktop or menu (depending on the Android OS version). It is a green square with the company logo of the Android operating system. The names of this label "Document reader". The example is in (Fig.5). To start the application, you need to click once on the icon of this application.

After starting, the user sees the main menu and application interface, an example is (Fig.6). When you click on the “Take a photo” button, the system will ask the device for permission to use the camera, an example is (Fig.7).

If you click the "Reject" button, the application will not get access to the camera and further work with it will not be possible. You must select "Allow". When obtaining rights, the program must be restarted. This procedure is performed once during the initial launch of the application. After all these actions, the standard Camera application is launched, which is installed in every smartphone that can take photos. The user needs to focus the camera lens on the text that he wants to scan. The image of the text should be in focus and readable. The phone must be kept in a horizontal position, since the text reading algorithm works in such a way that correct text recognition will occur only when all these conditions are met. To take a picture you need to click on the button responsible for creating the image. Depending on the application, it may have its own unique look. The application will save the captured image in the memory of your device for future use.

It can be found by following the Android / data / com / example.skript.documentreader / files / Pictures path on the mobile device itself. With these images you can work, as with any photos on the device. After the snapshot is taken, the next page of the application opens, where its main actions take place, an example is (Fig.8).

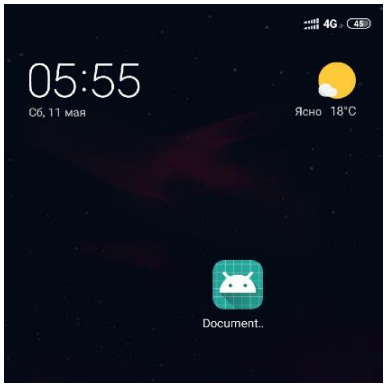


Fig.5. Application Label: Document.

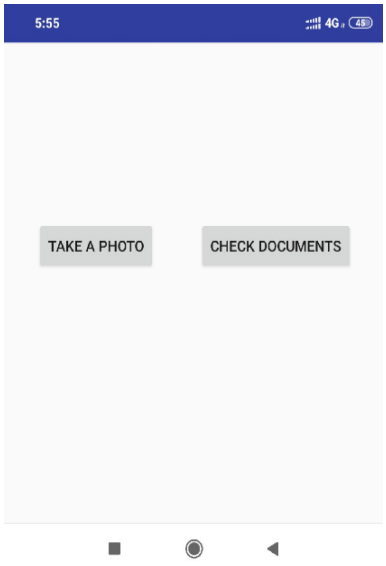


Fig.6. Main Menu.

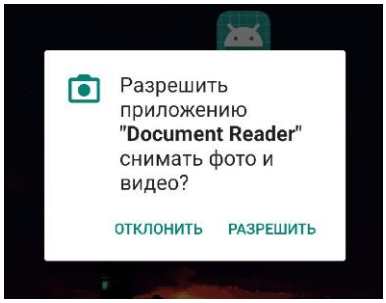


Fig.7. Camera access: allowing to the application to use camera?

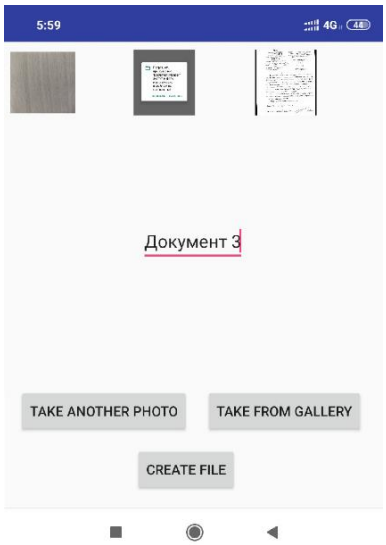


Fig.8. Document Creation Page.

In the upper part are displayed all the images that will be recognized and included in the created document. Each selected file is a new document page.

When you click on the "Take another photo" button, the system will reopen the "Camera" application to create another image. All actions on the requirements for photographs have been described in the manual earlier. They remain unchanged for this situation. The photo taken is also stored in the phone's memory and is added to the top of the form to the other, existing files.

Clicking on the "Take from gallery" button will open the standard "Gallery" application with the latest saved images in the phone's memory, which you can select by tapping on the necessary. The graphic file will be added to the list and displayed at the top of the previous menu, where the first photo taken will be displayed.

