



# Hawking

Communication system for deaf-blind people

## User Guide



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# Background

The increasing accessibility to today's smart technology enables the search for solutions for populations with different disabilities, such as deafness and blindness, to improve their lives. According to statistics, over 1200 Israelis have the dual disability of deaf-blindness, when the leading cause of deaf blindness in Israel is an incurable disease called "Usher syndrome".

Blind deaf people do not hear the blind or see the sign language of the deaf and therefore cannot fit into their company. Therefore, the deaf-blind are excluded from every framework, cut off from an accessible means of communication with their surroundings.

The main purpose of this project is to develop a system that will enable verbal communication with the deaf-blind, thus relieving their loneliness and enhancing their independence. Today there is no technological solution available to this community, especially in Hebrew. Development of the system will emphasize accessibility to the Israeli community using the tools available to them and on meeting their daily needs.

The system consists of an application on Android device which is connected to a standard Braille keyboard. The application performs Speech-to-Braille and Braille-to-Speech operations accompanied with appropriate accessibility indicators so that the conversation is understandable and continuous for both the speaker and the deaf-blind person.

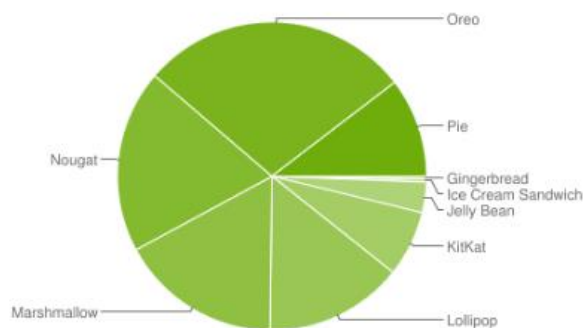
The system's features and interface support English & Hebrew, and the development process was done in collaboration with the Deaf-blind center in Israel - Beit David Institute and the deaf-blind community in Israel.

The project began with a genuine effort to improve the communication experience of this particular community and people who suffer from hearing loss or vision in general. The process of design, development and accessibility was carried out in cooperation with this community and entities that assist them.

This product was developed as part of a final engineering project by **Maor Assayag** and **Rafael Shetrit** - computer engineering students, under the guidance of Prof. Hugo Gutterman and Dr. Ariel Luzzatto.

# Prerequisites

In the first year of the project, the app was developed and designed in Android Studio for devices running **Android 6** or higher (API 23 Marshmallow). This version is selected due to the features it offers and the fact that all Android devices from 2015 with this version or higher than it. The next official illustration shows that 75% of the Android devices in the world with Android 6 and above, so the application is supported by them.



*Data collected during a 7-day period ending on May 7, 2019  
Any versions with less than 0.1% distribution are not shown.*

The application does not require a braille keyboard or an external keyboard, but of course a deaf-blind person will need at least a braille display (or braille keyboard) to read from and reply to (Braille or standard Bluetooth keyboard). In the appendixes to this document, we provide possible products that were tried by us during development and feedback tests.

## To check the Android version in your device

1. Open the Settings app on your device.
2. At the bottom of the screen, tap on 'System' → 'Advanced' → 'Information'. Check that the number displayed under 'Android version' is greater than or equal to 6.

# Installations and Downloads

## TalkBack

The TalkBack screen reader service can read items and messages from the device screen.

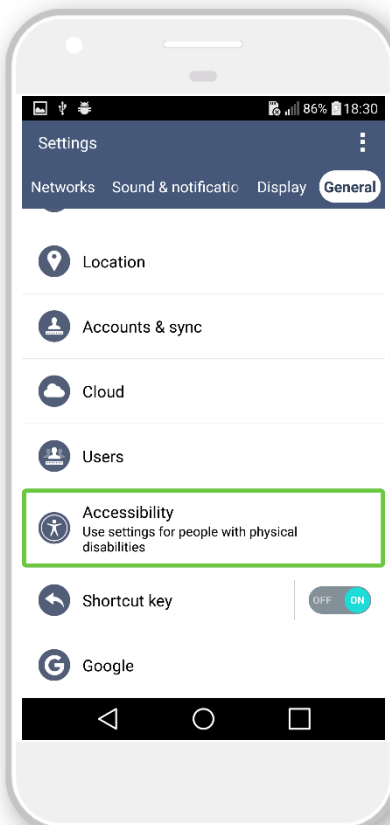
Android operating system requires this service to enable the Braille keyboard to control the phone remotely.

### Step 1: Enable TalkBack using your device's settings

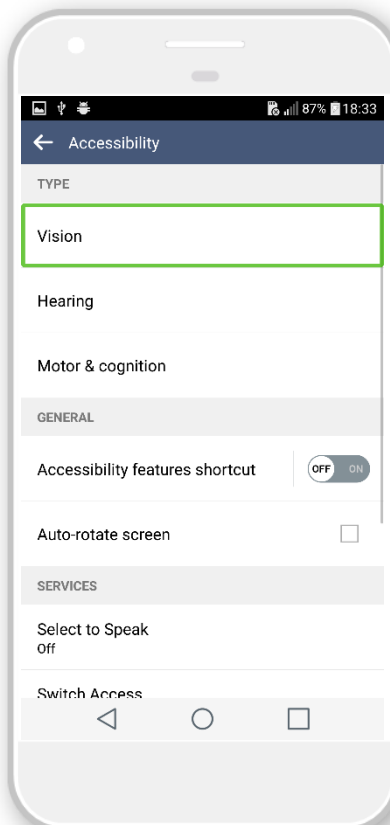
1. Open the Settings app on your device.
2. Click '**Accessibility**' → '**TalkBack**' or '**Accessibility**' → '**Vision**' → '**TalkBack**'

If you do not see TalkBack on the accessibility screen, use the TalkBack Download section on the next page to install it.

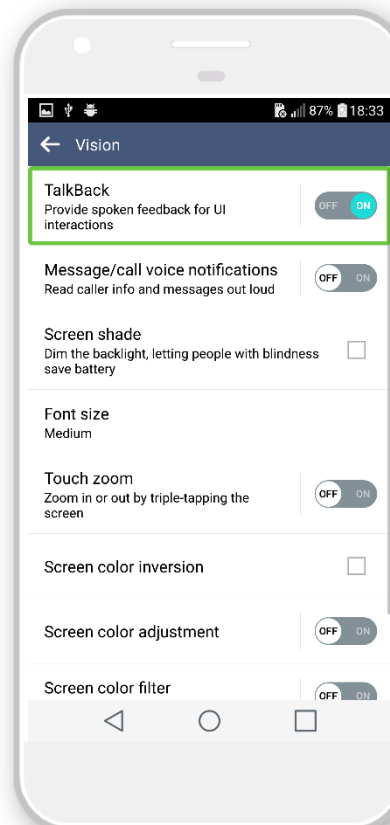
3. In '**TalkBack**', click '**Settings**' at the bottom of the screen.
4. We recommend turning off all the settings on the main screen and under the 'Accessibility Level' sub-screen except for 'Explore by Touch'.
5. It is important to note that 'Speech Volume' is set to 'Adjust Media Volume'.
6. After we finish setting up below the speech engine in the **Text-To-Speech** section, we will return to the 'Text-to-Speech output setting' on this screen.



