MCU-SMHMI-UG

Smart HMI User Guide

Rev. 0 — 29 September 2022　　　　　　　　　　　　　　**User guide**

Document information

Information	Content
Keywords	MCU-SMHMI-UG, SLN-TLHMI-IOT, Human Machine Interface (HMI), Smart Home, IoT
Abstract	This document describes the smart Human Machine Interface (HMI) solution, and its associated out-of-box features. The SLN-TLHMI-IOT turnkey solution provides OEMs with a fully integrated, self-contained, software, and hardware solution.

1   Introduction

The SLN-TLHMI-IOT development kit implements NXP's EdgeReady turnkey solution for smart Human Machine Interface (HMI) projects. A high-performance member of the i.MX RT1170 microcontroller (MCU) family enables this solution. It runs on a Real-Time Operating System (RTOS) under dual-core architecture. One is Arm Cortex-M7 at 1 GHz clock rates and the other is Cortex-M4 at 400 MHz, with 2 MB on-chip SRAM. The smart HMI solution provides OEMs with a fully integrated, self-contained, software, and hardware turnkey solution. It includes cross-platform framework, pre-integrated machine learning vision, voice algorithm, a 2D graphics accelerator supported by Light and Versatile Graphics Library (LVGL). The SLN-TLHMI-IOT also includes required drivers for all necessary peripherals, including memories, cameras, mics, speaker, display, and Wi-Fi + Bluetooth Low Energy combo chipset. A runtime license to this software solution is bundled with the i.MX RT117H-numbered devices in the i.MX RT1170 family. The solution enables developers to implement multi-modal smart interactions with Machine Learning (ML) vision (face and gesture recognition), far-field voice control, and 2D graphical user interface on their products. This functionality can be enabled by using only a single high-performance NXP crossover MCU, simplifying the overall system design. NXP's cross-platform dual-core framework architecture empowers designers with the flexibility to customize their products, making i.MX RT117H a versatile fit for numerous smart HMI applications. These applications include but are not limited to both consumer and industrial applications.

Target applications

Smart appliance, smart home, smart building, and smart industrial applications that require smart, intuitive human machine interactions.

- Smart appliances
  - Whitegoods (fridge, standing air conditioner, ovens, laundry, and so on)
  - Counter-top (coffee machine, purifier food processor, and so on)

- Smart home
  - Alarm and smart home control panels
  - Thermostats
  - Universal remote controls
  - Home entertainment
- Smart building, smart industrial
  - Elevator
  - Industrial HMI
  - Healthcare
  - Transportation
  - Access and Identification
- Remote conference system, and so on

1.1   Processor overview

The i.MX RT117H is an EdgeReady member of the i.MX RT1170 family of crossover MCUs, targeting low-cost embedded intellectual HMI applications. It features advanced implementation of the Arm Cortex-M7 core from NXP. The i.MX RT117H operates at speed up to 1 GHz and has a power-efficient Cortex-M4 core up to 400 MHz to provide high-performance and real-time response. The i.MX RT117H has available CPU and memory resources and many integrated peripherals. These features offer customers

the maximum flexibility to customize and define products for a multitude of different use cases.

The i.MX RT117H MCU is licensed to run NXP's facial biometric authentication library, audio front-end runtime library, and ML speech engine runtime library, which includes:

- Unified cross-platform framework
- Camera drivers, image capture, and pre-processing
- Face detection, tracking, alignment, and recognition (with quantified results and confidence measure)
- Voice seeker Audio Front-End (AFE) for Acoustic Echo Cancellation (AEC), Noise Reduction (NR), beamforming, and barge-in
- Conversa for full duplex speakerphone
- Cyberon or Voice Intelligent Technology (VIT) for automatic speech recognition (wake words and commands)
- Display drivers, 2D graphics accelerator supported by LVGL
- Built-in security, bootloader, and application validation
- All drivers, including Bluetooth Low Energy and Wi-Fi
- USB mass storage device updates
- Support secure firmware update over a wireless connection
- Factory automation scripts
- Supported by an MCUXpresso SDK, MCUXpresso IDE, and configuration tools

1.2 Voice library limitations

Voice seeker AFE and Cyberon ASR libraries are provided with our SLN-TLHMI-IOT projects as evaluation versions.

Note: Voice seeker AFE stops working after 25 hours, while Cyberon ASR stops working after 100 detections.

To have voice detection work again, a power cycle is required when either one of these thresholds is met.

Production versions of the libraries can be shared upon request.

2 Recommended configuration

Modifying and debugging the SLN-TLHMI-IOT example projects requires an up-to-date computer that can run MCUXpresso IDE version **11.5.0**.

Note: Both the 11.5.1 and 11.6.0 versions have bugs preventing the SLN-TLHMI-IOT development experience from working as intended.

Table 1. Recommended computer configuration

Computer type	OS version	Terminal program
Apple	MAC OS	PuTTY
PC	Windows 7/10/11	PuTTY/Tera Term
PC	Linux	PuTTY

MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

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3 / 51

3 Hardware

The SLN-TLHMI-IOT turnkey solution for combined face and voice recognition comes with a cost and form-factor-optimized hardware reference designs and access to full software source code. In addition to the i.MXRT117H MCU, the board employs different sensors and peripherals to provide tools to help develop applications with a wide array of functions. Many of the onboard sensors and peripherals can be seen in Figure 1 and Figure 2.
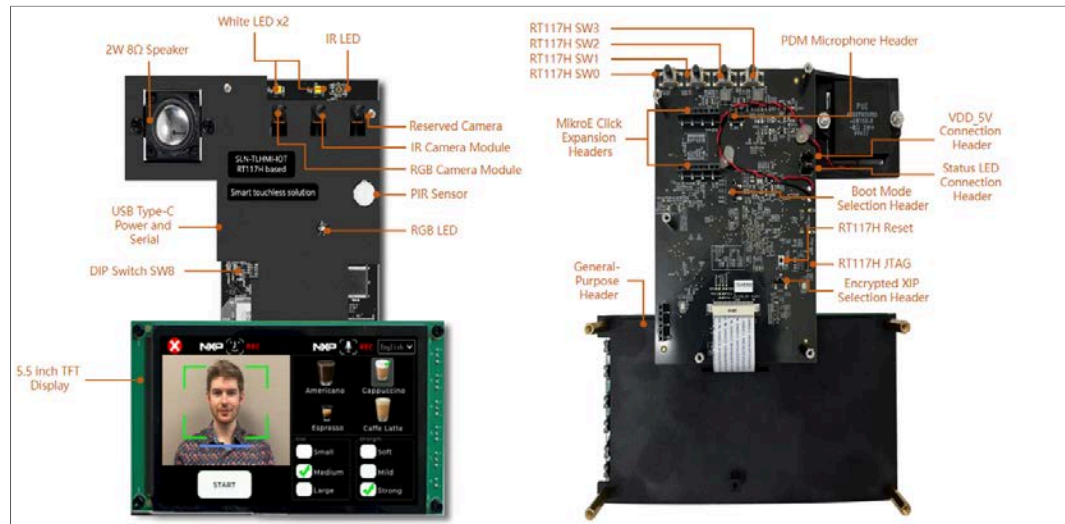

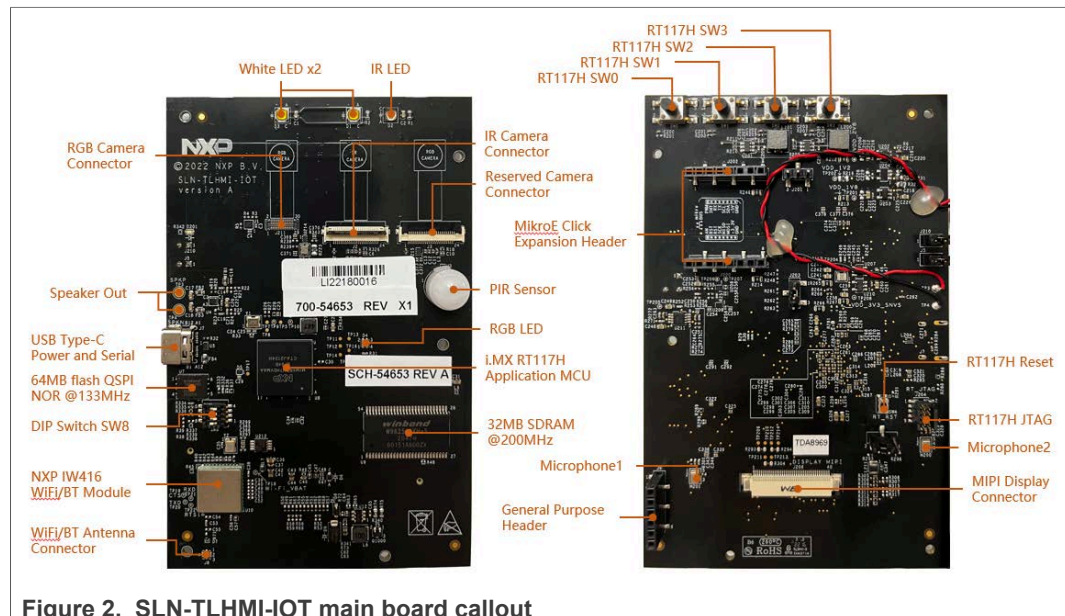**Figure 1. SLN-TLHMI-IOT kit callout**

Figure 2. SLN-TLHMI-IOT main board callout

CAUTION: Depending on the mode of operation, the SLN-TLHMI-IOT kit can emit highly concentrated white or non-visible infrared light which can be hazardous to human eyes. Products which incorporate these devices must follow the safety precautions given in IEC 60825-1 and IEC 62471.

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

4 / 51

For more information about the hardware design of the SLN-TLHMI-IOT, see the *Smart HMI Hardware Development User Guide*.