The field is displayed in the center of the page, it is necessary to enter the text in it, example (Fig.9). This will be the name of the file that will create the application. You can enter letters, symbols and numbers in this field. To create a file, click on the "Create file" button. The created file will be in the DOC format and located in the phone's memory on the Android / data / com / example.skrpt.documentreader / files / documents path.

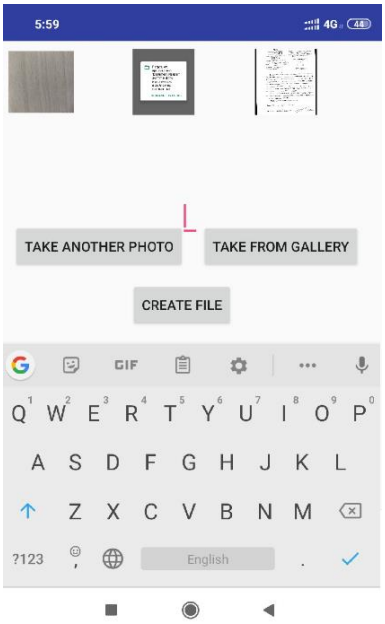


Fig.9. The input field for entering the file name.

Clicking the “Check documents” button opens a list of files that were created by the application or added by the user to the “Documents” folder on their own, for example, (Fig.10). These files, the user can edit, send or move on his request.

Fig.10. List of Documents.

3 Testing Implemented Solutions

The implementation of the application was based on the Google Text Recognition API framework. The purpose of this test is to analyze the percentage of correctness of text recognition and its accuracy, as part of integration into a mobile application based on the Android OS. The task of the chosen framework is the recognition of printed text in real time. In his technical description the possibility of working with a large list of languages is indicated, namely with these 18 languages:

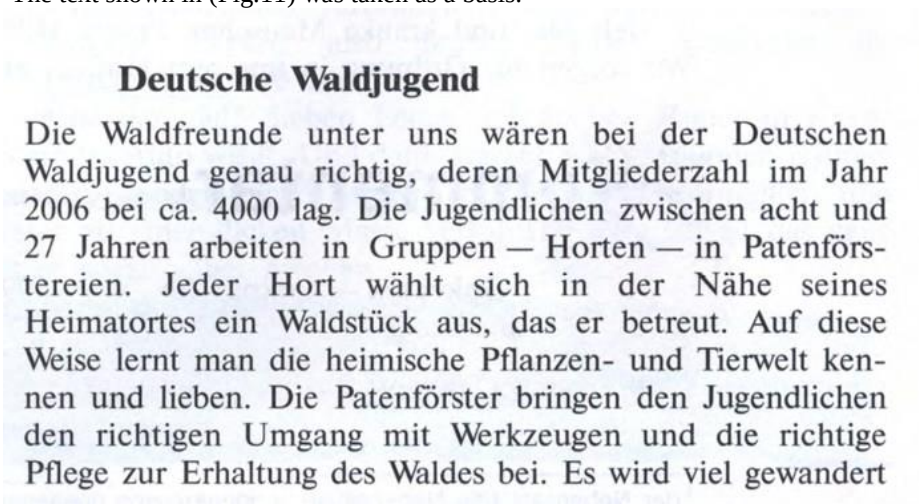
- English
- Deutsch
- Danish
- Dutch
- Finnish
- French
- Hungarian
- Italian
- Catalan
- Latin
- Norwegian
- Polish
- Portuguese
- Romanian
- Spanish
- Swedish
- Tagalog
- Turkish

In the course of this analysis, it is necessary to determine the degree of correctness of text recognition. Since English is the main language and all applications are mainly written under it. For objective analysis, a not less popular German language was chosen as the basis for testing.

For testing arbitrary text in German, an undefined font was chosen in order to make the task as difficult as possible and to simulate everyday use. A text was printed on paper to simulate various situations. Testing took place in three stages:

1. Recognition of a text of an unknown format, taken at random, from a photograph from a paper carrier.
2. Recognition of the same text in Times New Roman format, size 14, from a photo from a paper carrier.
3. Recognition of text in Calibri format, size 14, from a photo from the monitor screen.

The text shown in (Fig.11) was taken as a basis.



