NAZARBAYEV INTELLECTUAL SCHOOL
OF PHYSICS AND MATHEMATICS IN ALMATY

Project «Oqyp ko'r» -

scanning and recognizing text, system, from media data, through the neural network, followed by tactile-relief visualization and sounding of data for visually impaired people

Developers: Dudchenko Lyubov
Selimzhan Chalyshkan
Supervisor: Dosmahambet N. Қ.,
head of the extended laboratory
of information technologies "Technotoria"

Almaty

2019

Content:

Short description

Oqyp kör is an innovative solution to the often-encountered problem of blind, access to information. The device reproduces the text of printed publications (teaching materials, literature, articles, newspapers, etc.) at the same moment through the camera in the form of a Braille alphabet. This invention does not require bulky printing machines and a ton of paper, the text in Braille is broadcast on a convenient display with 1 cell (1 cell = 1 letter) in fractions of a second.

Up to 80% of all information a person perceives with the help of visual skills. Printed publications are the main resources of information, perceived visually. The innovative device developed by us allows visually impaired to get information from any printed text, thereby expanding the opportunities for the blind in society. One of

the main goals of this project is the distribution of this product in Kazakhstan and global market and its implementation in local and international schools.

.

Importance

According to a study published in the Lancet Global Health Journal, there are 39 million visually impaired people and 940 million people with partial loss of sight. In 2050, the number of visually impaired is projected to reach about 115 million.

Loss of vision creates a great ravine between information and a human as 80% of the information we recieve through vision. Blindness limits a person's abilities in many spheres, including education, since informational resources mostly appear in printed versions. Despite the fact that numerous actions have been undertaken to expand the abilities of visually impaired, the society is still struggling

with a number of problems, notably:

1. Limited number of resources for the visually impaired (fiction, scienctific literature, mass media, periodically printed editions)
2. Deficiency of educational resources adapted for visually impaired across the world
3. Limited number of printing houses
4. Inaccessible apparatus (due to its absence in the domestic market, high prices, immobility)
5. The absence of a device adapted for both visually and auditorily impaired

Objectives of the project work

- to gather information about life of visually impaired (common problems)
- To analyzethemarket of goods and services forthedisabled
- To review the main disadvantages of commodities (accessibility, prices, design, environmental concerns)
- To create conception of innovational product
- To design a model of project (images, schemes, model)
- To build the first prototype and test it
- To develop a programming code and to make alpha and beta tests

- To optimize project work according to testing

Scientific substantiation

The device can be conditionally divided into two components: reading text from printed publications and displaying it in the form of a Braille alphabet. Smartphone Application(Image 1.), taking a picture of the page, sends a raster image of the document page to the input of the recognition system, which works through a

neural network.