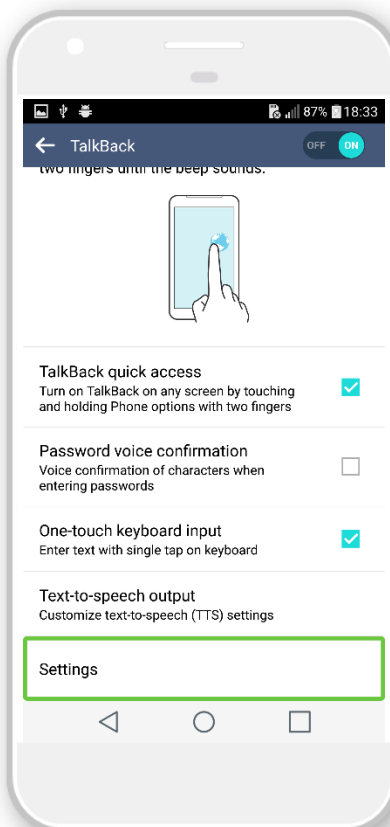
Step 2.1 – click on **Accessibility**



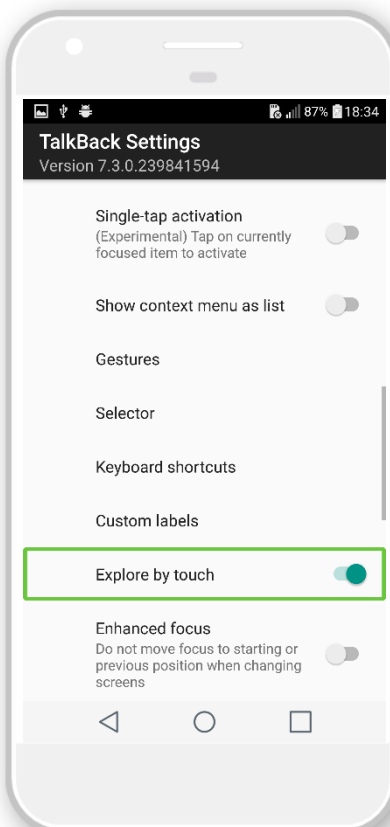
Step 2.2 – click on **Vision**



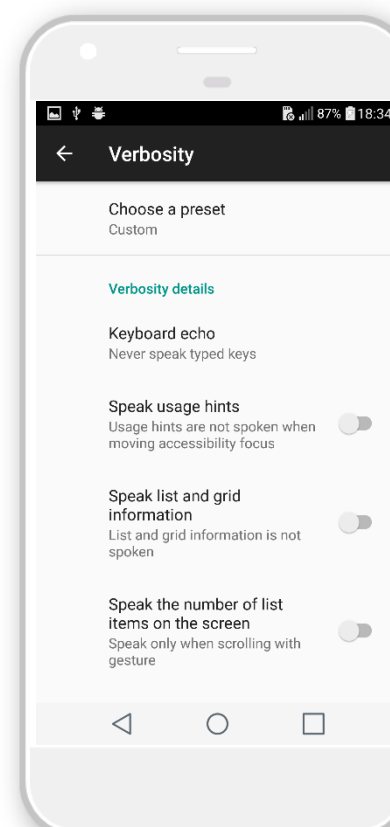
Step 2.3 – click on **TalkBack**



Step 3.1 – click on **Settings**



Step 3.2 – keep this turn **ON**



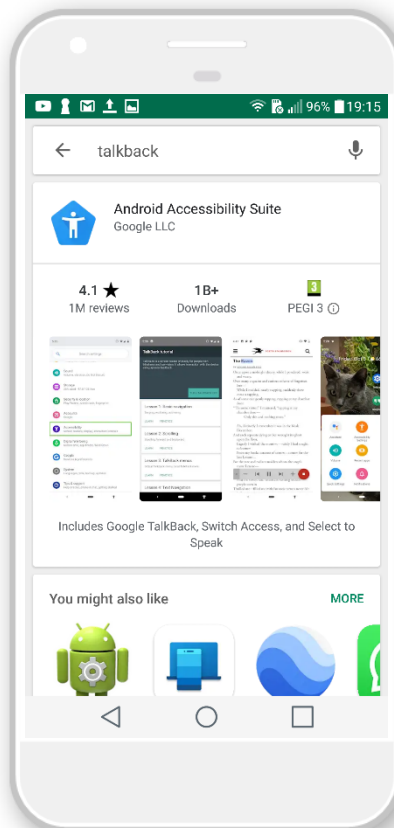
Step 3.3 – turn **OFF** all settings

## Step 2: Download and install TalkBack

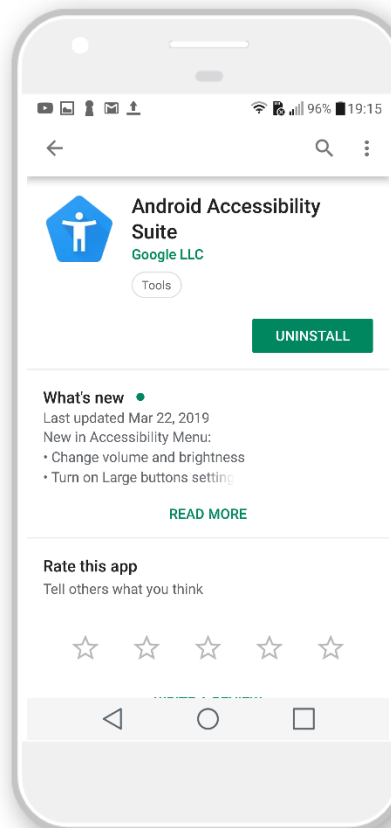
If this service is missing in the Accessibility section, it is easy to download the app store.

1. Open the 'Play Store' app store.
2. In the search bar type: TalkBack.
3. Click **Install** to add the service to your device.
4. Return to the previous section. You can now see the TalkBack option on the 'Accessibility' screen.

Click [here](#) for a direct link in the app store.



Step 2 – search **TalkBack**



Step 3 – click on **Install**



## Speech To Text

Speech-to-text conversion service provides an engine that analyzes sound (speech) and converts it into text.

Android operating system provides **Google's** speech recognition engines free of charge, and we will work with them to identify speech in Hebrew and English.

Currently, speech recognition in Hebrew requires an active internet connection, but over time the languages are added to speech recognition even without a network connection

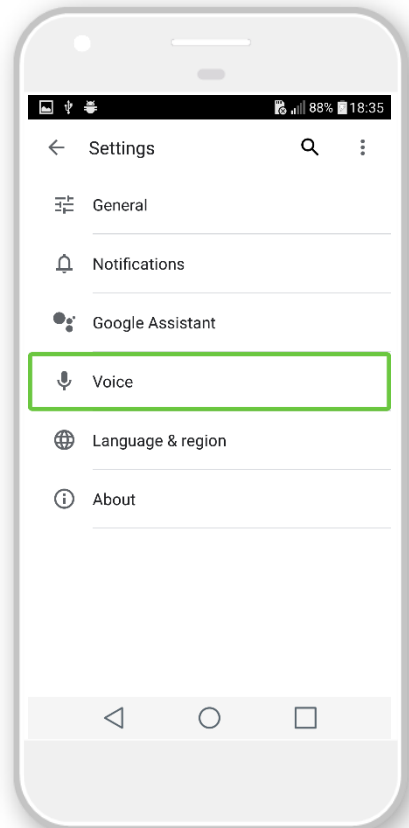
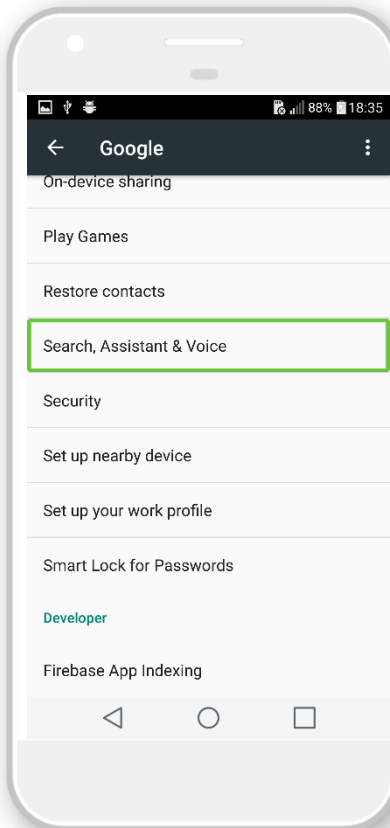
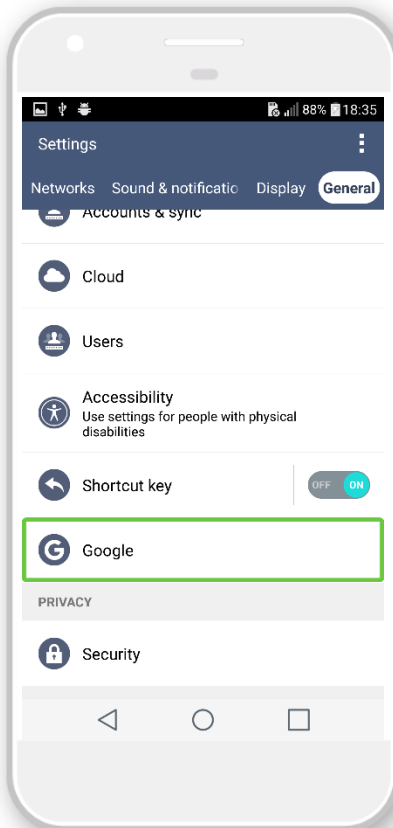
The steps include installing the 'Hebrew' language pack, which is **optional** depending on the user's needs.

### Checking speech-recognition languages installed using the device's settings

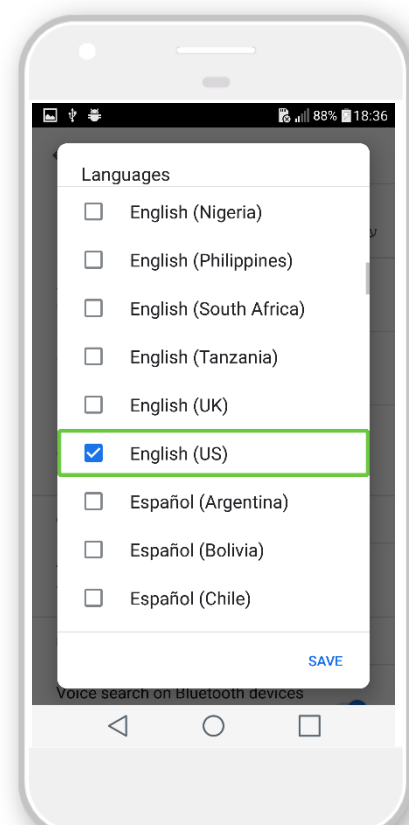
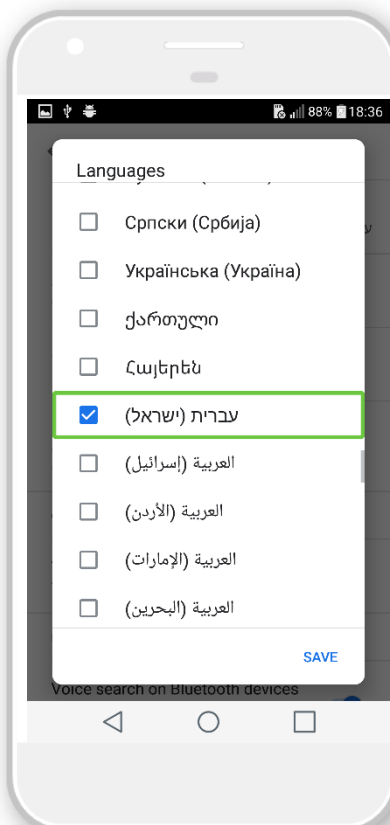
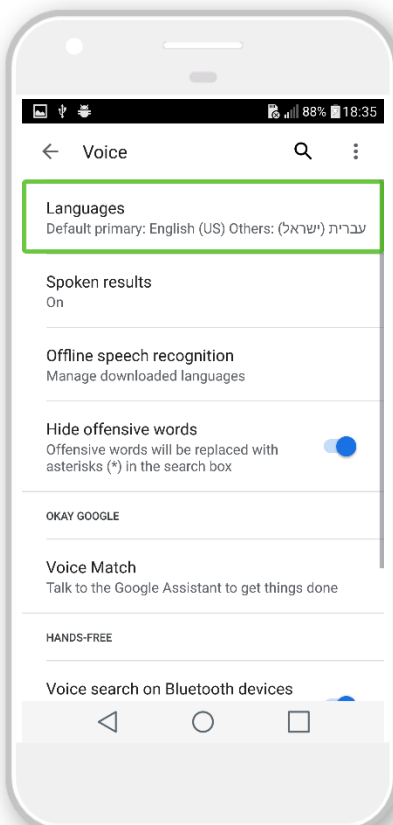
1. Open the Settings app on your device.
2. Click on **'Google' → 'Search, Assistant, and Voice' → 'Voice'**

In this screen we have to define two things: the English and Hebrew language, and the English language for offline speech recognition.