Deutsche Waldjugend

Die Waldfreunde unter uns wären bei der Deutschen Waldjugend genau richtig, deren Mitgliederzahl im Jahr 2006 bei ca. 4000 lag. Die Jugendlichen zwischen acht und 27 Jahren arbeiten in Gruppen — Horten — in Patenförstereien. Jeder Hort wählt sich in der Nähe seines Heimatortes ein Waldstück aus, das er betreut. Auf diese Weise lernt man die heimische Pflanzen- und Tierwelt kennen und lieben. Die Patenförster bringen den Jugendlichen den richtigen Umgang mit Werkzeugen und die richtige Pflege zur Erhaltung des Waldes bei. Es wird viel gewandert

Fig.11. Free-form text in German (*about 4000 young volunteers working in forests*).

Two photos were taken from the same paper carrier in the same light conditions, for comparison. The result is shown in (Fig.12). After conducting a primary, superficial analysis of the results obtained with a glance, it can be noted that despite the fact that the photographs were taken under the same conditions, the results differ. We will conduct a more detailed analysis [3, 4].

Recognizable text contains 569 characters, 88 words. Judging by the first example, the application was able to recognize the text correctly, but for some reason the characters “a”, “s”, “s”, “h” were added, only 4, which were not in the original version. In the example, they are underlined in red. Despite this, the result was pretty good. With a more accurate calculation, it becomes clear that the error of 4 characters from 569 was only 0.7%. Therefore, the text is correctly recognized at 99.3%.

After retesting, using the same text, a more positive result is seen. The application was able to recognize the text completely correctly, without any errors. A positive result was 100%. Improvement is achieved by training the neural network; after the first attempt, the system makes it easier to recognize almost identical images.

The second step is to test the recognition of the same text, given in the Times New Roman format, size 14, from a photograph from a paper medium. The example we can see in (Fig.13).

At the first result obtained, a similar picture is displayed, which was in the first stage. When recognizing the text from the first photo, it is clear that the application was mistaken several times, namely the word “*Jahren*” was recognized as “*ahren*” and the word “*seines*” was recognized as “*senes*”. The system made 2 errors out of 569 characters. Having calculated the percentage ratio, it becomes clear that the error in the result obtained is 0.35%. Therefore, the text is correctly recognized at 99.65%. This result is better than at the previous stage.

After retesting the second stage, using the same text, a positive result is seen. The application, like last time, on the second attempt was able to recognize the text completely correctly, without any errors. A positive result was 100%. This is due to the fact that the neural network is trained and the recognition becomes more accurate.

The third stage of testing is the recognition of text in Calibri format, size 14, from a photo from the monitor screen. The photo was taken in good quality and with sufficient illumination, but at the same time the camera focuses well on the pixels of the screen itself. In addition, the monitor from which the photo was taken is curved. All these facts distort the resulting image, which creates additional difficulties for the system in recognizing text, an example is (Fig.14). Even in such a complex task, the system performed well. Despite the experience of the previous steps, this time, the application recognized the text correctly the first time. A positive result was 100%.

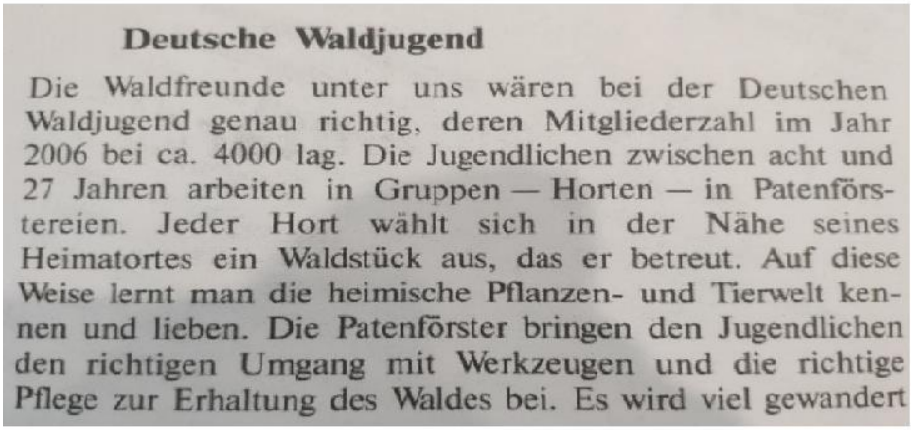
As a result of the tests performed, you can make an intermediate result. The application behaves very well, the error in recognition does not exceed 1%. To achieve this result, it is necessary to observe good conditions for photos, namely:

- In addition to high resolution, the camera of the phone should have a good matrix to create clear pictures.
- In the location where the picture is taken, there should be sufficient illumination, preferably the source should be daylight or cold light.
- The photo must be taken at right angles to the source with the text.
- The phone must be kept in a strictly horizontal position, relative to the object to be removed [5].
- The text should be placed on a flat surface and clearly stand out from the background.

Further, in the course of testing, it is necessary to reproduce conditions uncomfortable for the application in order to check how it will work in stressful situations. Indeed, in various situations it is not always possible to fulfill the entire list of conditions listed above. During the second honor test, the following situations are modeled.

1) Photo at an angle of 45 degrees;
2) Low light conditions;
3) Photos from a crumpled sheet of paper.

For the test, previously used text was taken, which will allow to objectively compare the results obtained. With a photo at an angle of 45 degrees, the application could not recognize the text accurately, even in good light. As can be seen from (Fig.15), one letter was confused with “W” to “V” and one letter “i” was missing, the word was also incorrectly transferred to a new line. Only 3 errors. The error of the total 569 characters was 0.53%, the accuracy was 99.47%.



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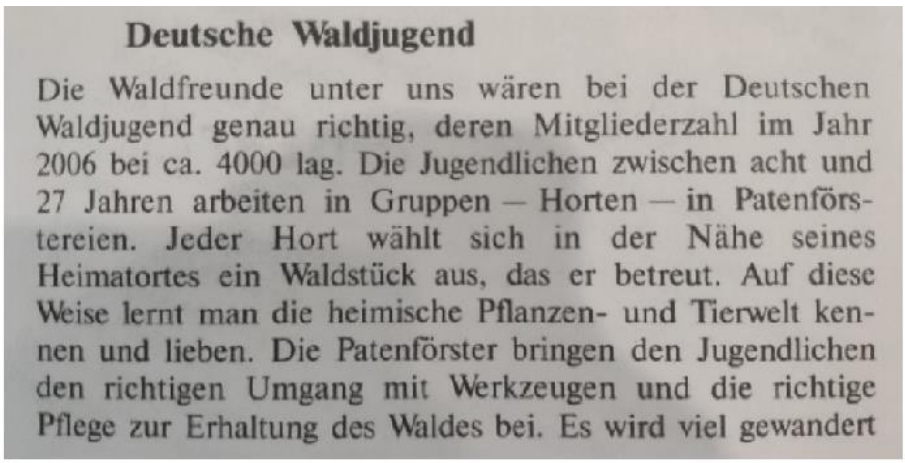

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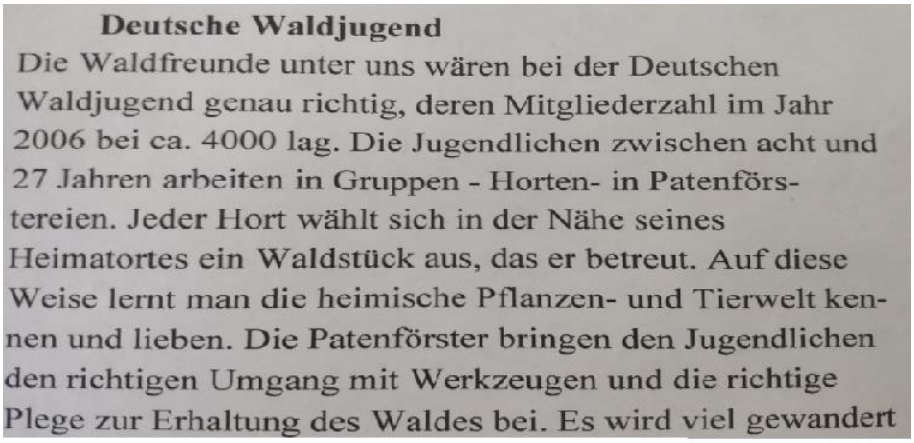
Fig.12. Example of reading the text with unspecified font design.