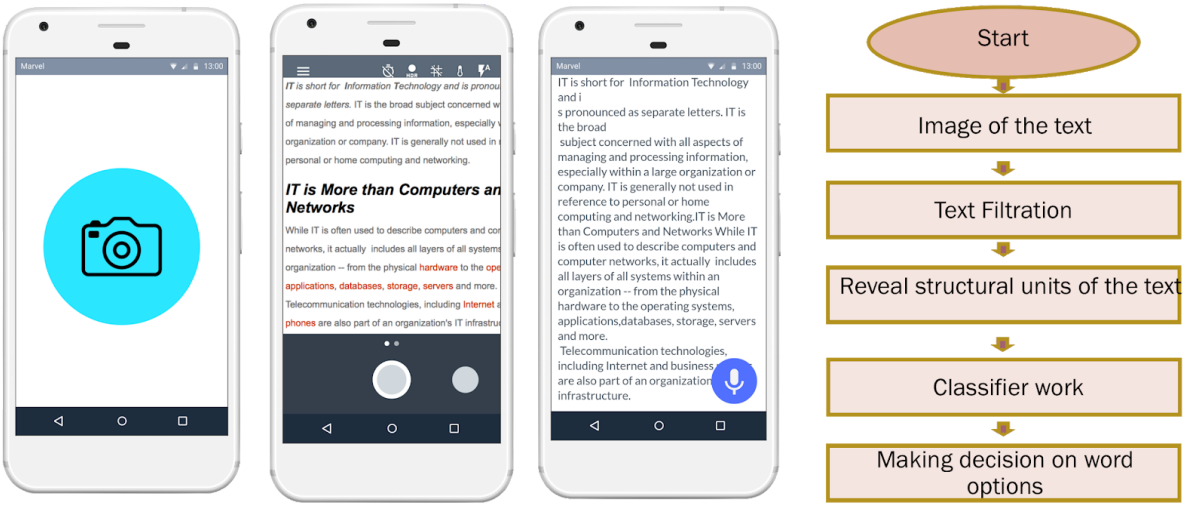


Image 1.

Pre-processing involves improving image quality: filtration of the image from noise, an increase of contrastand sharpness of a photo, alignment and transformation in the format used by system. Pre-processed image falls on the input of the segmentation module. The task of this module is to identify the structural units of text - lines, words and symbols. The result of the segmentation module is the segmentation tree, a data structure whose organization reflects the structure of the text on the page. The highest level corresponds to the page object. It contains an array of objects that describe strings. Each line in turn includes a set of word objects. The detected fragments of the image are fed to the input of the classifier, the output of which is the vector of the possibility of

the image belonging to the class of one or another letter. The result of the classifier is a fuzzy set obtained because of combining at the highest level. At the last stage, the most suitable variant of words arrangement is chosen. For this, the levels of the ability to read individual letters, inter-letter segmentation and the frequency of

combinations of letters in Russian are used. Testing revealed that of the total number of letters 97.83% was recognized.

The recognized text is converted to Braille. For each letter of the Braille alphabet, up to 6 points are required. After the neural network recognizes the letters in words, text is sent to the device via Bluetooth. Arduino microcontroller decides which letter cells should leave the plane, and which ones do not.

6 round holes are made on the plane, under each of which there is a parallelepipedoid with an upper base smaller than the diameter of the hole. It, in turn, is suspended under the holes and freely movable up and down. If in the recognized letter a certain cell should be convex, then the servomotor rotates the lever, 2 cm long by 15 degrees, directing it upwards. After, the parallelepipedoid, lifts a segment of the letter of the relief-dotted tactile font. In the future, it is planned to expand the number of cells to 10. Pressing the button “Voice over”, lifelike speech is generated. as it showen on scheme No. 3.

Image 2.

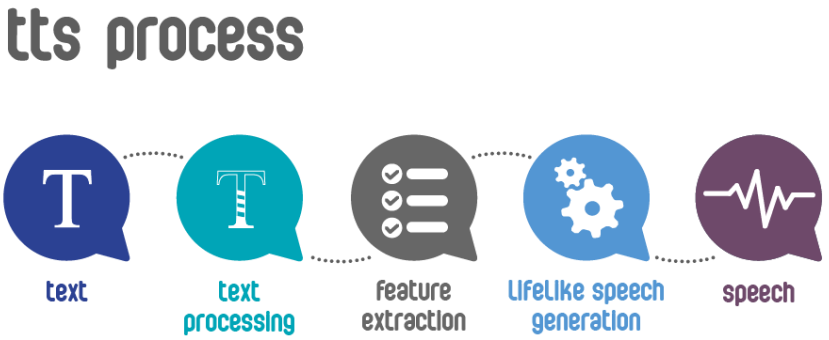


Image 3.

Materials and methods

Technical characteristics of the servo drive SG90 (Fig. 3):

Operating voltage: from 3V to 7.2V (Volts)

Dimensions of the device: 22mm x 11.5mm x 22.5mm

Weight: 9 grams

Operating temperature: -30 to +60 degrees Celsius

Image 4.

The main platform is Arduino Uno (Fig. 4). The case (Fig. 6) is made of acrylic, and printed with a laser machine. The protruding elements from PLA plastic are printed on the 3d printer. The components of the body are glued, and the platform is attached to the servos via wires. In the future, it is planned to replace the micro servos with pico linear actuators, and reduce the dimensions of the enclosure.