3. Click on **'Languages'** and select 'English (US)' and 'Hebrew (Israel)' and click 'Save'.
4. You automatically returned to the 'Voice' screen. Click on **'Offline Speech Recognition' → 'All' → English (US)**. After downloading the language should be displayed in the Installed tab. In future Android updates you will be able to also download the 'Hebrew (Israel)' language in this way.



Step 2 - Click on '**Google**' → '**Search, Assistant, and Voice**' → '**Voice**'



Step 3 - Click on '**Languages**' and select 'English (US)' and 'Hebrew (Israel)'

## Text To Speech

The Text to Speech service provides an engine that reads textual elements displayed on the screen.

Android operating system provides **Google's** read engine for free in English, but not in Hebrew.

Therefore, we will download and use a third-party call engine called **Vocalizer TTS**, which enables the purchase of a Hebrew voice at a one-time cost of 15 NIS.

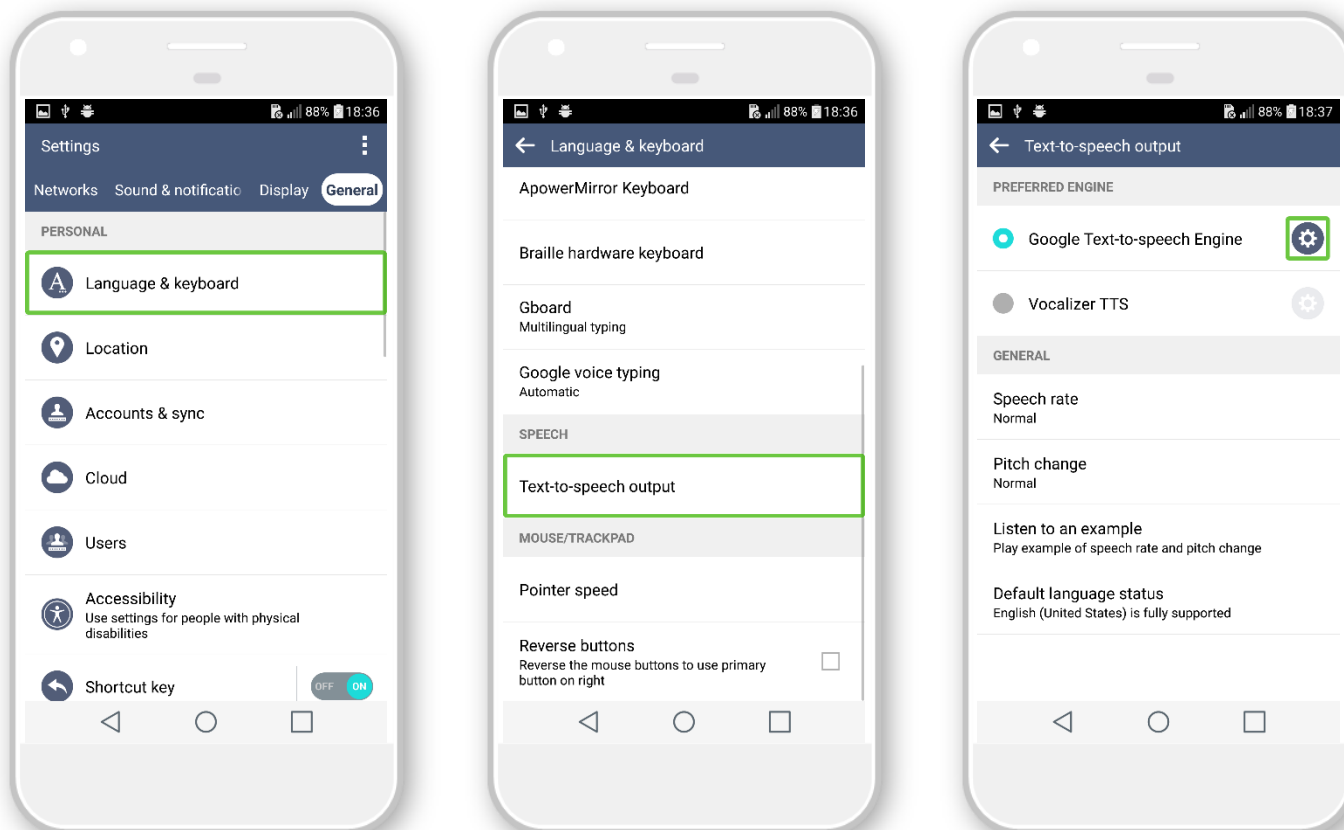
Because **Google** will add Hebrew voice in future updates, the first step will be to check whether Hebrew is available for free in the TTS engine.

The steps include installing the 'Hebrew' language pack, which is **optional** depending on the user's needs.

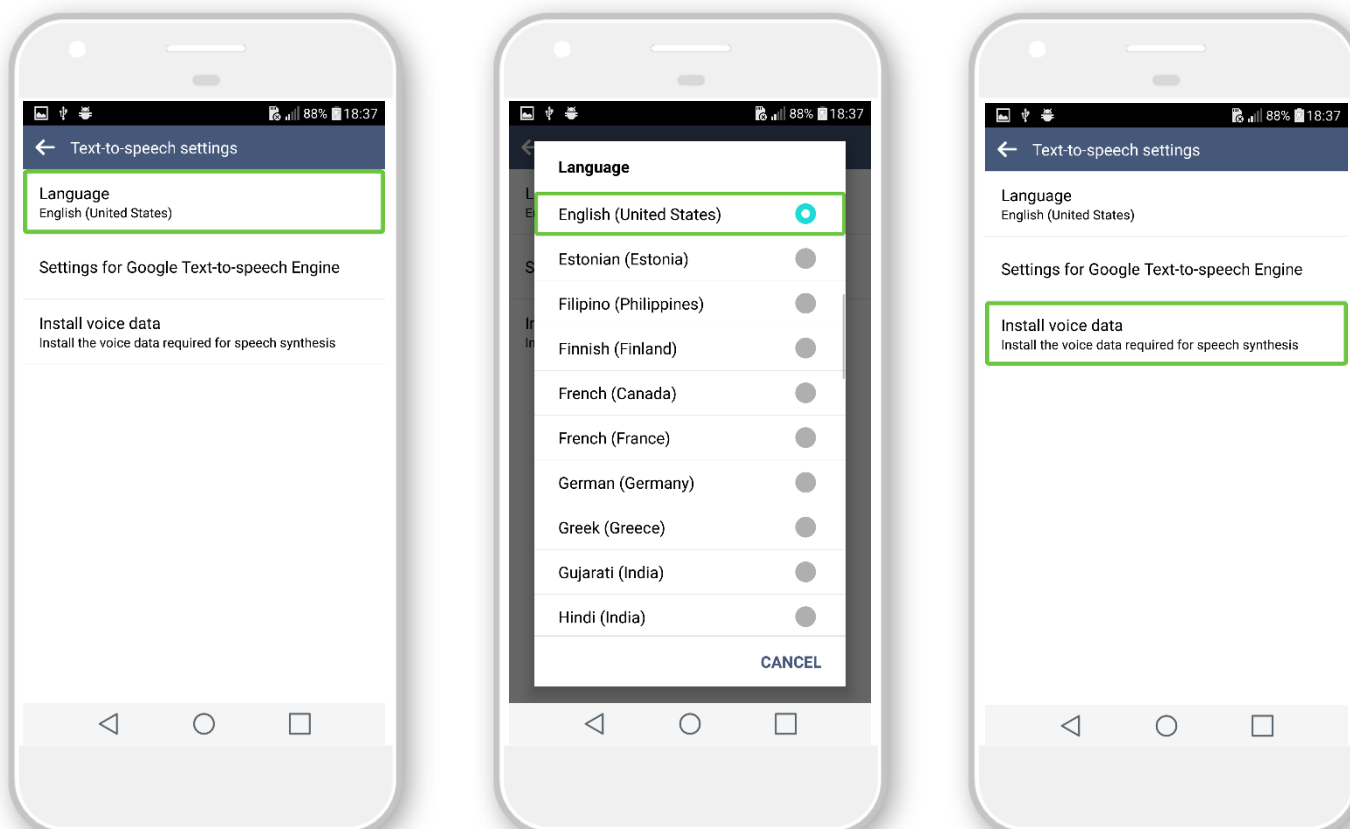
### Check text-to-speech engine languages available on your device

1. Open the Settings app on your device.
2. Click '**Language and keyboard**' → '**Text-to-speech output**'  
In this screen, we need to check two things: which languages are available for Google's text-to-speech engine, and later install a new third-party engine that supports Hebrew reading.
3. Click the Google Text-to-speech Engine settings icon
4. In '**Language**' select '**English (United States)**' and click Back on device buttons. If the language does not exist in the list, go to '**Install Sound Data**' and download the English language.