3.1 Screen

The SLN-TLHMI-IOT kit, by default, uses a 5.5 inch TFT display (Rocktech RK055MHD091A0-CTG) with 720*1280 resolution, LED backlight, full viewing angle, MIPI interface, and a capacitive touch panel.

Datasheet: Rocktech RK055MHD091A0-CTG

Purchase link: Rocktech RK055MHD091A0-CTG

3.2 Speaker

A PUI ASE02808MR-150-R enclosed 8 Ω 2 W speaker is embedded in the SLN-TLHMI-IOT kit.

Datasheet: ASE02808MR-LW150-R

Purchase link: ASE02808MR-LW150-R

3.3 Cameras

The SLN-TLHMI-IOT kit uses a GC2145 camera sensor by default. The GC2145 is a high-quality 2MP CMOS image sensor. It incorporates a 1616 V x 1232 H active pixel array, on-chip 10-bit ADC, and an image signal processor. The camera sensor connects to the kit via a Mobile Industry Processor Interface (MIPI) interface. Additionally, the SDK associated with the SLN-TLHMI-IOT has software support for both the device driver and Hardware Abstraction Layer (HAL) driver for the sensor.

The stock firmware utilizes the camera sensor to register face data and recognize faces.

In addition to the GC2145 camera sensor, alternative image sensors are available for use, including the GC0308 sensor. The default firmware does not support the GC0308 sensor. Enabling this camera requires minor code modifications to enable the respective HAL device driver in the firmware. The GC0308 sensor connects to the kit using a CSI-DVP interface.

3.4 Wireless radios

Usage condition

The following information is provided per Article 10.8 of the Radio Equipment Directive 2014/53/EU:

(a) Frequency bands in which the equipment operates

(b) The maximum RF power transmitted

Table 2. Bluetooth/WLAN frequency and power

PN	RF technology	(a) Frequency range	(b) Maximum transmitted power
SLN-TLHMI-IOT	Bluetooth	2402-2483 MHz	4 dBm

Table 2. **Bluetooth/WLAN frequency and power**...*continued*

PN	RF technology	(a) Frequency range	(b) Maximum transmitted power
	WLAN	2.4 GHz ISM Bands 2.412-2.472 GHz 5.15-5.25 GHz (FCC UNII-low band) for US/Canada and Europe 5.25-5.35 GHz (FCC UNII-middle band) for US/Canada and Europe 5.47-5.725 GHz for Europe 5.725-5.825 GHz (FCC UNII-high band) for US/Canada	18.5 dBm

EUROPEAN DECLARATION OF CONFORMITY (Simplified DoC per Article 10.9 of the Radio Equipment Directive 2014/53/EU)

This apparatus, namely SLN-TLHMI-IOT, conforms to the Radio Equipment Directive 2014/53/EU. The full EU Declaration of Conformity for this apparatus can be found at: www.nxp.com/mcu-smhmi.

4   Bootloader

The SLN-TLHMI-IOT uses a multi-stage boot process to enhance the capabilities of the out-of-box firmware (FW) to include additional functionality. Such as the ability to flash new firmware images remotely and without a debugging probe.

The bootloader operates as the first stage of the boot process, determining which available out-of-box demo applications (coffee machine and elevator) to use, if any. The bootloader, in addition to choosing which of the default out-of-box applications to use (Normal Boot mode), also supports an additional boot mode: Mass Storage Device (MSD) update mode. The following sections describe each of these different boot modes in more detail.

4.1   Boot modes

The bootloader supports several different boot-up methods which augment the boot-up behavior. These methods include Normal Boot mode (default) and Mass Storage Device (MSD) mode for drag-and-drop flashing of new firmware images. The following sections describe the usage of each different boot mode and how to enable them.

A high-level overview of the purpose of each of these features is discussed below. Information regarding their usage, creating update payloads, and more can be found in the *Smart HMI Software Development User Guide*.

4.1.1   Normal boot

By default, if no boot flags are set during the boot phase, the Normal Boot mode is used.

During Normal Boot, the bootloader simply boots into the "main" out-of-box demo application that is most recently used. For example, if the coffee machine application is used most recently, the bootloader jumps to the flash address associated with the coffee machine application. Similarly, if either the elevator or smart home panel application is used most recently, the bootloader jumps to the flash address associated with the elevator or smart home panel application. If powering the kit for the first time and no

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

6 / 51

previous application has been selected, the bootloader requires an application to be manually selected first.

The OoBE FW has a set of three different applications that can be booted into at startup. To select an application for the bootloader to use, while the kit is being powering on, press and hold one of the onboard push buttons on the back of the kit. The switch corresponding to each application is shown below:

- SW1 – Coffee Machine
- SW2 – Elevator

4.1.2 Mass Storage Device (MSD)

The MSD feature allows the SLN-TLHMI-IOT to receive firmware updates without a debugging probe like a SEGGER J-Link. Instead MSD uses USB to emulate an MSD interface like the one that is used for USB flash drives.[1] This feature can be especially useful for marketers or engineers in the field without access to a dedicated debug probe tool.

MSD mode is enabled by pressing and holding the SW0 pushbutton on the back of the kit while the kit is powering on.

Once enabled, a blinking purple LED on the front of the kit which pulsates at an interval of roughly 1 second indicates MSD mode.

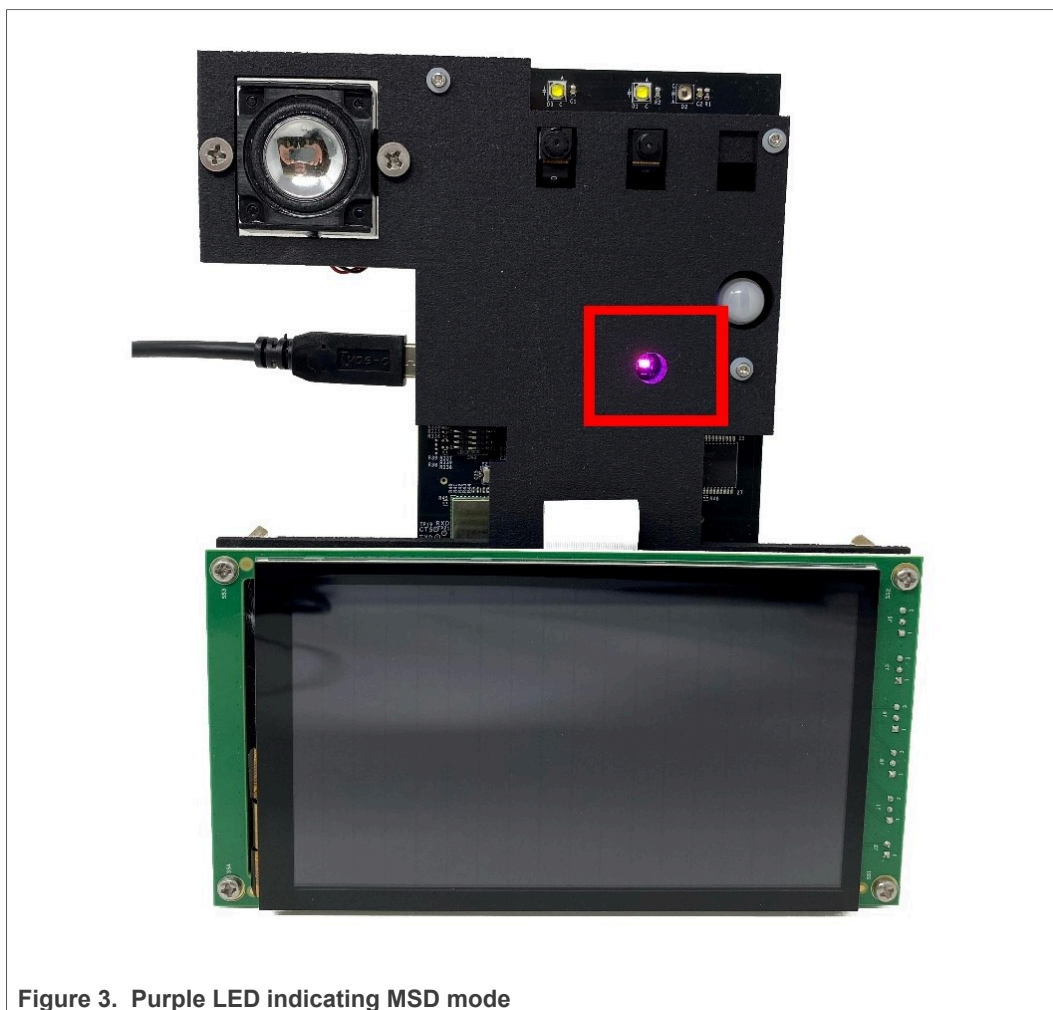1 Currently only supported on Windows PC devices running Windows 7 or newer

Figure 3. Purple LED indicating MSD mode

Additionally, the PC recognizes the USB interface, assuming your SLN-TLHMI-IOT is connected to a Windows PC. It shows a new USB Drive corresponding to your SLN-TLHMI-IOT kit.