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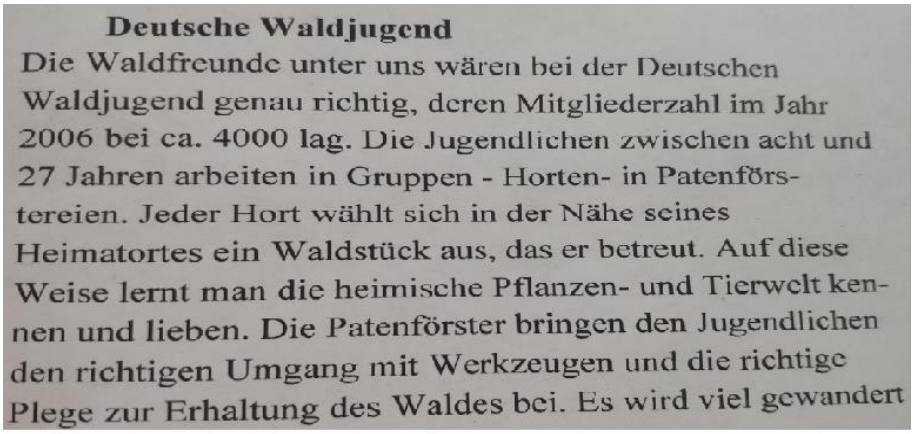

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Fig.13. Example of reading text in Times New Roman format.

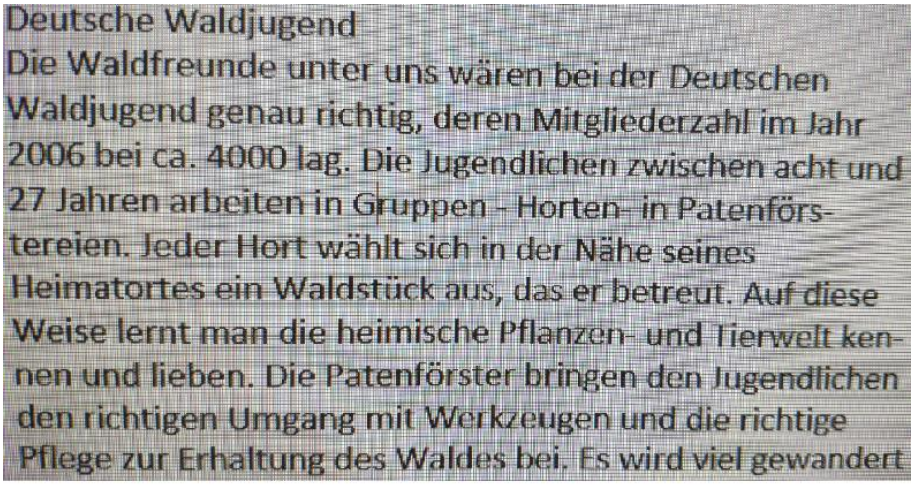


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Fig.14. Example of reading Calibri format text from a monitor.

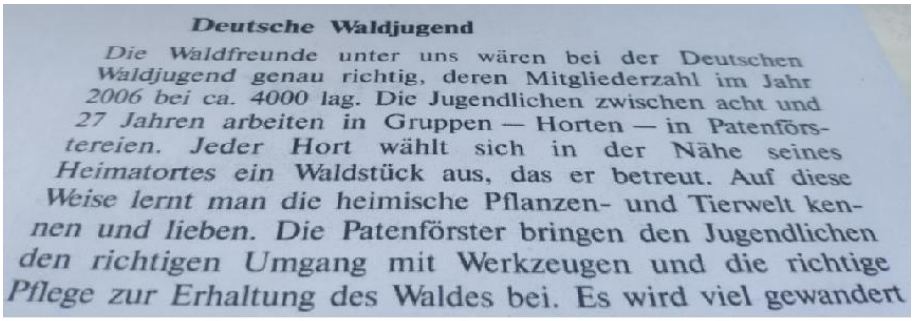

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Fig.15. Photo at an angle of 45 degrees.

Insufficient illumination was created in 2 stages, from light to darker. In the first example of (Fig.16), you can see that the image in the photo has become darker by 40%. Despite this fact, the application did a pretty good job with its task, making only one mistake, missing the letter "f" in the last line. The error in recognition was 1.0.18%, the accuracy was 99.82%.