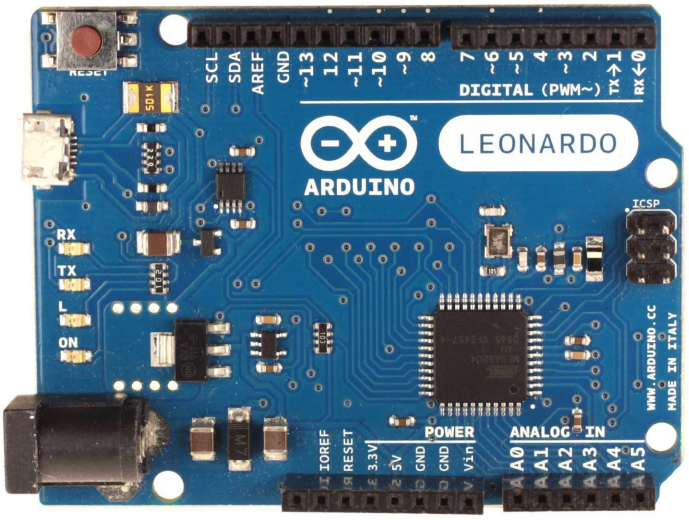
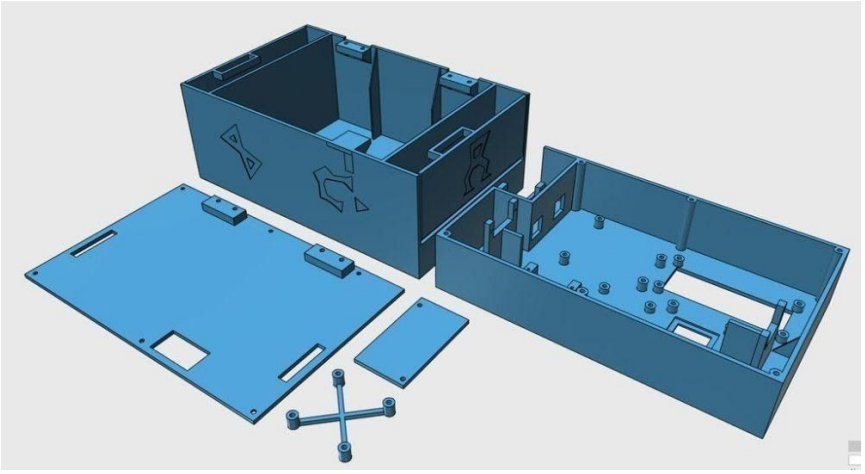


Image 5.