Figure 4. New USB drive for SLN-TLHMI-IOT kit

To update the firmware image on your kit, drag and drop the new binary to the USB drive corresponding to your kit. Assuming the binary is properly generated, the bootloader automatically updates the firmware on your device. Flashing a new firmware image results in a pop-up window identical to the one used when copying files to a real USB flash drive device.
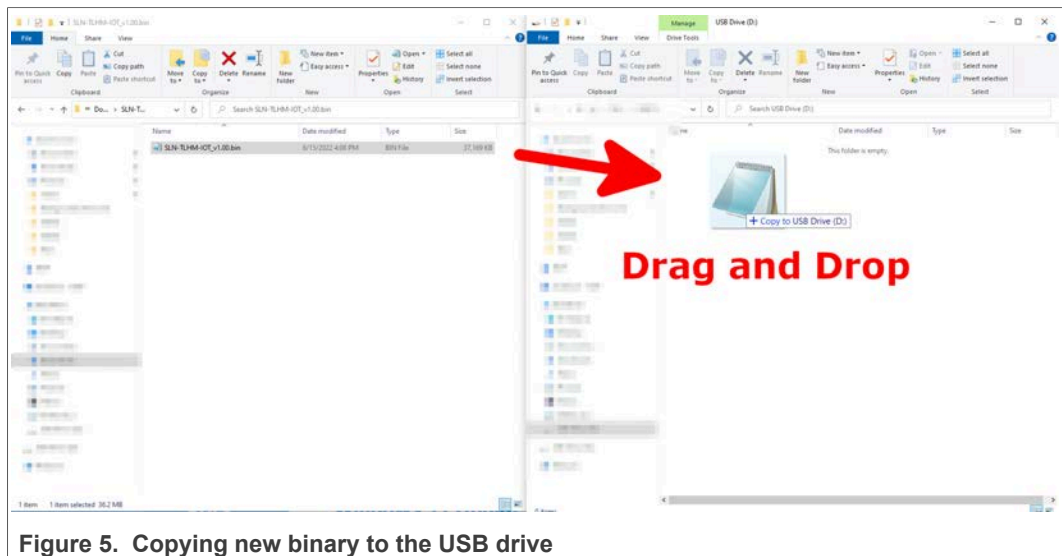
Figure 5. Copying new binary to the USB drive

Note: Only the main application (for example, coffee machine or elevator) can be updated using MSD. The bootloader cannot be updated using MSD and requires the use of a SEGGER J-Link Debug Probe or the Factory Programming Flow. Instructions MSD, J-Link-based updates, and the Factory Programming Flow can be found in the Smart HMI Software Development User Guide.

For more information regarding MSD mode and its usage, as well as instructions on generating FW binaries compatible with MSD mode, see the Smart HMI Software Development User Guide.

5 Out-of-box demo applications

5.1 Overview

There are two distinct applications that come pre-flashed with your kit: **Coffee Machine** and **Elevator**. These example applications are built to showcase the complex machine vision, machine voice, and advanced graphical UI capabilities the kit supports. They also provide a base software platform for rapid integration of unique customer applications and requirements.

The **Coffee Machine** application presents an example of a potential smart HMI use case. Here, an HMI device must operate using hands-free voice control capabilities while providing custom user experiences using face recognition to recognize repeat users of the machine.

The **Elevator** application presents similar capabilities to the coffee machine demo by providing an example of a smart HMI device. This device operates using hands-free voice control capabilities to interact with an elevator, selecting the floor number, opening and closing the elevator doors, and so on. Additionally, the elevator demo application automatically recognizes new users and asks to save the floor number they traveled to.

When powering on your kit, a brief startup screen appears which shows icons for each available out-of-box demo application. The icon associated with the currently enabled application is most prominently displayed using a slightly larger icon.
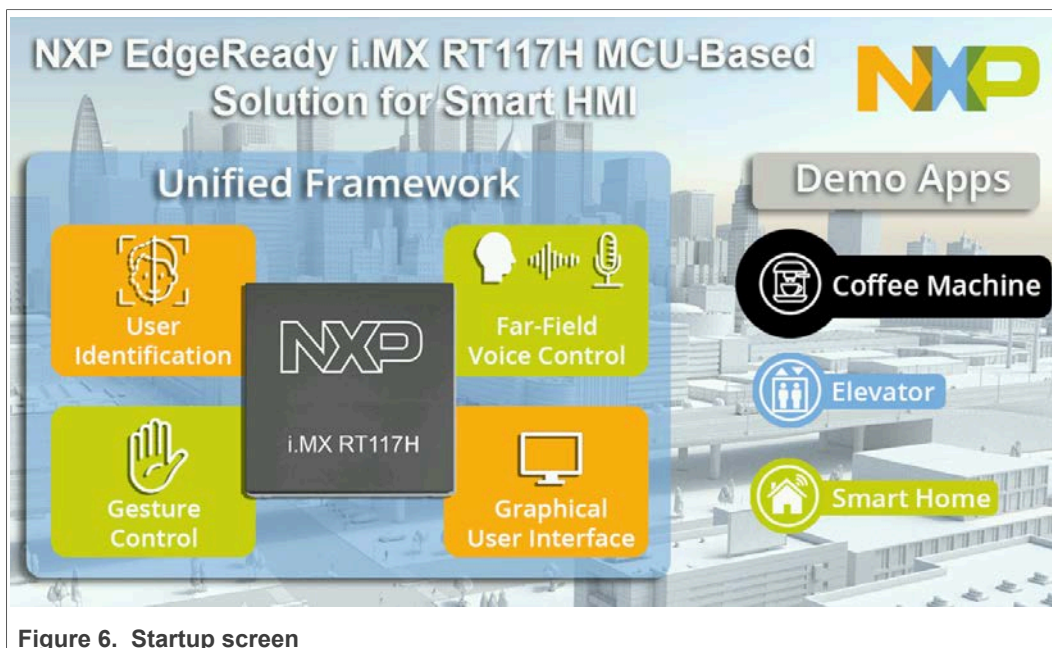
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User guide

Rev. 0 — 29 September 2022

9 / 51

Figure 6. Startup screen

Each of the out-of-box demo applications is described in more depth in the following sections.

5.2 Coffee machine

5.2.1 Overview

The coffee machine application, preprogrammed in the SLN-TLHMI-IOT kit, presents a demo application. This application integrates both face and multi-language speech recognition while showcasing the advanced graphics capabilities of the RT117H's 2D GPU as well.

In the demo, users can select their coffee preferences using onscreen touch controls and hands-free voice control. After selecting their preferred coffee, they can save their order by anonymously associating it with their face. The next time that face is recognized, they can either choose a new coffee selection or automatically use their saved coffee selection.

The following sections describe the out-of-box features of the coffee machine demo and their usage.

5.2.2 Standby screen

After exiting the startup screen, a standby screen is displayed, which acts as a screen saver to indicate that the system is waiting for user interaction. The standby screen is shown in a few different scenarios, including: after startup, after coffee has finished brewing, and after a ~60 second timeout with no user interaction (voice commands/touch controls) has been reached.
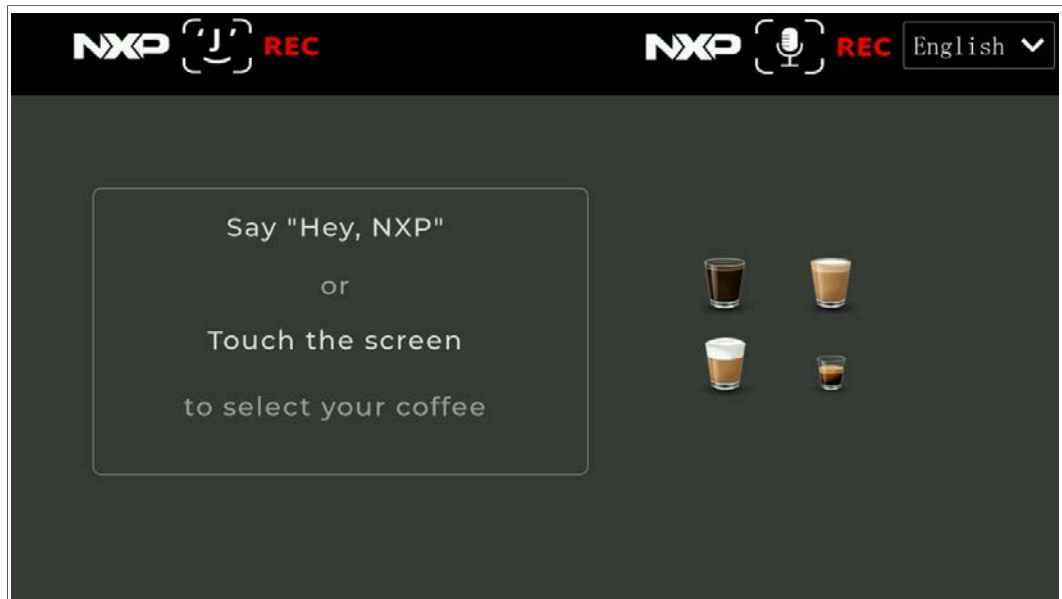
Figure 7. Standby screen

The standby screen also allows you to select your preferred language settings using the drop-down language selector menu found in the top-right corner of the screen or by using the wake word associated with your preferred language.

To exit the standby screen, simply touch the touchscreen or use the wake word supported by your preferred language, as described in Section 5.2.6.

5.2.3 Home screen

You can access the home screen by speaking the wake word "Hey NXP" or touching the screen while the application is in Standby mode.

The home screen is split into two distinct sections: a camera preview pane on the left side of the screen, and a coffee selection section on the right side of the screen.