If the light source is dimmed even more, thereby making the photo even 30% darker, then the application starts noticeable problems. It is strikingly more difficult for the system to identify the text on the image, as a result of which, in the second part of (Fig.16), we see a large number of errors, namely 11, which is an error of 1.93%. But despite a small percentage of errors, the system incorrectly distributes the string order and tears up some sentences, skipping letters, into several lines. Because of the dark background, it is difficult for him to determine the line boundaries.

At the final stage of testing, a photo was taken with sufficient lighting, but from a crumpled paper source, an example is shown in (Fig.17). This method distorts the order of the letters, relative to their original position. These conditions should complicate text recognition. Despite the complicated conditions created, the system was mistaken only 4 times. Inaccuracy was made in the following situations: the "-" sign was missed, the letter "ä" was recognized incorrectly and replaced with "a", an error in the letter "d" that appeared as "J", the letter "f" was omitted. It can be concluded that a crumpled paper source does not greatly affect the operation of the application. The percentage of errors in the recognition of the text was 0.7%, the accuracy of the process was 99.3%.

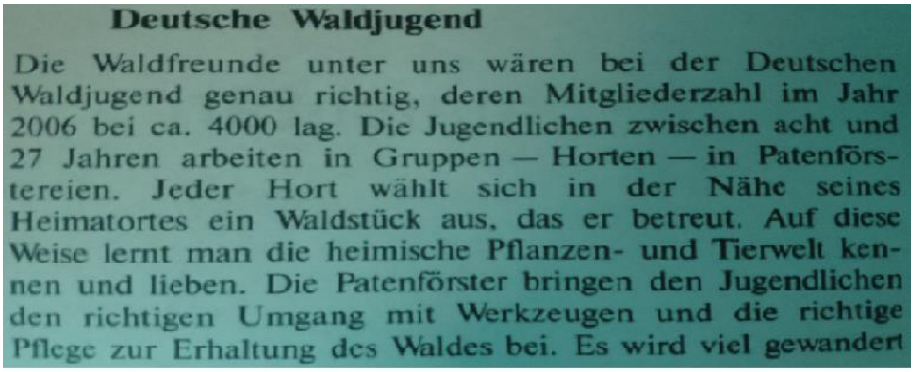
After all the planned stages have been completed, a final conclusion can be made on the basis of the tests performed. The accuracy of recognition is directly dependent on the quality of the image.

One of the key factors for a successful photo is a high-quality light source. The decrease in the light level in the photograph led to a significant deterioration in recognition accuracy. If under comfortable conditions the application can read the text with an accuracy of 100%, then when the light is reduced by 40%, this Picture drops to 99.82%. With a decrease in illumination indicators by another 30%, the accuracy drops to 98.07%, which is a record low for all the tests performed. It is also clearly seen that under these conditions, the application copes worse with the positioning of lines in the text.

Changing the angle of inclination, while maintaining a sufficient light source, did not greatly affect the quality of recognition. Deformed paper source, too, is not critical. The results were very similar. In the first case, 3 errors, in the second 4, respectively. Recognizing the test from a photograph on the monitor screen showed that even with large interference, the application can perform its functionality with an accuracy of up to 100% without making a single mistake.

If you create the right conditions for the application, despite the different text formats and their sources, it can show the result with an accuracy of up to 100%.

After analyzing the general statistics (an example is given in Table 1), the result shows that the application does much worse in stressful situations than in ordinary ones. But regardless of the simulated situations remains relevant for use, and the accuracy in the recognition of the text does not fall below the mark of 98%.