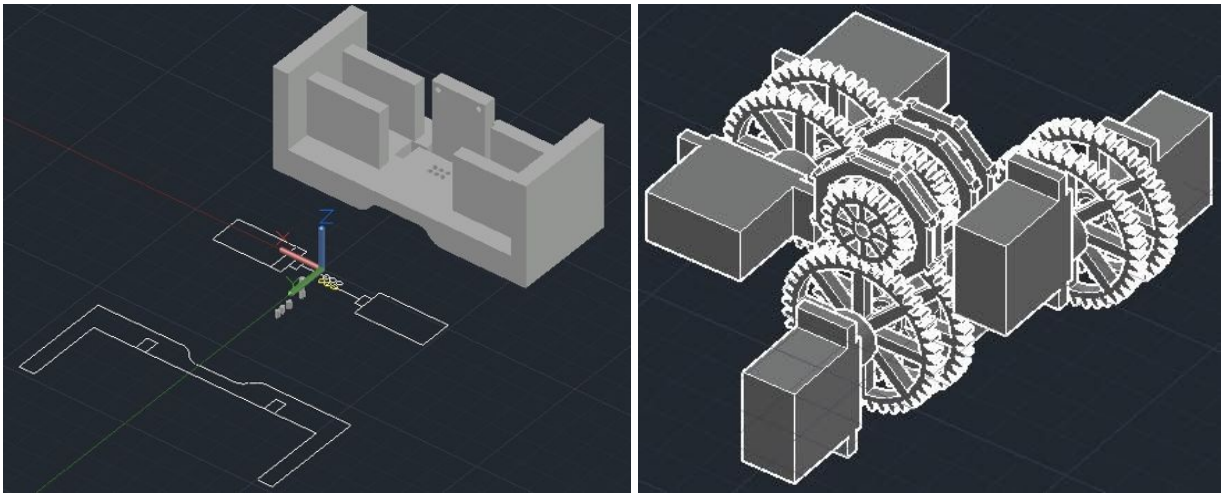


Image 6.

Net cost

№	The name of material or detail	The Amount	Price, dollars	Total cost, dollars
1	RASPBERRY PI 3 MODEL B	1	46$	46$
2	Micro Servo Motor MG90S - Tower Pro	10	2.5$	25$
3	Web-camera HP HD 2300	1	25$	25$

4	PLA plastic	100 g	0.99$	0.99$
5	Power source	1	3$	3$
6	Arduino UNO	1	7$	7$
				Total: 106.99$

Market analysis

In the course of research it was noted that there is no such device which mimics the functions of Oqyp Ko'r, however, there are some similar technologies such as synchronizers and Braille display. Furthermore, we observed several other traits:

1.Most of the visually impaired prefer Braille to synchronizers. Firstly, the visually impaired are restricted to manage pace, pauses and intonations. Also, noise in certain places (public places) interferes with auditory perception.

2.Oqyp ko'r can convert text in two versions of Kazakh language (Latin and Cyrillic alphabet). Even though high-pricedtechnologies recognize a lot of languages, they do not make voice overs in Kazakh (ZoomText ImageReader)

3. This devicedoes not need anythingbutaninformation resource and the device itself. Braille displays (ALVA USB 640 Comfort, Pronto!18 V3, Focus 14 blue) function only in the presence ofacomputer. Some models of synchronizers (Pearl, Eye-Pal vision) require the presence of monitors and PCs

4. Oqyp ko'r is a unique device that is in popular demand within theinclusive education field. It excludes differences in learning opportunities among all students.

Commercialization

We highlighted several niches where the project is in much demand:

1. There are about 20libraries specialized for visually impaired National library for the visually impaired in Almaty receives more than 3000 visitors, while regional libraries welcome no less than 4500 visitors each year.

2. Educational institutions, specialized schools in Almaty and Karaganda where more than 150 students study are the main customers

3. Sales outlets dedicated for disabled people.

Financing:

Special grants, attraction of large companies (Chevron, Qazkom), large investors (Samruk-Kazyna, Damu Fund), charitable foundations (Ayala, Bauyrzhan, Kus zholy), organizations of the blind (OYL Nur, Kazakh Society of the Blind).

Commercialization risks:

1. Termination of financing.
2. Devaluation of the tenge

Reference list

- https://rus.azattyq.org/a/obuchenie-slepyh-detei-kazakhstan/25394700.html
- http://newtimes.kz/eshche/mneniya/item/23844-desyatki-tysyach-invalidov-kazakhstana-mogut-ostatsya-bez-raboty-kos
- http://www.abctv.kz/ru/news/slepye-deti-uchebnikov-ne-uvidyat

- https://www.vesti.ru/doc.html?id=2916975
- https://365info.kz/2014/09/odin-den-iz-zhizni-shkoly-dlya-slepyx-muzyka-tancy-i-sport/
- http://www.inform.kz/ru/internat-dlya-slabovidyaschih-detey-otkroyut-v-karagande_a3047804
- https://www.zakon.kz/4456009-kazakhstanskikh-nezrjachikh-snabzhaet.html
- http://www.livingmadeeasy.org.uk/communication/text-to-speech-scanning-machines-1458-p/
- https://papirusprint.kz/g2759223-taktilnye-tablichki-shrift
- http://dostupsreda.ru/store/dlya_invalidov_po_zreniyu/chitayuschie_mashiny
- http://www.trosti.com.ua/braille-displays/
- https://www.smartaids.ru/sighting_loss/366/