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

11 / 51

Figure 8. Home screen

By default, the dedicated camera preview shows output from the RGB camera[2]. A bounding box in the center of the camera preview window is intended to help users properly align their faces with the camera. The box indicates the status of the face recognition pipeline ("Face Not Detected", "Face Detected", and "Face Recognized") based on the color of the box.
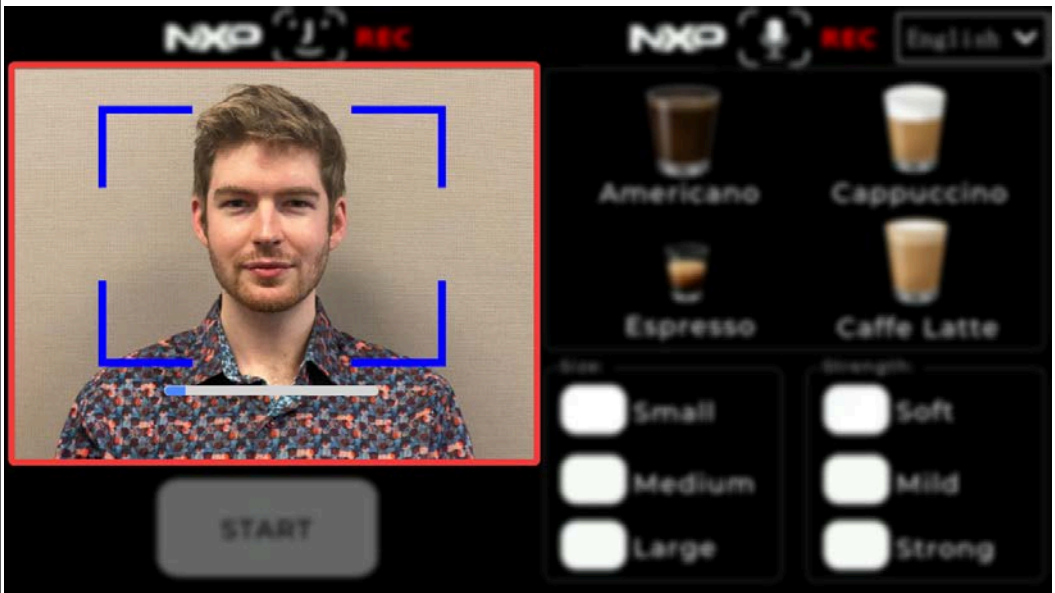

Figure 9. Face not detected

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2 For an alternative to the camera preview pane, see the <u>Section 5.2.7</u>.
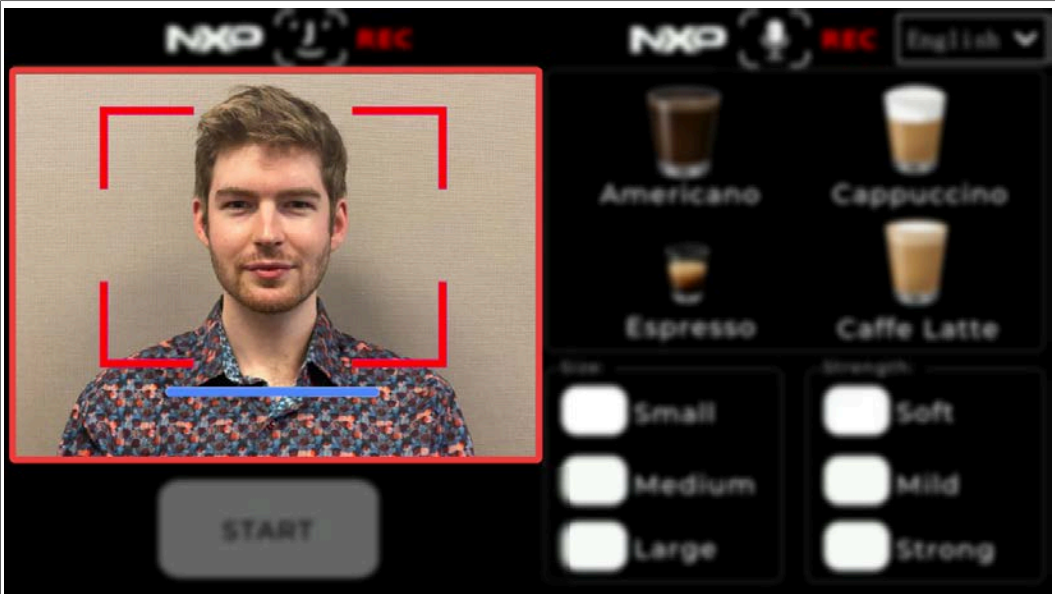
Figure 10. Face detected
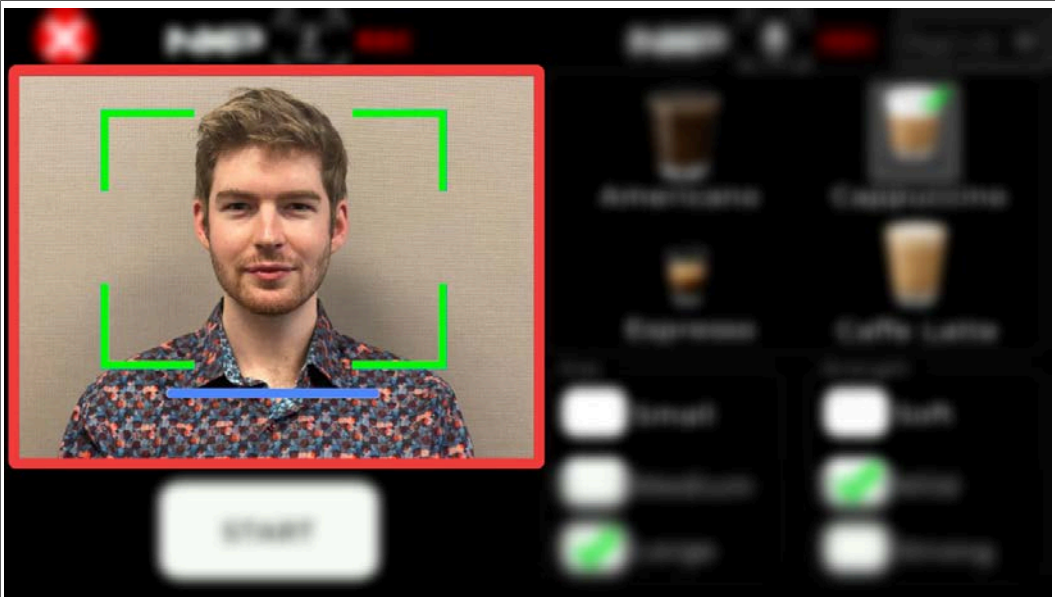
Figure 11. Face recognized

On the right half of the screen are the three different selections for modifying the coffee selection: the coffee *type*, *size*, and *strength*.
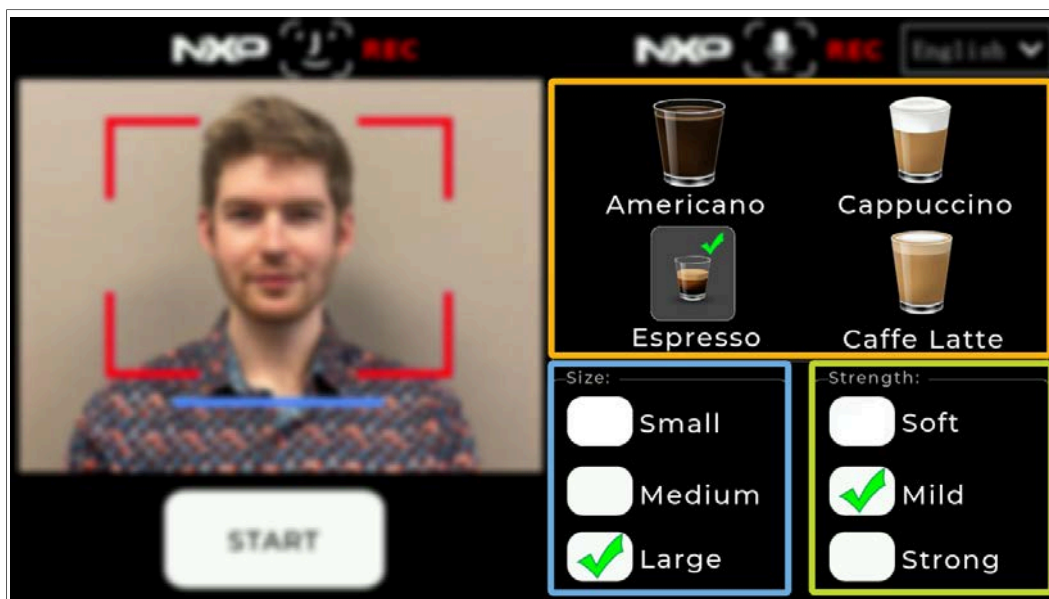
MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

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13 / 51

Figure 12. Coffee selection

In addition to the camera preview and coffee selection menu, there is also a **Start** button in the bottom-left portion of the screen. The screen also has a language selector drop-down menu in the top-right corner.

The **Start** button enables the brewing screen which "brews" a coffee based on the user's selected coffee preferences.

The language drop-down menu is used to configure the UI language settings as well as the language used for the hands-free voice commands. See Section 5.2.6 for more info regarding supported languages, wake words, and commands.

5.2.3.1 Bounding box colors

As previously mentioned, the coffee machine home screen has a camera preview window with a bounding box for helping users align their faces properly for detection.