Deutsche Waldjugend

Die Waldfreunde unter uns wären bei der Deutschen Waldjugend genau richtig, deren Mitgliederzahl im Jahr 2006 bei ca. 4000 lag. Die Jugendlichen zwischen acht und 27 Jahren arbeiten in Gruppen — Horten — in Patenförstereien. Jeder Hort wählt sich in der Nähe seines Heimatortes ein Waldstück aus, das er betreut. Auf diese Weise lernt man die heimische Pflanzen- und Tierwelt kennen und lieben. Die Patenförster bringen den Jugendlichen den richtigen Umgang mit Werkzeugen und die richtige Pflege zur Erhaltung des Waldes bei. Es wird viel gewandert

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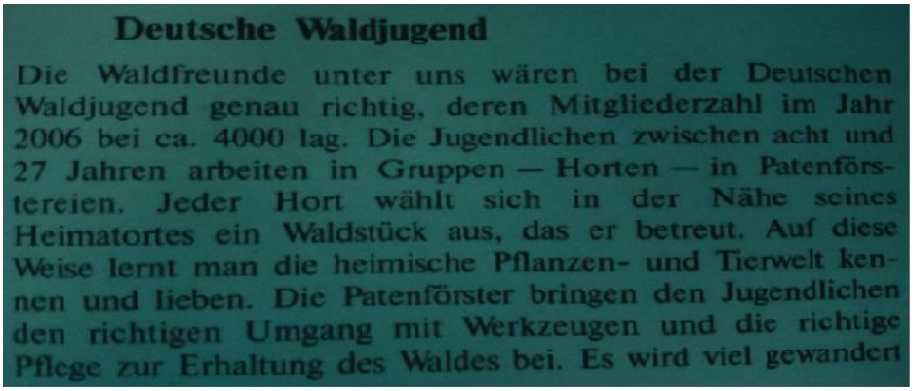

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den richt
Pflege zu rErhaltung des Waldes bei. Es wird viel gewandert h

Fig.16. Photography with low light.

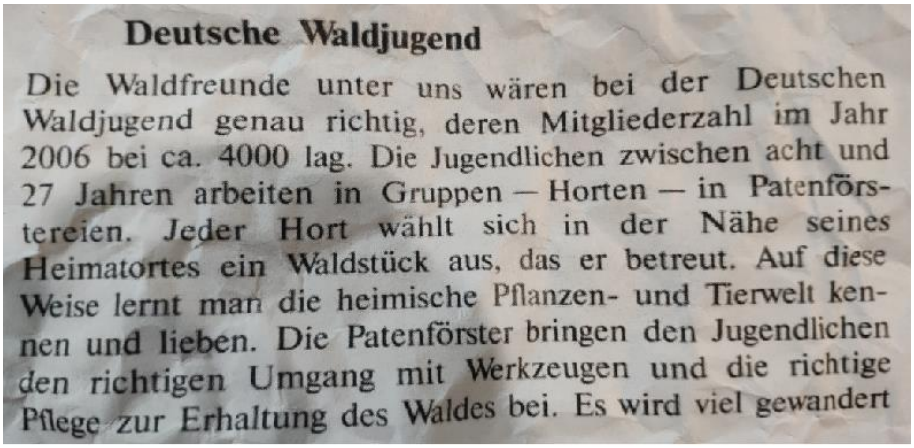

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Fig.17. Crumpled paper source.

Table 1. Statistics of the results in all simulated situations

	Ordinary conditions			
	Attempt	Accuracy	bias	Errors
Free text	1	99.3%	0.7%	4
	2	100%	0%	0
Times New Roman	1	99.65%	0.35%	2
	2	100%	0%	0
Calibri	1	100%	0%	0
	Stress test			
	Attempt	Accuracy	bias	Errors
Incline 45^{O}	1	99.47%	0.53%	3
fogging	1	99.82%	0.18%	1
	2	98.07%	1.93%	11
Deformation	1	99.3%	0.7%	4

Conclusion

As a result of this work, an application for phones based on the Android OS has been developed to create DOC files in which the text obtained from the image is written.

All the previously set conditions for the development of the application have been met, namely:

1. The analysis is carried out and existing text recognition methods are analyzed.
2. Analysis and analysis of existing API and text recognition methods. Selected the most suitable and integrated into the application.
3. An algorithm for creating and storing a file in the memory of a mobile device has been developed and implemented.
4. An algorithm has been developed and implemented that will allow you to receive files created by an application from a mobile phone. Implemented the ability to send them.
5. Designed and implemented application interface.
6. Tested application.

The mobile application has the following functionality:

- The user has the ability to create documents from the image.
- You can create an image using the camera of the phone or download them from the device's memory.
- The user independently enters the name of the created document.
- The application saves a DOC file in the phone memory.
- Implemented the ability to view a list of created documents.
- It is possible to work with the created files and send them through the functions of the Android OS.

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