Raspberry Pi Code:

```
import RPi.GPIO as GPIO
Import time
from subprocess import call
import re
from BrickPi import *
GPIO.setmode(GPIO.BOARD)
GPIO.setup(03, GPIO.OUT)
GPIO.setup(04, GPIO.OUT)
GPIO.setup(05, GPIO.OUT)
GPIO.setup(06, GPIO.OUT)
GPIO.setup(07, GPIO.OUT)
GPIO.setup(08, GPIO.OUT)
pwm1=GPIO.PWM(03, 50)
pwm2=GPIO.PWM(04, 50)
pwm3=GPIO.PWM(05, 50)
pwm4=GPIO.PWM(06, 50)
pwm5=GPIO.PWM(03, 50)
pwm6=GPIO.PWM(04, 50)
def SetAngle1(angle):
duty = angle / 18 + 2
GPIO.output(03, True)
pwm1.ChangeDutyCycle(duty)
sleep(1)
GPIO.output(03, False)
pwm.ChangeDutyCycle(0)
def SetAngle2(angle):
duty = angle / 18 + 2
GPIO.output(04, True)
pwm1.ChangeDutyCycle(duty)
sleep(1)
GPIO.output(04, False)
pwm1.ChangeDutyCycle(0)
def SetAngle3(angle):
duty = angle / 18 + 2
GPIO.output(05, True)
pwm2.ChangeDutyCycle(duty)
sleep(1)
GPIO.output(05, False)
pwm2.ChangeDutyCycle(0)
```

```
def SetAngle4(angle):
duty = angle / 18 + 2
GPIO.output(06, True)
pwm3.ChangeDutyCycle(duty)
sleep(1)
GPIO.output(06, False)
pwm3.ChangeDutyCycle(0)
def SetAngle5(angle):
duty = angle / 18 + 2
GPIO.output(07, True)
pwm4.ChangeDutyCycle(duty)
sleep(1)
GPIO.output(07, False)
pwm4.ChangeDutyCycle(0)
def SetAngle6(angle):
duty = angle / 18 + 2
GPIO.output(08, True)
pwm6.ChangeDutyCycle(duty)
sleep(1)
GPIO.output(08, False)
pwm.ChangeDutyCycle(0)
#Function splits a big paragraph into smaller sentences for easy TTS
def splitParagraphIntoSentences(paragraph):
sentenceEnders = re.compile('[.!?]')
sentenceList = sentenceEnders.split(paragraph)
return sentenceList

while True:
#Take an image from the RaspberryPi camera with sharpness 100(increases the
readability of the text for OCR)
call ("raspistill -o j2.jpg -t 1 -sh 100", shell=True)
print "Image taken"

#Start the Tesseract OCR and save the text to out1.txt
call ("tesseract j2.jpg out1", shell=True)
print "OCR complete"

#Open the text file and split the paragraph to Sentences
fname="out1.txt"
f=open(fname)
content=f.read()
print content
```

```
sentences = splitParagraphIntoSentences(content)
for s in sentences:
print s.strip()
if s.strip() == “а”:
setAngle1(90)
        setAngle2(90)
        setAngle3(90)
if s.strip() == “б”:
setAngle1(90)
        setAngle6(90)
        setAngle3(90)
if s.strip() == “в”:
setAngle1(90)
        setAngle2(90)
        setAngle5(90)
if s.strip() == “г”:
setAngle4(90)
        setAngle2(90)
        setAngle3(90)
if s.strip() == “д”:
setAngle1(90)
        setAngle6(90)
        setAngle2(90)
if s.strip() == “е”:
setAngle1(90)
        setAngle5(90)
        setAngle2(90)
if s.strip() == “ж”:
setAngle1(90)
        setAngle4(90)
        setAngle5(90)
pwm1.stop()
pwm2.stop()
pwm5.stop()
pwm3.stop()
pwm4.stop()
pwm6.stop()
GPIO.cleanup()
```

Блок схема работы устройства "Oqyp kör"