By default, this bounding box is blue. The blue color indicates the default face recognition state, which means that no face is recognized yet.
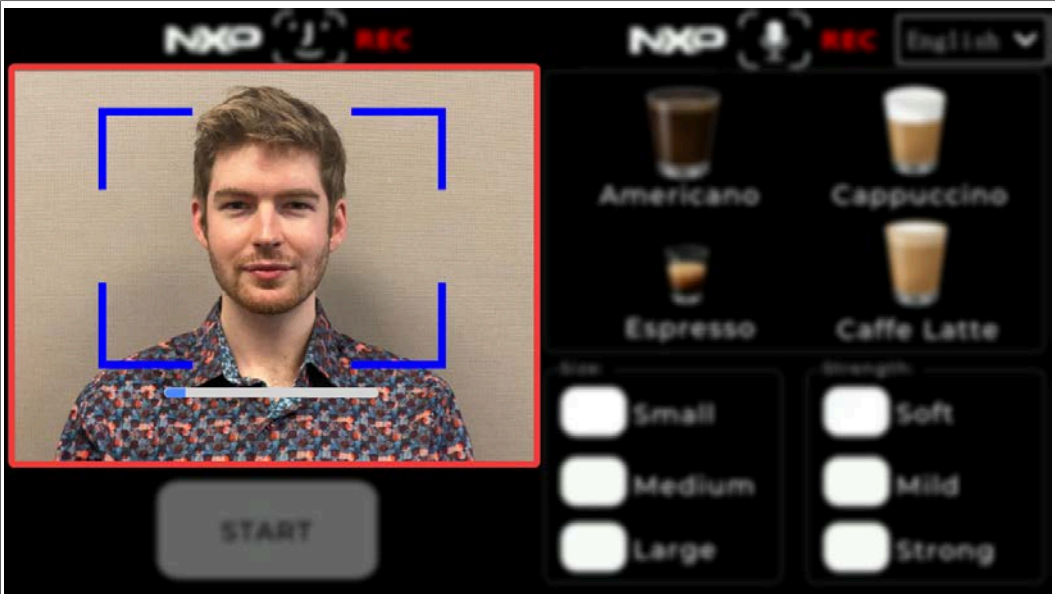
Figure 13. No face detected

The bounding box turns red when a face is detected but is not recognized. This state indicates that the following coffee selection can be associated with the face detected.
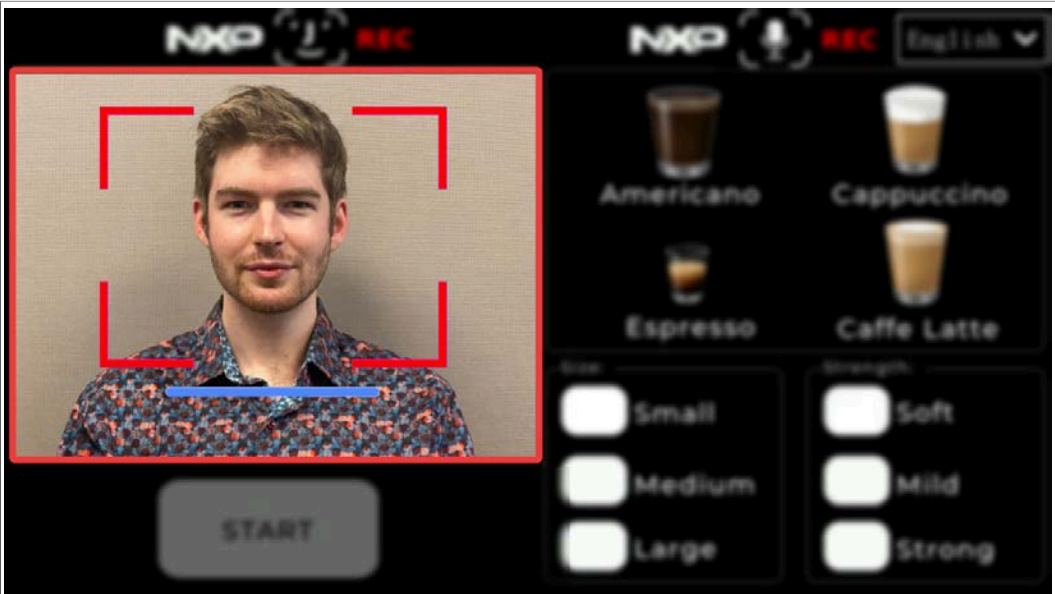

Figure 14. Face is detected but not registered

The bounding box turns green when a face is detected and a coffee selection is associated with it. Additionally, a red **X** for removing the recognized face is displayed in the top-left corner of the screen. For information about how to save your coffee selection, see Section 5.2.3.6.
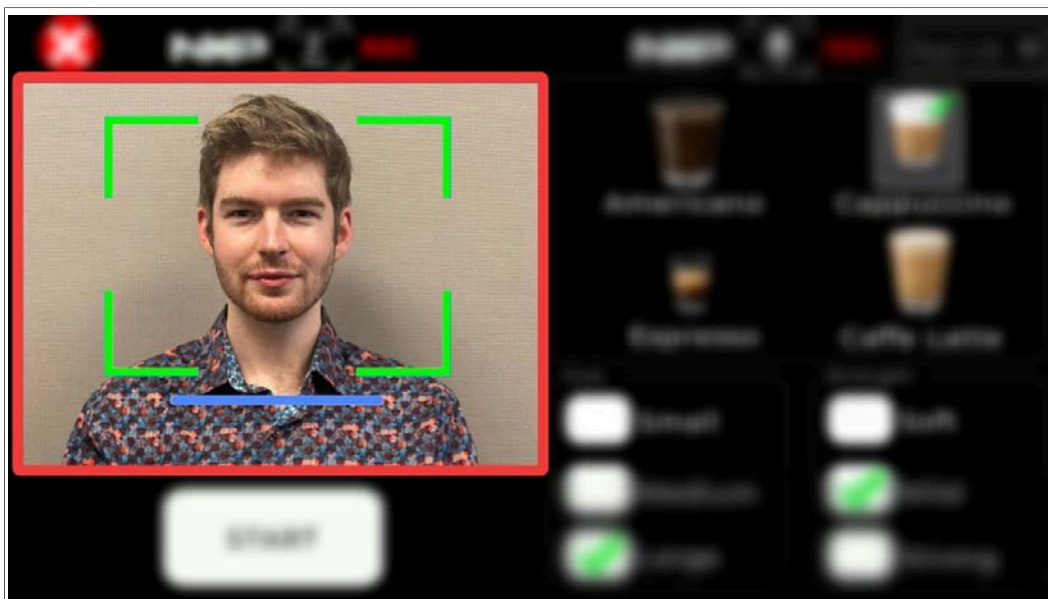
MCU-SMHMI-UG

User guide   **Rev. 0 — 29 September 2022**

15 / 51

Figure 15. Face is detected and a coffee is associated with it

5.2.3.2 Selecting coffee type

The coffee machine application allows configuring several different coffee preference settings, including the *type* of coffee. The coffee machine application has four default coffee types: Americano, Cappuccino, Espresso, and Café Latte. Each coffee type can be selected using touch controls or hands-free voice commands.

Figure 16. Available coffee types

When using voice commands, a confirmation tone plays, saying "Americano", "Cappuccino", "Espresso", or "Café Latte", and a green LED indicates that the command is successfully recognized.

When the onscreen coffee type touch controls are used or a "Coffee Type" voice command is recognized, the icon indicating the currently selected coffee type updates to reflect the new selection.

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

17 / 51

Figure 17. Selecting coffee type

5.2.3.3 Selecting coffee size

The coffee machine application allows configuring several different coffee preference settings, including the *size* of the coffee. The onscreen **Size** selector can be used to adjust the size of the coffee to "Small", "Medium", or "Large" by using the touchscreen controls.
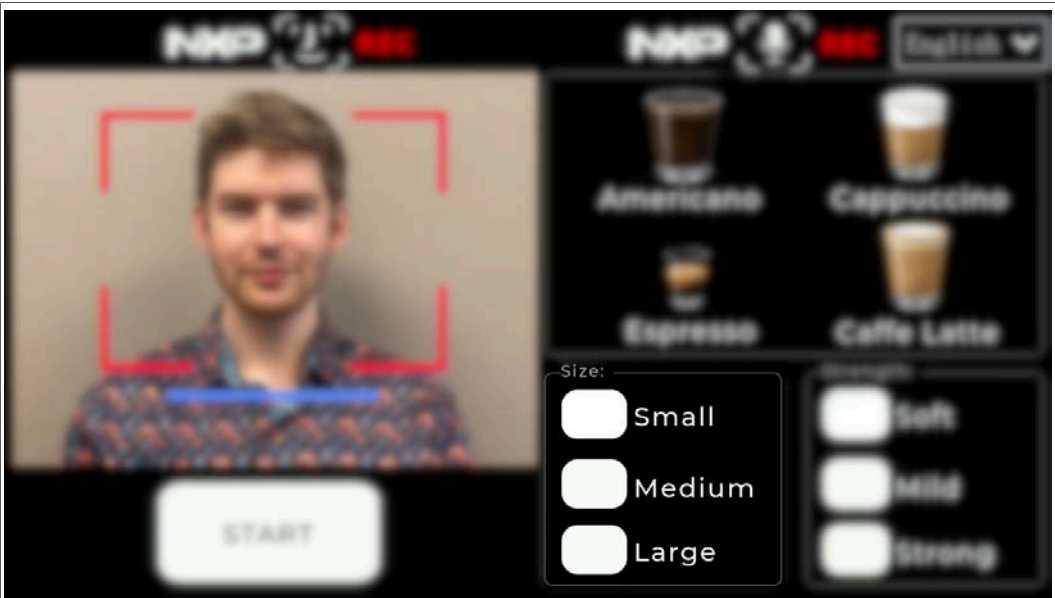

Figure 18. Selecting coffee size

In addition to the touchscreen controls, the coffee size can be adjusted using the "Small", "Medium", and "Large" voice commands, depending on the desired coffee size[3].

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3 These commands apply only when the language setting is set to "English." For commands supported in other languages, see the Voice Commands section.

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User guide

Rev. 0 — 29 September 2022

18 / 51

Upon successfully recognizing a voice command, the slider position updates, and a confirmation tone with a green LED pulse indicate the success of the voice command.

The chosen size affects how long the animation on the brewing screen takes. For example, small takes the shortest amount of time while large takes the longest.

5.2.3.4 Selecting coffee strength

The coffee machine application allows configuring several different coffee preference settings, including the *strength* of the coffee. The onscreen **Strength** slider can also be used to adjust the strength of the coffee by using the touchscreen controls.