Also check to see if the language 'Hebrew (Israel)' is there, as in the future it will be added here so there will be no need to purchase a third-party engine.



Step 2 – Click on '**Language and keyboard**' → '**Text-to-speech output**' → '**Google Engine**'

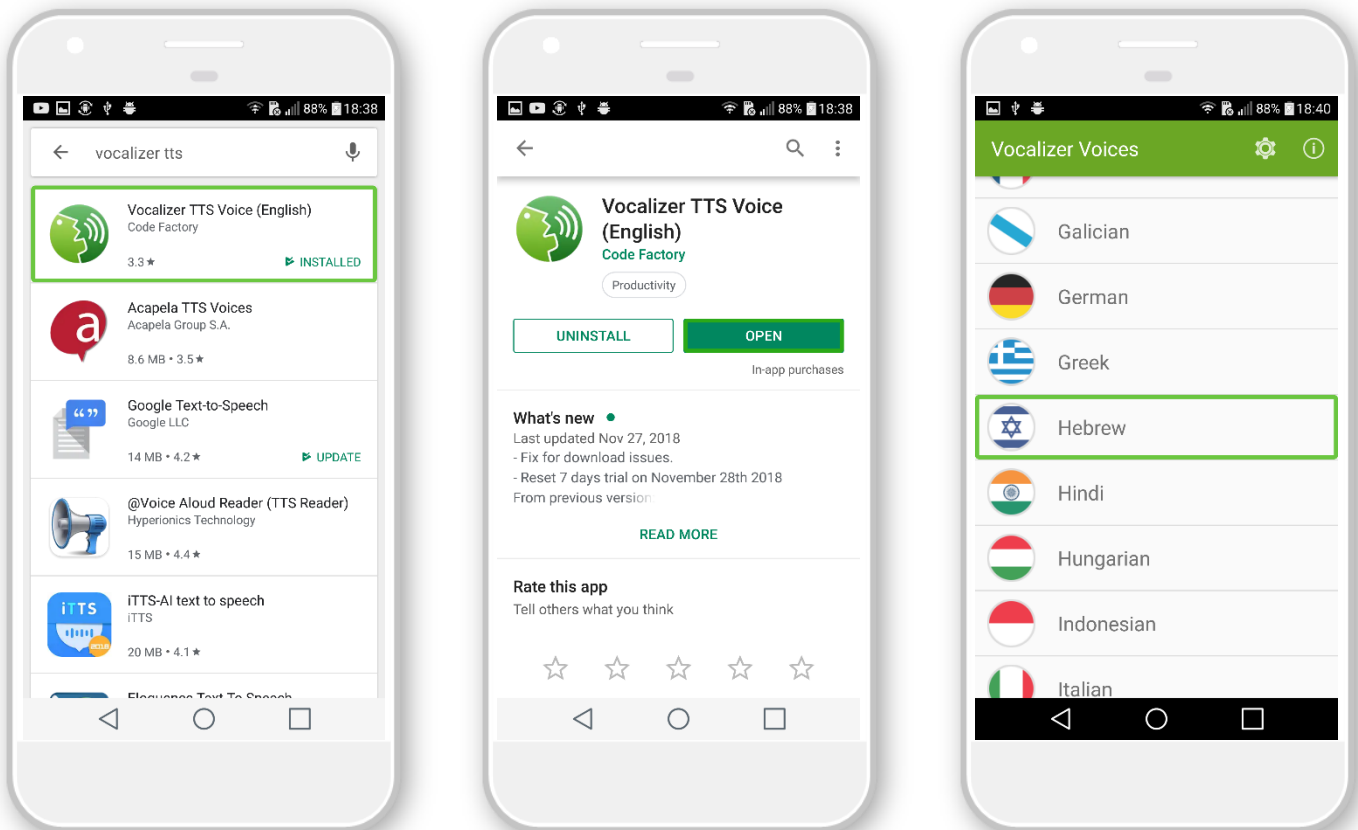


Step 3 – In '**Language**' select '**English (United States)**'

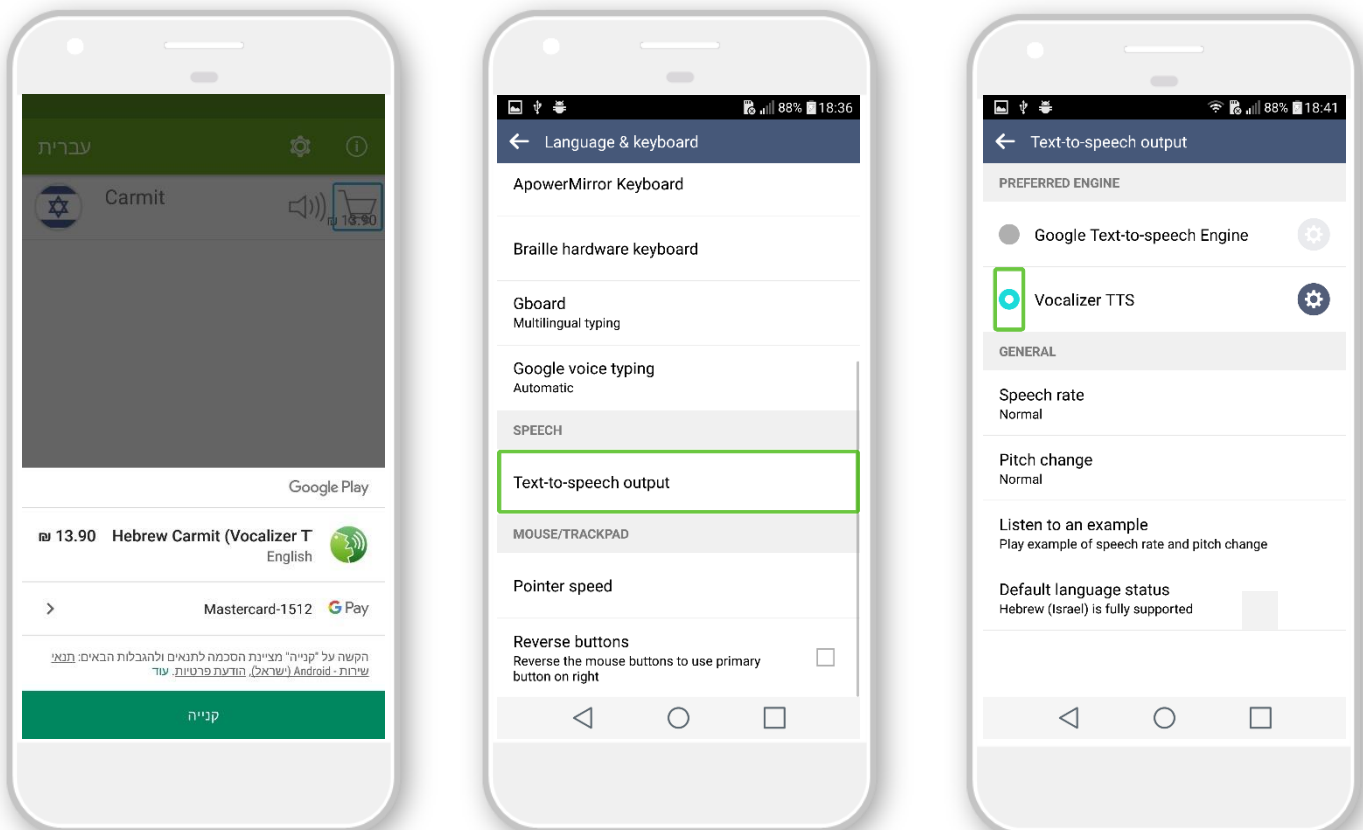
### **Download and install TTS Vocalizer – for Hebrew Voice only**

If it is missing in the Accessibility section, this service can be easily downloaded from the Applets store.

1. Open the 'Play Store' app store.
2. In the search bar type: 'Vocalizer TTS' (click [here](#) to link directly to the app store).
3. Click 'Install' to add the app to your device.
4. Open the Voices Vocalizer app installed on your device.
5. Select the voice 'Hebrew'
6. Click the purchase cart icon. You'll be taken to a secure purchase screen through Google's app store. At the end of the purchase, go back to the application → Click on the voice 'Hebrew' → Now a new download icon appears, click on it and download the Voice package.
7. Open the **Settings** app on your device.
8. Click on '**Language and keyboard**' → '**Text-to-speech output**'
9. Select the new motor that has been added '**Text to Speech Vocalizer**'  
Now your device supports reading text in Hebrew.



Step 2 – Search 'Vocalizer TTS' → Install → Open the app



Step 6 – Select the voice 'Hebrew' → Cart icon → Buy

## BrailleBack

The **BrailleBack** app lets you connect a refreshing Braille display to your Android device. The keyboard is connected via Bluetooth. BrailleBack works with the TalkBack screen reader service to provide a combined voice and braille experience.

When BrailleBack is used, the screen content appears on the Braille display and you can navigate the device and perform actions using the keys on the braille display. You can also enter text using the braille keyboard.