In addition to the touchscreen controls, the coffee strength can be adjusted using "Soft", "Mild", or "Strong" voice commands depending on the desired coffee strength[4]. Upon successfully recognizing a voice command, the slider position updates, and a confirmation tone with a green LED pulse indicates the success of the voice command.
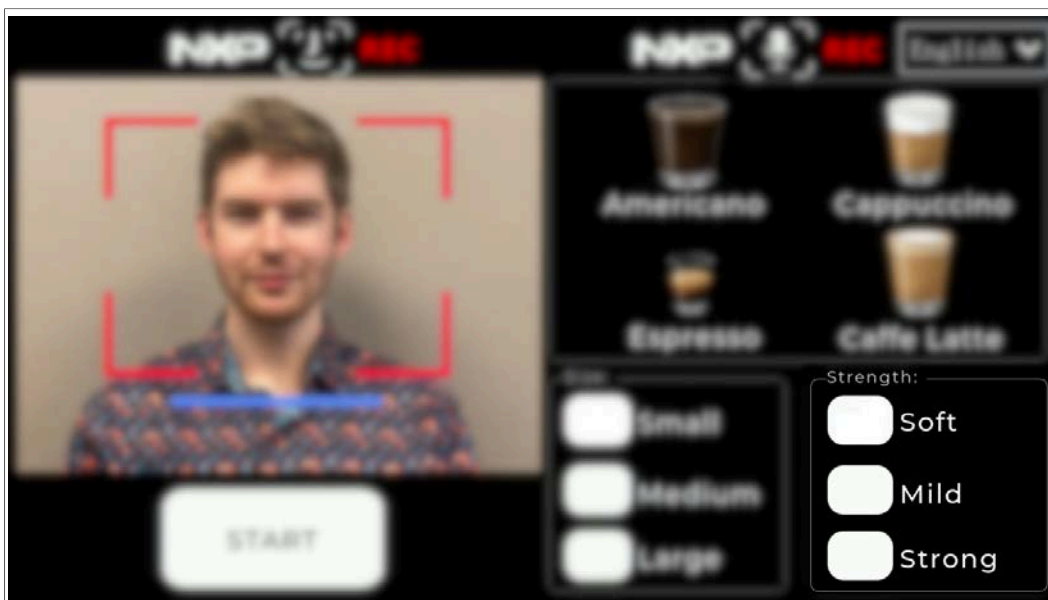
Figure 19. Selecting coffee strength

5.2.3.5 Brewing coffee

After setting coffee preferences, users may begin brewing the coffee by pressing the onscreen **Start** button or using the equivalent "Start" command in the configured language. The **Start** button remains greyed out and unusable until a coffee type, size, and strength have been selected.

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4 These commands apply only when the language setting is set to "English." For commands supported in other languages, see the Voice Commands section.
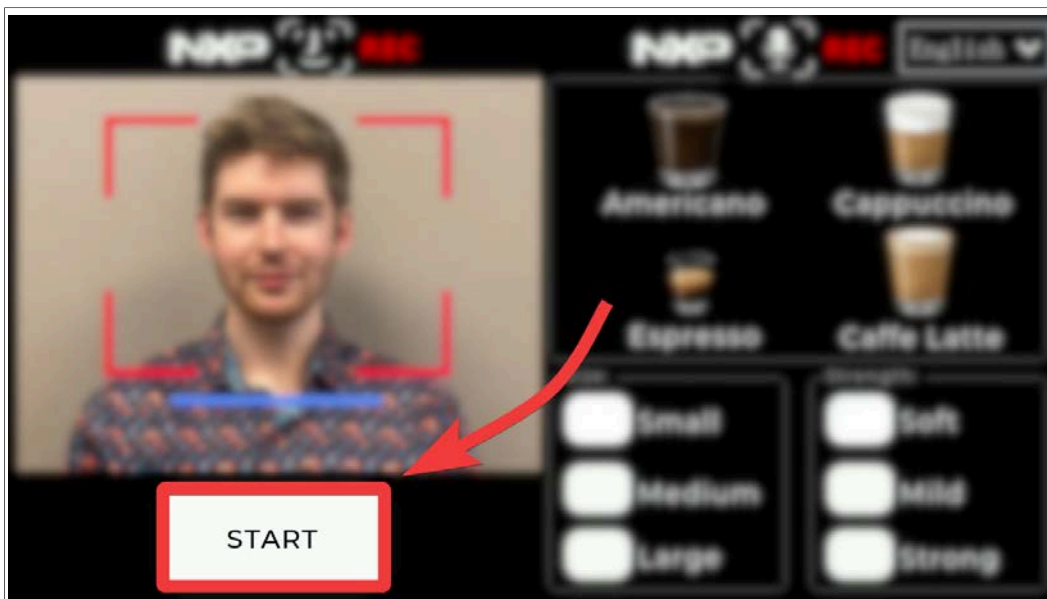
Figure 20. Start button

During the brewing process, the display transitions to the brewing screen, which represents a coffee being brewed and dispensed. While coffee is brewing, the selected type, size, and strength of the coffee being brewed are shown onscreen.

5.2.3.6 Saving coffee selection

Users can associate their preferred coffee and language settings with their face for the TLHMI kit to reuse their coffee preferences when the camera next recognizes them.

To save a new user, configure the preferred coffee and language settings using the controls described in the previous sections. After configuring the settings, begin brewing coffee, by pressing the **Start** button or using the "Start" voice command.

When the coffee brewing animation is complete, the screen briefly transitions to the final screen before re-enabling the standby screen.

While the final screen is being shown, an audio prompt plays, "Save your coffee selection? Confirm or Cancel" for either of the following events:

• The application detects an unrecognized face
• A face is recognized, but a coffee different from the saved preferences is chosen

Replying "Confirm" (or the equivalent in the configured language) saves the current coffee selection to the user's face and transitions the kit back to Standby mode.

Replying "Cancel" (or the equivalent in the configured language) aborts saving the current coffee selection and transitions the kit back to Standby mode.

5.2.3.7 Automatic coffee selection

When the application boots and/or transitions out of Standby mode and recognizes a face, an audio prompt asks users if they would like to reuse their saved coffee selection.
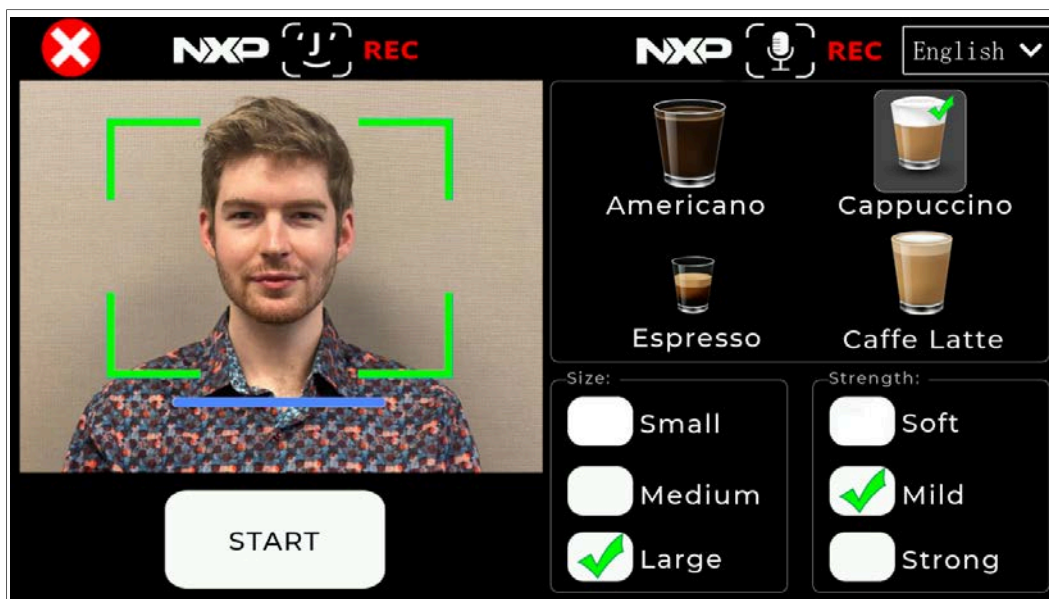
Figure 21. Face recognized

Saying "Confirm" (or the equivalent for your configured language) automatically starts brewing the coffee.

Saying "Cancel" (or the equivalent for your configured language) allows you to choose a different selection from the one currently saved to your face.

5.2.3.8 Deleting a saved face

If the application recognizes a face, the user may delete it using either a voice command or onscreen touch control. This process permanently deletes the face and the coffee preferences associated with the face.

To delete a face, use the "**Delete User**" or equivalent voice command in your configured language. Alternatively, press the red **X** in the top left corner of the screen. Once the application recognizes the **Delete User** command or the user presses the **X** icon, it permanently removes the currently recognized face and the associated coffee selection from the local database.
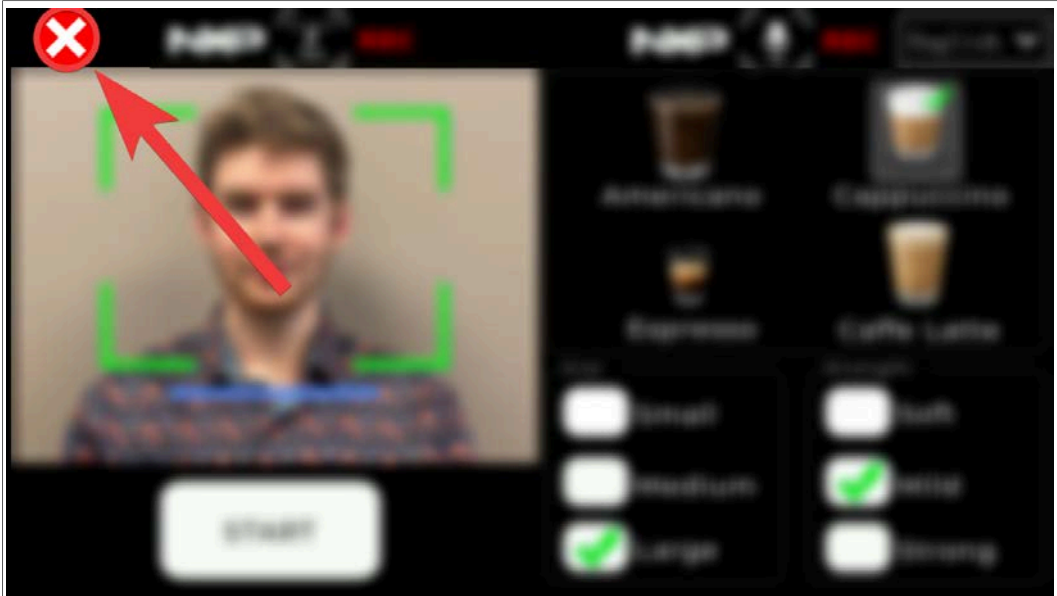
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User guide

Rev. 0 — 29 September 2022

21 / 51

Figure 22. Deleting a saved face

Note: If a face is deleted, saving a new face requires power cycling the board, or waiting for the board to enter standby and reawakening it.

5.2.3.9 Face recognition debugging information

To activate debugging information that can help with debugging issues recognizing your face, tap the face icon next to the NXP logo icon 3 times.
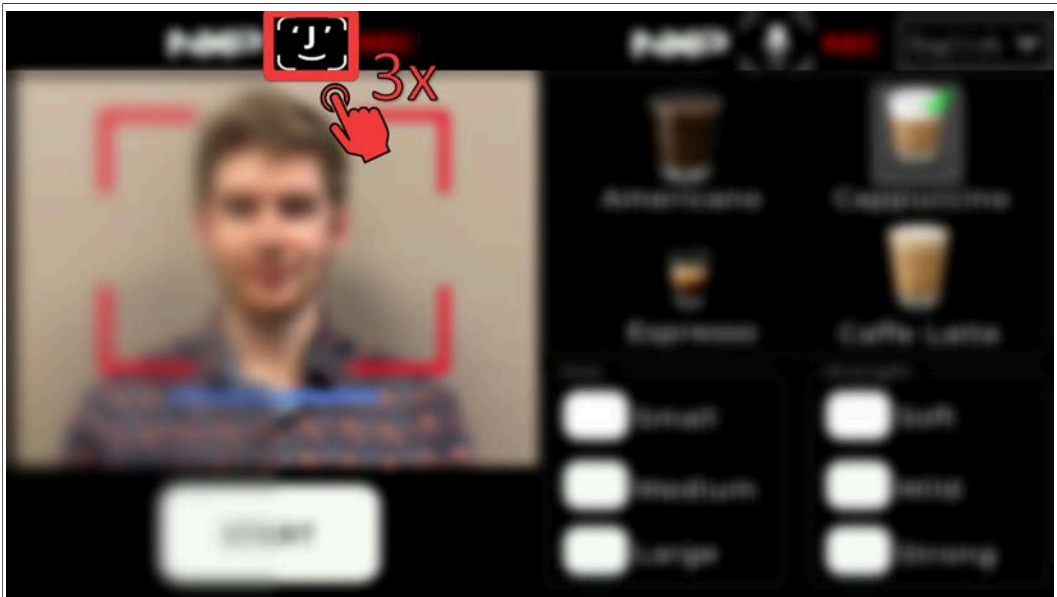

Figure 23. Face icon

Once enabled, messages appear at the top of the screen to the right of the face REC icon. Information can include messages like "No Face", "New User", "Invalid", and a generic user name assigned to a recognized face.

MCU-SMHMI-UG
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User guide
Rev. 0 — 29 September 2022

22 / 51
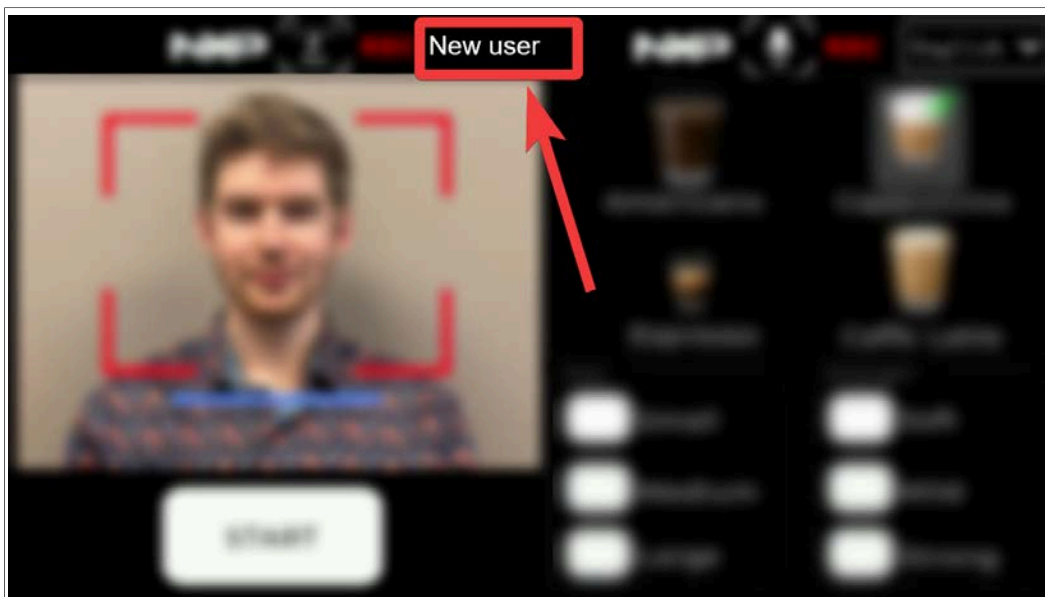
Figure 24. Debugging messages

For more information on debugging messages and their meaning, see the Section 6.1.2.

5.2.4 Brewing screen

The brewing screen is reached from the home screen after the **Start** button is touched onscreen or if the voice command "Start" is given.

The brewing screen displays the preferences chosen on the home screen: coffee type, size, and strength. An animation of coffee brewing is displayed to the right of these options. The duration of the animation is proportional to the size of the coffee selected on the previous screen.
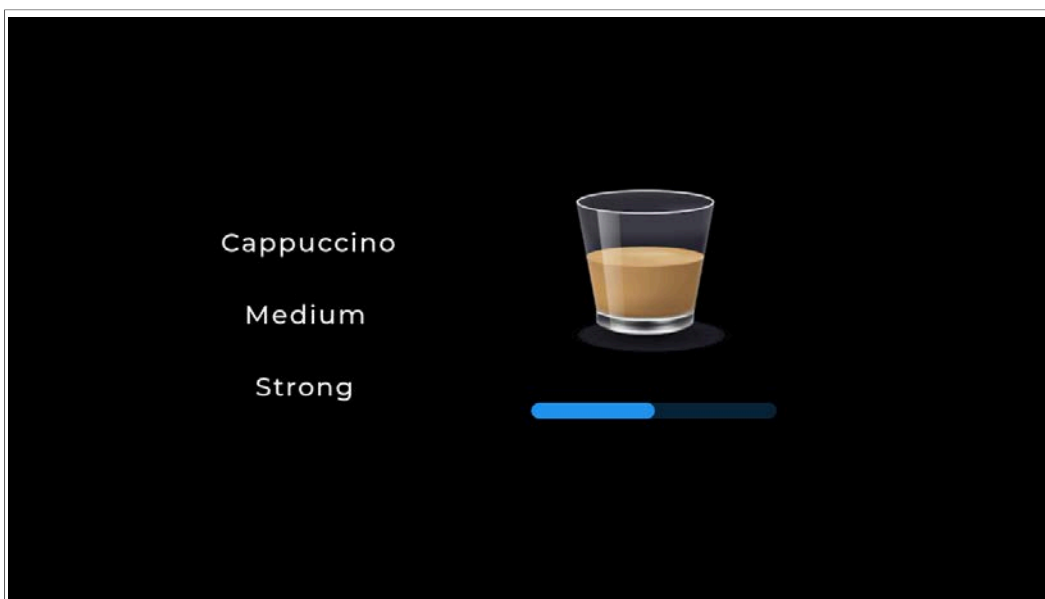
Figure 25. Brewing screen

The brewing screen automatically transitions to the final screen once the animation is complete (progress indicated by the blue bar).

5.2.5 Final screen

The final screen indicates that the selected coffee has been brewed. The final screen displays the original preferences selected on the home screen. On this screen, an audio prompt asks the user whether they want to save their current coffee selection if their face is not recognized. The prompt also plays if a face is recognized, but the user selects a different coffee from their saved preferences.

Figure 26. Final screen

Saying "Confirm" updates the coffee preferences of an existing user or creates a new set of coffee preferences associated with the face of the user.

Saying "Cancel" preserves the saved coffee preferences of the user if they exist. If the user is a new, unrecognized face, the application forgets the user and does not associate any coffee selection with their face.

5.2.6 Voice commands

The coffee machine application supports over a dozen commands in four languages to enable a hands-free demo experience.

The system language used for both the UI and voice commands can be configured in several different ways:

- In Standby mode, the default Cyberon Automatic Speech Recognition (ASR) engine listens for one of four different wake words to determine which language to use. For example, waking the board using "Hey NXP" configures the system language to English, while "Salut NXP" configures the system language to French.
- On both the home screen and standby screen, the system language can be configured using the onscreen language selector drop-down.