### Step 1: Check that BrailleBack supports your Braille keyboard

The current version of BrailleBack supports the following devices:

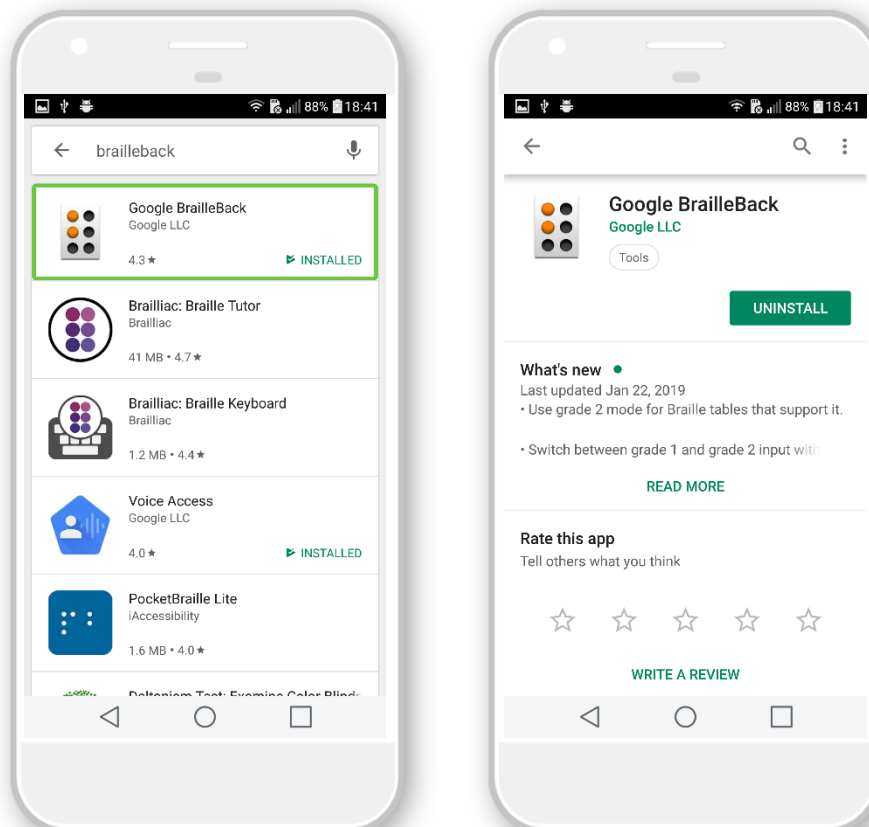
- Baum VarioUltra
- APH Refreshabraille
- APH Orbit Reader 20
- Baum VarioConnect
- Esys EuroBraille
- Freedom Scientific Focus Blue (models with 14 and 40 cells)
- HandyTech (Basic Braille, Active Braille, Braille Star, Braille Wave, Braillino, Easy Braille)
- Harpo Braillepen 12
- HIMS (BrailleSense, Braille EDGE, Smart Beetle)
- Humanware Brailiant (first generation and BI models)
- Optelec Alva (BC640, BC680)
- Optelec EasyLink 12 Touch
- Papenmeier Braillex Trio
- Seika (notepad and monitor 40 cells)

## Step 2: Install BrailleBack on your Android device

To download BrailleBack from Google Play, follow these steps:

**Option 1:** Use a [direct link to BrailleBack on Google Play](#) and select Install. Select the device on which you want to install the app and select Install.

**Option 2:** Open the Play Store app on your Android device, then search for "BrailleBack." In the search results, select BrailleBack, and then select Install.



In Google Play search '**BrailBack**' → **Install**



### Step 3: Turn on BrailleBack and adjust it to your Braille display

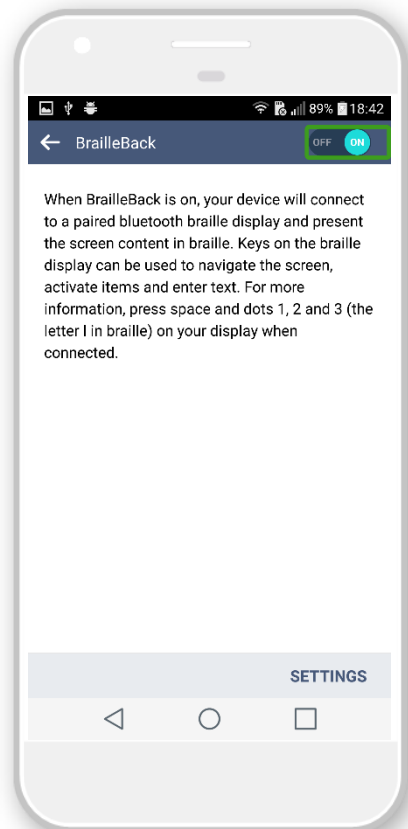
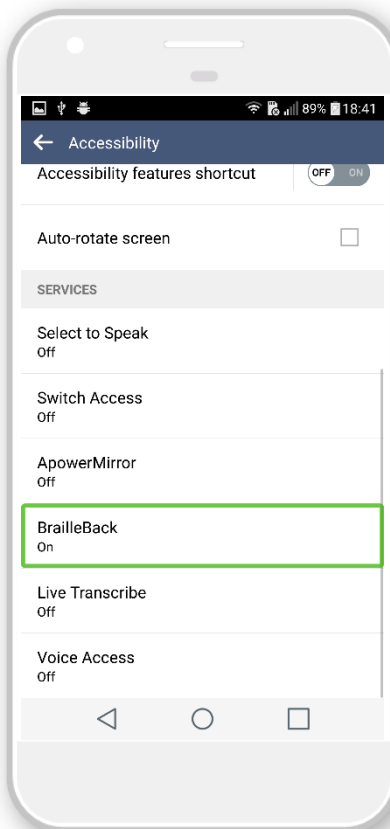
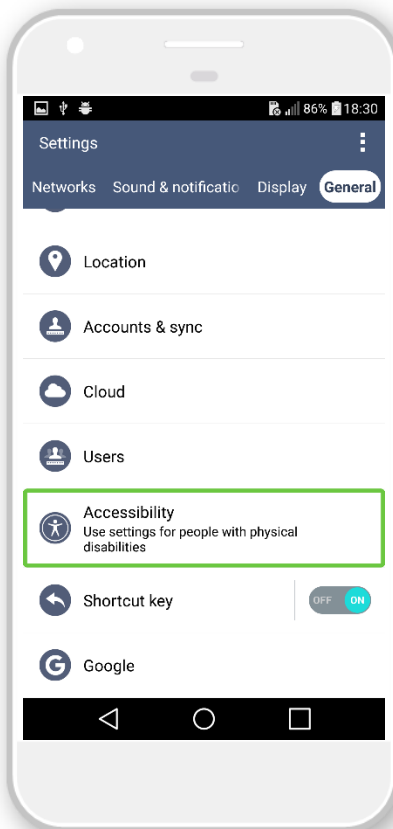
Note: Before turning on BrailleBack, make sure the TalkBack app is also enabled by the previous section of the guide.

To turn on **BrailleBack** on your Android device:

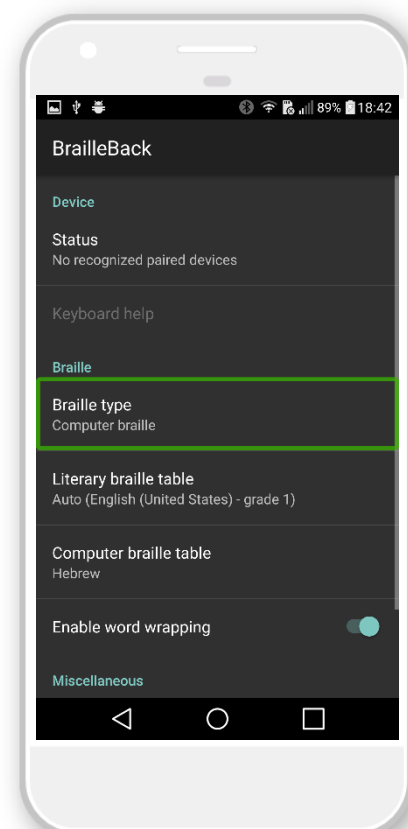
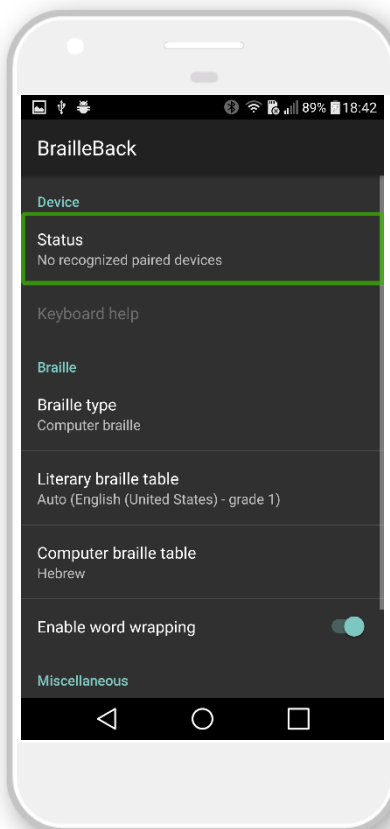
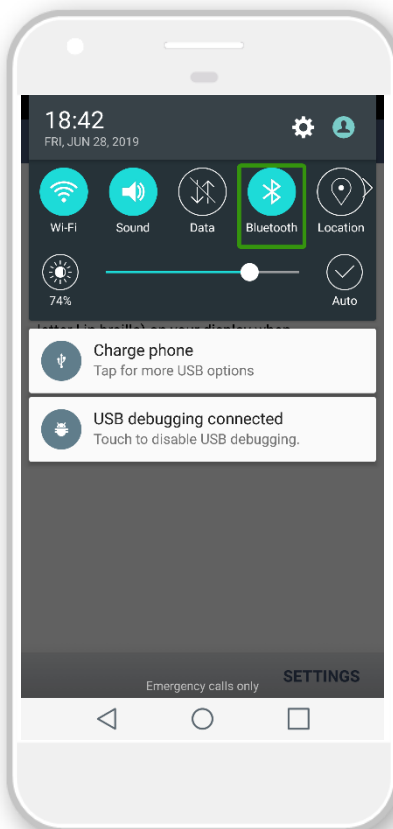
1. Open the **Settings** app on the Settings app.
2. Select 'Accessibility', then select 'BrailleBack'.
3. Turn on BrailleBack.
4. Return to Settings. Under 'Wireless & networks', select 'Bluetooth'.
5. Turn on 'Bluetooth'.
6. Return to 'Accessibility', then select 'BrailleBack'.
7. Click Settings at the bottom of the screen → Click 'Status', the braille keyboard name should be displayed accompanied by sound.
8. In the 'Braille Type' setting select 'Braille Machine'. Our app will make sure that the Hebrew keyboard is correctly translated using the Braille keyboard if needed be (currently Android does not support this).

#### **If the connection fails:**

9. Return to the device settings. Under 'Wireless & networks' select Bluetooth.
10. Select the name of your braille display.
11. If the braille display is not listed, make sure the monitor is in pairing mode, then select Search devices on your Android device.
12. For instructions on adjustment, refer to the braille keyboard documentation.



Step 2 – in Settings click on '**Accessibility**' → '**BrailleBack**' → Turn **ON**



Step 5 – Turn on '**Bluetooth**' → in BrailleBack screen click on '**Status**'

## Hawking

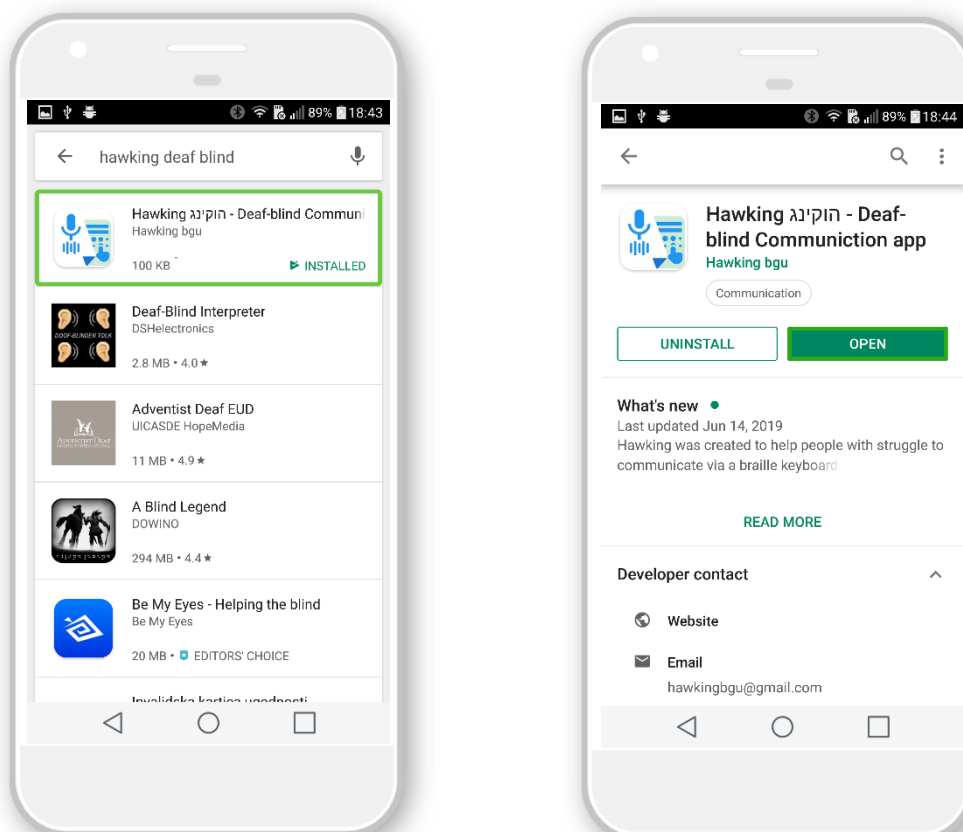
The application we developed enables ongoing conversation with a deaf-blind person accompanied with appropriate accessibility indicators so that the conversation is understandable and continuous for both the speaker and the deaf-blind person.

### Install Hawking on your Android device

To download **Hawking** from Google Play, follow these steps:

**Option 1:** Use a [direct link to Hawking on Google Play](#) and select Install. Select the device on which you want to install the app and select Install.

**Option 2:** Open the Play Store app on your Android device, then search for "Hawking deaf blind" In the search results, select Hawking, and then select Install.



# System Introduction

## Introduction with the system components

The user interface is designed to simplify the communication process as much as possible, whether the user has visual impairment or whether the user is interacting with the device using the braille keyboard only.

The application was developed and designed according to design principles that enable intuitive activity as much as possible, from the user interface to the accessibility indicators.

The following sections introduce the user settings and system alerts in case of errors. The user settings have been designed to allow the user to fully control the application's functionality according to his personal needs.

## Simple operation with a Braille keyboard

Braille keyboard users do not need to scroll or navigate the app in a complicated way.


**Type** anywhere in the app (no matter where the focus is) will jump straight to typing mode, enables the user to make sure he was right in the braille display.

The **ENTER** key from anywhere in the application activates speech recognition with the appropriate accessibility indication.

When the speaker finished speaking, the focus automatically jumps to the newly detected message and transmitted directly to the Braille keyboard to read, without the need to complex navigation.

If the user is currently typing and pressing **ENTER**, the message he typed will be spoken by the device with an appropriate accessibility indicator for both the deaf-blind and the surrounding.

Through these automated actions, we remove the need for deaf-blind people to deal with complex navigation and scrolling, which enables them to communicate more naturally with the environment.

Click on  **YouTube** to watch a system demo in **Hebrew** and here

 **YouTube** For demo in **English**.

## User Interface

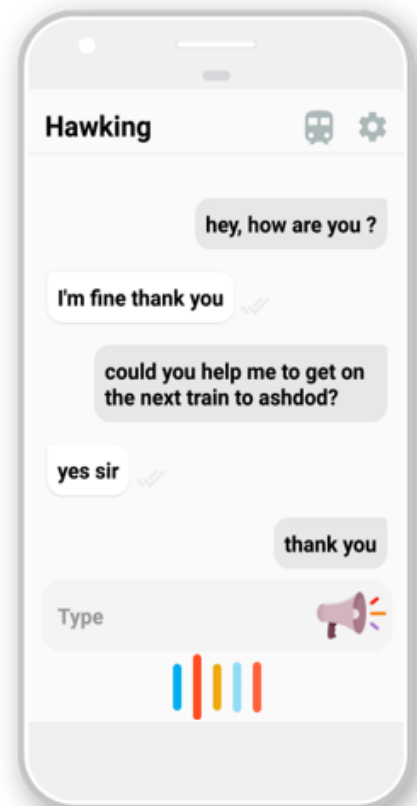
### Upper area – Action Bar

In this area you can find a personal name label, mode controls (Conversation mode, Train mode) that can be hidden and the application Settings key

### Middle area - Chat

In this area the conversation will be displayed between the user and his surroundings.

Messages on the right will be messages that the user will type and send, and messages on the left will be messages detected by speech recognition \ system messages (errors, alerts, etc.).



### Lower area - Typing

In this area, the user types the desired message.

For Braille users (automatically recognized by the application) the Send button is not selectable and the sending operation is simple and convenient by pressing ENTER on the braille keyboard (space + dot to the right of the space) or ENTER on the standard Bluetooth keyboard.

If there is no text in the input box, the ENTER key anywhere in the application starts the speech recognition operation.

### Voice recognition indicator

The lower area illustrates real-time voice recognition and processing of the device.

Please note that for Braille users, these areas are **not relevant**.

The operation for them is very simple and involves only one button - the **ENTER** button.

## App settings

In this section, we will describe each setting in the settings screen and how to customize the usage experience for different needs

### General

#### Enter your name

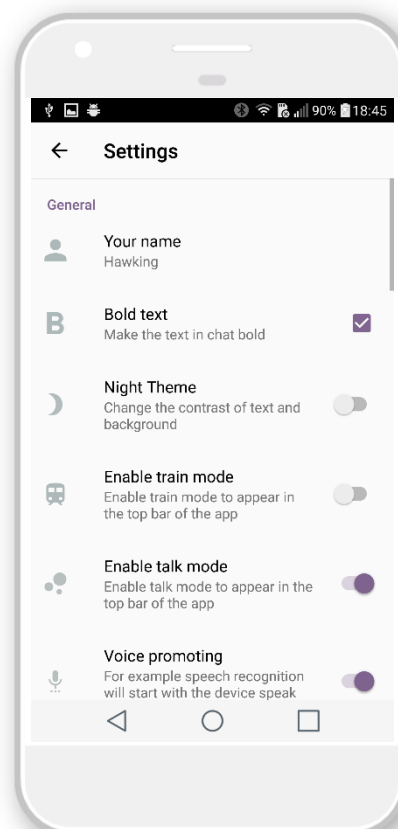
Change the name displayed on the app main screen to the user's name.

#### Bold text

The text displayed in the Messages section (messages sent by the user and messages from speech recognition) will be highlighted for people with visual impairments.

#### Night Theme

Turn on a dark theme with reverse contrast to text and background.

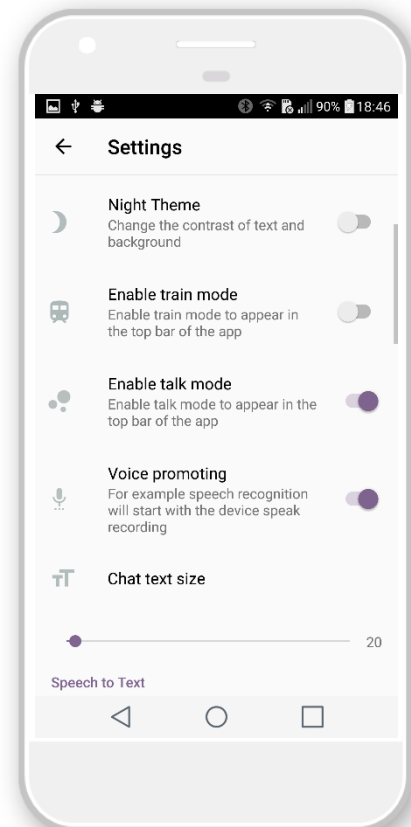


### **Enable Train mode**

Enable the Train mode icon on the main screen of the application (top section), if this setting is turned off the icon will be hidden - to reduce elements for users to navigate with Braille keyboard.

### **Enable Conversation mode**

Enable the call status icon on the main screen of the application (top section), if this setting is turned off the icon will be hidden - to reduce elements for users navigating with Braille keyboard.



### **Voice promoting**

Enable voice prompts in response to actions – for example the device will say "Recording" at the beginning of each speech recognition operation to alert the speaker to start talking.

### **Text size in chat**

Resize the text displayed on the app main screen to help users with visual impairments.



## Voice recognition

### SST language - voice recognition

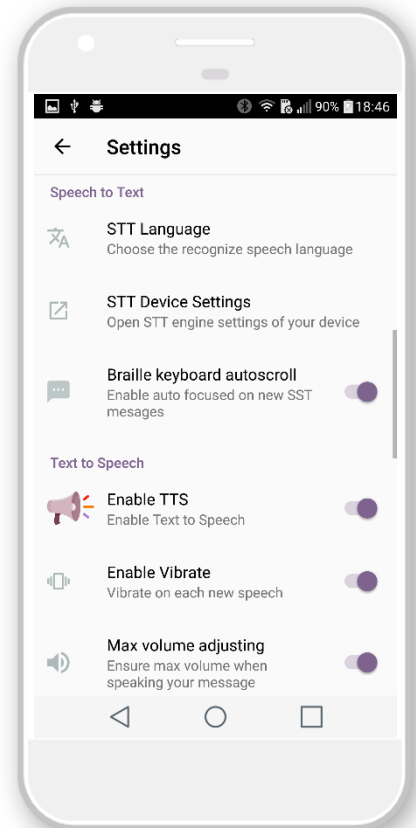
Select the speech recognition language for the Speech to Text operation.

### SST Device Settings

Open the speech recognition engine settings on your device, serves as a direct link to install additional language support for the speech recognition engine.

### Braille keyboard auto scroll

Enable auto focused on new SST messages



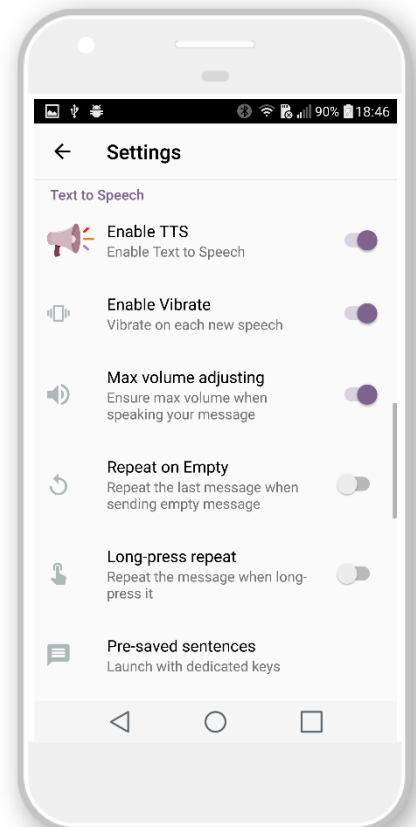
## Text To Speech

### Enable TTS

Read user messages. This feature can be used for users who want only speech recognition.

### Enable Vibrate

Enable Vibration Accessibility Indicator. Vibrating in different and unique patterns (for each action) will be activated to give indication of the current situation. For example, the user will be able to distinguish between the start and end of the speech recognition operation, an error in the last action, whether the device is currently being read and more.



### Max volume adjusting

Make sure your device reads messages at maximum volume. Necessary to activate if the *TalkBack Fix* setting is enabled.

### Repeat on Empty

When the user sends an empty message, the last message will be repeated. This option is available to those who do not use the braille keyboard only.

### Long-press repeat

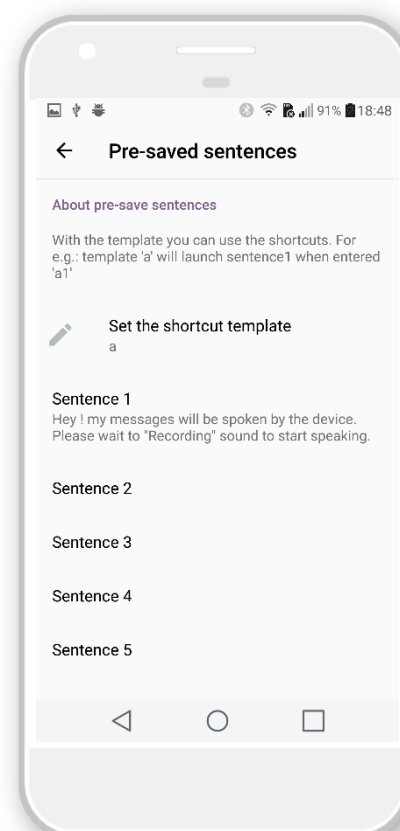
Long press a message to repeat it (read it again). This option is available to those who do not use the braille keyboard only.

### Pre-saved sentences

You can set up predefined saved sentences as long as you want and set special templates to trigger them. For example - typing **a1** will send the sentence 1, **a2** the sentence 2 and so on.

### TTS language

Select the language for reading the text - the language that is translated from text to speech.



### TTS device settings

Open the Text-To-Speech engine settings on your device to change the TTS engine if necessary.

### Fix TalkBack

For a deaf-blind person there is no need to speak out-loud the elements on the screen, and in order not to interfere with the operation of the application, this option **must be activated**. This will silence the TalkBack service and enable voice output controlled by the application only. For Android 8 or higher please manually mute the **Accessibility volume** channel.

### Fix braille typing in Hebrew

Allow the app to fix the typing encoding on the Braille keyboard so writing through it will enable Hebrew writing which is not supported by BrailleBack.

### About

#### Questions and Answers

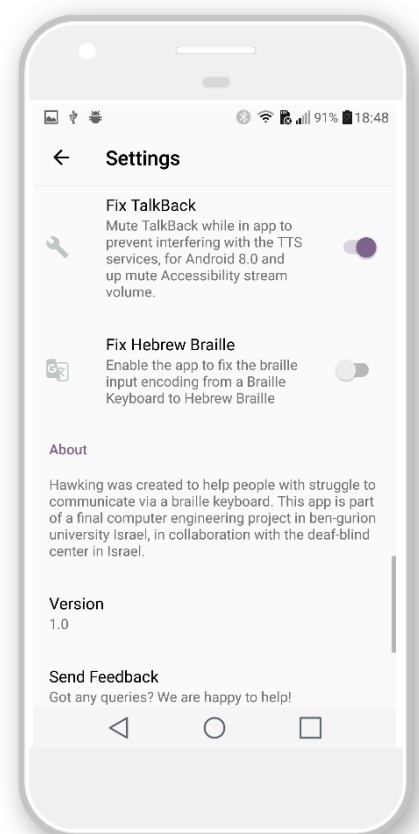
Clicking will lead to the [product site](#) where you can find more information about the project and frequently asked questions.

#### User guide in Hebrew

Direct link to the user guide in Hebrew.

#### User guide in English

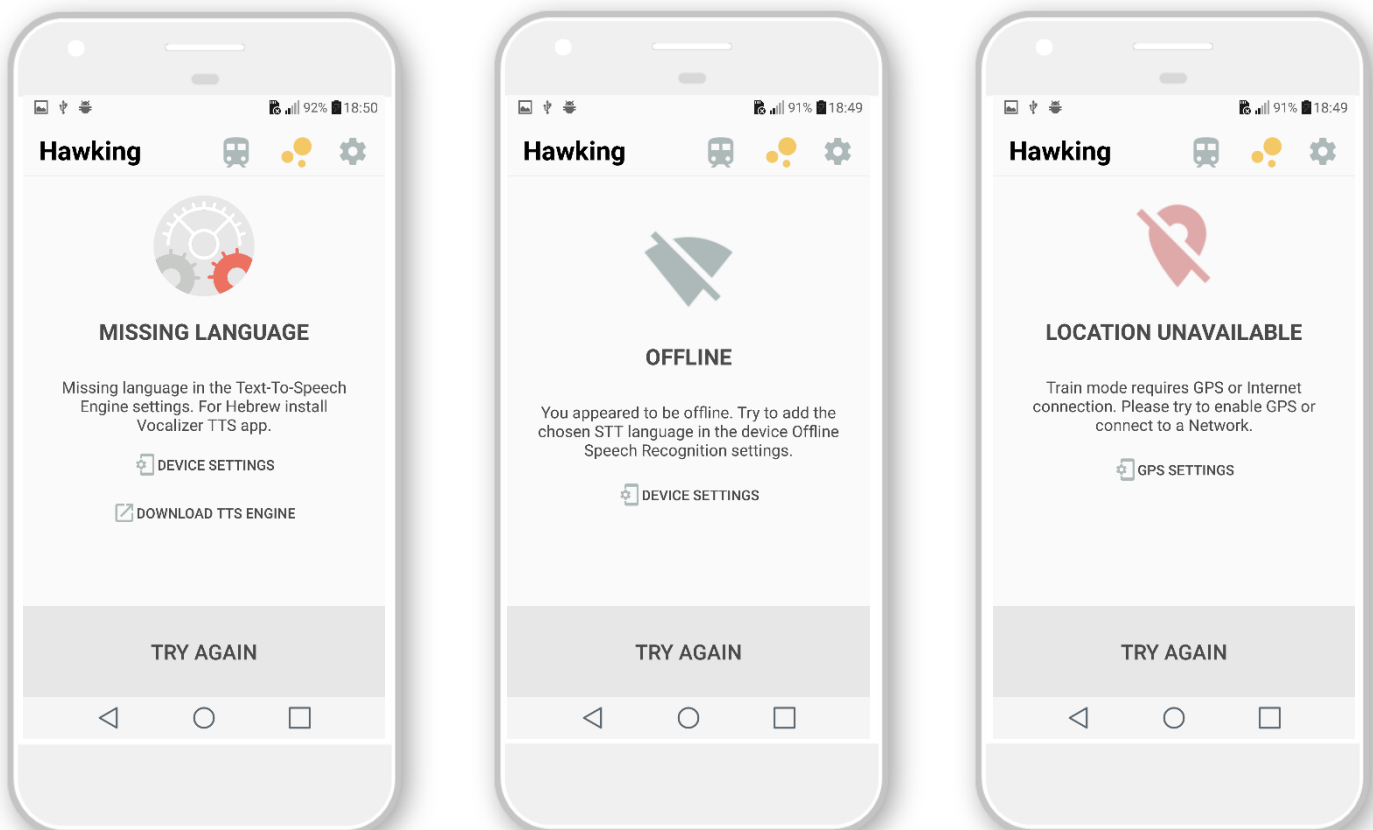
Direct link to the user guide in English.



## Error notifications

For users who do not use a Braille keyboard, the system pops up pop-up messages that alert you to the type of problem and ways to address it, such as the language you choose for SST operation is missing from your device, and so on.

For Braille users, these messages will be written as a system message (the message prefix is 'System:') to avoid user confusion.



## Accessories

During the application development process, we purchased accessories that we recommend to people who need them. Their quality was also reviewed by us for general uses beyond just our application.

### Orbit Reader 20 Braille Keyboard

This product is an affordable solution (relative to competitors) to a standard Braille keyboard. Contain a Braille display with 20 braille cells (8 points supporting Hebrew and English encoding), system features:

- 20 refreshable eight-dot braille cells
- Eight Braille Input keys and Space bar
- Navigation pad with four directional buttons (Up, Down, Left, Right) and the Select button
- Micro-B USB charging port, SD card slot
- 2 Panning rocker keys
- Bluetooth® wireless technology
- User-replaceable, rechargeable batteries



The keyboard was developed by **Orbit Research Labs**, a research lab based in the United States, and is being used by associations and centers that assist the deaf-blind community in the United States, UK and more. Check the official [product page](#) on the company's website.

We purchased the product from the official supplier in Israel (as of 2019)

**Let's Talk Assistive Technologies Ltd.**

The [official website](#) of the supplier in Israel.

Email of the supplier in Israel - [support@ltalk.net](mailto:support@ltalk.net)

Unlike other braille keyboards on the market (which range in price from 5,000 NIS to 10,000 NIS), this keyboard can be purchased for 2,600 NIS (~600 USD) from the Israeli supplier, which is a lot more affordable - taking a step forward the direction of making technology solutions available to this community.

## Standard Bluetooth keyboard

In addition to the Braille keyboard, we purchased a standard Bluetooth keyboard, because our test showed that deaf-blind people might prefer to write in blind writing than Braille.

The keyboard was purchased from a standard product shelf on AliExpress with a nominal cost of about 30 NIS (~7 USD),

You can find products that are described by searching for "mini bluetooth keyboard"

[Link to a sample product.](#)



# About Us

## **Final engineering project - Communication system for deaf-blind people**

Maor Assayag, Refael Shetrit

Advisers' names: Prof. Guterman Hugo, Dr. Luzzatto Ariel

The increasing accessibility to today's smart technology enables the search for solutions for populations with different disabilities, such as deafness and blindness, to improve their lives. According to statistics, over 1400 Israelis have the dual disability of deaf-blindness. The leading cause of deafness in Israel is an incurable disease called "Usher syndrome". Usher syndrome is a genetic syndrome characterized by congenital deafness and accompanied by a gradual reduction of the visual field to total blindness around the age of 40.

Apart from their impairments, the deaf-blind are intelligent people who have desires, aspirations and hopes, like all of us - but they suffer from terrible loneliness. A blind-deaf cannot live with deaf people, because he does not see the sign language of the deaf. In addition, he cannot fit into the company of the blind, because he does not hear them. They are not even able to communicate with family members, especially young people, but only with people who are particularly skilled in sign language, transmitted by touch. When people with this syndrome lose their sight, the deaf-blind emerge from every framework, and remain trapped in the darkness and silence of their illness, cut off from natural communication with the environment.



Ben-Gurion University helps the deaf-blind population and its researchers develop a communication system that will enable them to converse with their surroundings. The system, developed by Maor Assayag and Raphael Shitrit, students for a bachelor's degree in the computer engineering program in the Department of Electrical and Computer Engineering and under the guidance of Prof. Hugo Guterman and Dr. Ariel Luzzatto, is designed to help integrate them with the general population and ease their loneliness.

The main purpose of this project is to develop a system that will enable verbal communication with the deaf-blind, thus relieving their loneliness and enhancing their independence. Today there is no technological solution available to this community, especially in Hebrew. Development of the system will emphasize accessibility to the Israeli community using the tools available to them and on meeting their daily needs.

The system consists of an application on Android device which is connected to a standard Braille keyboard. The application performs Speech-to-Braille and Braille-to-Speech operations accompanied with appropriate accessibility indicators so that the conversation is understandable and continuous for both the speaker and the deaf-blind person.

This innovative system enables the blind person to speak freely with his surroundings. The basic idea is simple: a deaf-blind person can read Braille, which is made up of striking patterns, which he feels with the touch of his fingers, and he can also write blindly on a regular keyboard (or special 8 dot keys represent Braille letters). A line of bold characters on the Braille display shows exactly what is written to make sure he typed correctly. "When an ordinary person speaks, the application translates its speech into the text

displayed on the mobile phone screen and transmitted it to the Braille keyboard so that the blind-deaf can read the sentences that were said", says Prof. Guterman.

An answer is written by the blind-deaf via the Braille keyboard. The text appears on the cell phone and is translated into speech by the app, so an ordinary person can hear what the blind-deaf type. The application also provides appropriate accessibility means and indicators that enable the deaf-blind to know when someone is talking to him, and when what he wrote was received in the form of proper speech to his interlocutor.

The system's features and interface support English & Hebrew, and the development process was done in collaboration with the Deaf-blind center in Israel - Beit David Institute and the deaf-blind community in Israel.

Maor Assayag and Refael Shetrit are the students chosen to lead this initiative as part of the final engineering project that students take during their fourth year of engineering studies. "During the process of developing this system, we faced one main goal: to help this population through The tools we acquired in engineering studies. We met with representatives of the community at the Beit David Institute to understand the complexity of the problem. The current situation, in which deaf-blind people are forced to communicate by means of a touch language that simulates the sign language, leaves them detached from their family, surroundings and undermines their independence", says Refael.

"When developing a product for a population with disabilities, it is not only proof of technical capabilities to perform the system's operations, but also important throughout the design and development process to take into account accessibility indicators to the various operations so that a user who does not see or hear can understand what is happening, for example Voice

indications for the person who speaks, Vibration in varies patterns and more" adds Maor.

Initial tests were performed with the deaf-blind community and the feedback were very positive and used to improve the application. Future work will be focused on porting the app for iOS and continue the design and development of a new portable braille keyboard that combines the layout of a standard keyboard (Write) and a braille display bar (Read) that can enable deaf-blind people to communicate more naturally and effectively.

**Keywords:** deaf-blind, communication, application, Android, Braille, Braille-to-Speech, Speech-to-Braille, accessibility indicators, Beit David Institute



אוניברסיטת בן-גוריון בנגב  
Ben-Gurion University of the Negev

The system developers are **Maor Assayag** and **Rafael Shetrit**, fourth year students in the Computer Engineering program at the Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, Israel, under the guidance of Prof. Hugo Guterman and Dr. Ariel Luzzatto.

[Official Website](#)

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