The following sections provide a list of each of the support commands in each of the available languages.

Note: *As discussed in the* [*Voice Library Limitations*](#) *section, the default out-of-box software uses the Voice Seeker AFE and Cyberon Automatic Speech Recognition (ASR) libraries as evaluation versions. As a result, the AFE and ASR cease to function after 25 hours and 100 voice instructions, respectively. To reset the ASR and the AFE, power cycle the board.*

5.2.6.1 English

Table 3. Voice commands in English

Voice Command	Description
"Hey NXP"	**Wake word** for the board
"Americano"	1 of 4 selections for coffee type
"Cappuccino"	1 of 4 selections for coffee type
"Espresso"	1 of 4 selections for coffee type
"Café Latte"	1 of 4 selections for coffee type
"Small"	1 of 3 selections for coffee size; shortest brewing animation time
"Medium"	1 of 3 selections for coffee size
"Large"	1 of 3 selections for coffee size; longest brewing animation time
"Soft"	1 of 3 selections for coffee strength
"Mild"	1 of 3 selections for coffee strength
"Strong"	1 of 3 selections for coffee strength
"Start"	Command to begin brewing the coffee
"Confirm"	1 of 2 responses used for answering prompts
"Cancel"	1 of 2 responses used for answering prompts
"Delete User"	Removes coffee selection from associated face and deletes face from database; available only while green bounding box and red **X** in top left corner are present

5.2.6.2 French

Table 4. Voice commands in French

Voice Command	Description
"Salut NXP"	**Wake word** for the board
"Café Americano"	1 of 4 selections for coffee type
"Cappuccino"	1 of 4 selections for coffee type
"Espresso"	1 of 4 selections for coffee type
"Café Latté"	1 of 4 selections for coffee type
"Court"	1 of 3 selections for coffee size; shortest brewing animation time
"Moyen"	1 of 3 selections for coffee size

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

25 / 51

Table 4. Voice commands in French...*continued*

Voice Command	Description
"Long"	1 of 3 selections for coffee size; longest brewing animation time
"Léger"	1 of 3 selections for coffee strength
"Normal"	1 of 3 selections for coffee strength
"Serré"	1 of 3 selections for coffee strength
"Commencer"	Command to begin brewing the coffee
"Confirmer"	1 of 2 responses used for answering prompts
"Annuler"	1 of 2 responses used for answering prompts
"Supprimer préférence"	Removes coffee selection from associated face and deletes face from database; available only while green bounding box and red **X** in top left corner are present

5.2.6.3 German

Table 5. Voice commands in German

Voice Command	Description
"Hallo NXP"	**Wake word** for the board
"Americano"	1 of 4 selections for coffee type
"Cappuccino"	1 of 4 selections for coffee type
"Espresso"	1 of 4 selections for coffee type
"Kaffee Latte"	1 of 4 selections for coffee type
"Klein"	1 of 3 selections for coffee size; shortest brewing animation time
"Mittel"	1 of 3 selections for coffee size
"Groß"	1 of 3 selections for coffee size; longest brewing animation time
"Leicht"	1 of 3 selections for coffee strength
"Mild"	1 of 3 selections for coffee strength
"Stark"	1 of 3 selections for coffee strength
"Starten"	Command to begin brewing the coffee
"Bestätigen"	1 of 2 responses used for answering prompts
"Abbrechen"	1 of 2 responses used for answering prompts
"Abmelden"	Removes coffee selection from associated face and deletes face from database; available only while green bounding box and red **X** in top left corner are present

5.2.6.4 Chinese

Table 6. Voice commands in Chinese

Voice Command	Description
"你好 恩智浦"	**Wake word** for the board
"美式咖啡"	1 of 4 selections for coffee type
"卡布奇诺"	1 of 4 selections for coffee type
"意式咖啡"	1 of 4 selections for coffee type
"拿铁"	1 of 4 selections for coffee type
"小杯"	1 of 3 selections for coffee size; shortest brewing animation time
"中杯"	1 of 3 selections for coffee size
"大杯"	1 of 3 selections for coffee size; longest brewing animation time
"柔润"	1 of 3 selections for coffee strength
"温和"	1 of 3 selections for coffee strength
"浓烈"	1 of 3 selections for coffee strength
"开始"	Command to begin brewing the coffee
"确定"	1 of 2 responses used for answering prompts
"取消"	1 of 2 responses used for answering prompts
"取消注册"	Removes coffee selection from associated face and deletes face from database; available only while green bounding box and red **X** in top left corner are present

5.2.7 Shell commands

The coffee machine out-of-box FW provides additional configuration options via a shell interface hosted over a USB virtual COM connection.

To connect to the shell interface, use a Serial Terminal Emulator program like PuTTY, Tera Term, or Minicom and configure the serial connection settings as shown below. Make sure to use the COM port corresponding to your kit.

- Speed: 115200
- Data: 8 bit
- Parity: none
- Stop bits: 1 bit
- Flow control: none

The shell commands for the coffee machine application are listed below:

- `help`
  Lists all the registered commands
- `version oasis`
  Gets the version of the current oasis library
- `version`
  Gets the version of the current software
- `info`

MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

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27 / 51

Gets the system information

- `reset`
  Resets the board
- `del -n <username>`
  Deletes user by user name
- `del -i <id>`
  Deletes user specified by id
- `del -a`
  Deletes all users
- `list`
  Prints a list of all users currently saved in the face database
- `list -c`
  Prints the number of users currently saved in the face database
- `volume <value>`
  Volume of the speaker. Value should be between 0 (muted) and 100 (max)
- `preview_mode <camera|virtual_face>`
  Enables or disables displaying output directly from the camera. The "virtual face" uses a stand-in icon of a face similar used in the elevator application rather than showing output from the camera directly.
- `preview_mode`
  Prints the currently enabled preview mode ("camera" or "virtual_face")
- `language`
  Prints the currently configured system language
- `wifi ssid <SSID>`
  Sets the SSID
- `wifi password <Password>`
  Sets the Password
- `wifi ip`
  Gets the IP
- `wifi credentials`
  Gets the current Wi-Fi credentials saved in flash
- `wifi credentials erase`
  Removes the current Wi-Fi credentials. After erasing, the WiFi disconnects from the network
- `wifi state <on/off>`
  Turns the Wi-Fi on and off
- `wifi state`
  Gets the current state of the Wi-Fi
- `wifi reset`
  Resets the Wi-Fi connection
- `wifi scan`
  Starts the scan process. This command returns a JSON-formatted list with<SSID><signal><channel> after the scan is completed.
- `serial_number`
  Prints the device serial number

5.3 Elevator

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

28 / 51

5.3.1 Overview

The elevator application, preprogrammed in the SLN-TLHMI-IOT kit, provides another example of how the kit can be implemented. The application incorporates both audio and facial recognition algorithms for a convenient hands-free environment while also supporting traditional touch-based controls. It also integrates a powerful personalization tool by associating your face with the floor where you reside.

5.3.2 Home screen

After transitioning past the startup screen, the home screen is displayed.

Figure 27. Home screen

The home screen is split into 3 distinct sections.

The top left side contains static data, including the date, time, temperature outside, and a weather icon. These are not currently functional in this demo, but represent an example of what a real elevator UI might contain.

Figure 28. Home screen with date, time, temperature, and weather information

On the right half of the screen is a classic elevator panel; not too dissimilar from what you might see in a physical elevator. There are six floor buttons, a hold-open and hold-close button, an alarm, and a status message which indicates the current floor number.
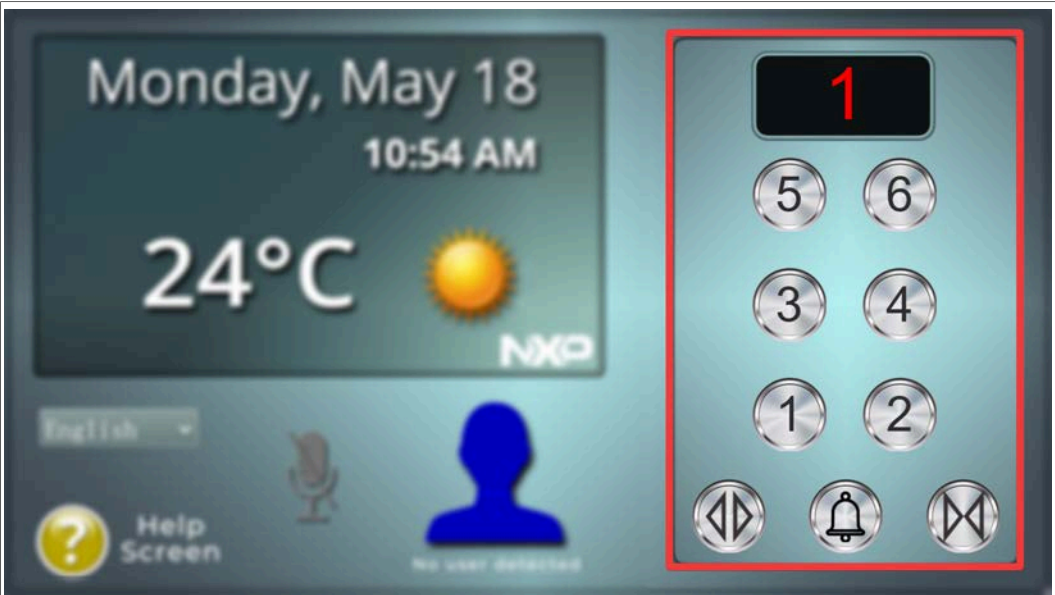
Figure 29. Elevator panel

Finally, the last section in the bottom-left contains two icons showing that NXP voice and vision are active on the board. The section also has a recognition status icon that can take three different colors corresponding to the status of the facial recognition.

MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

30 / 51
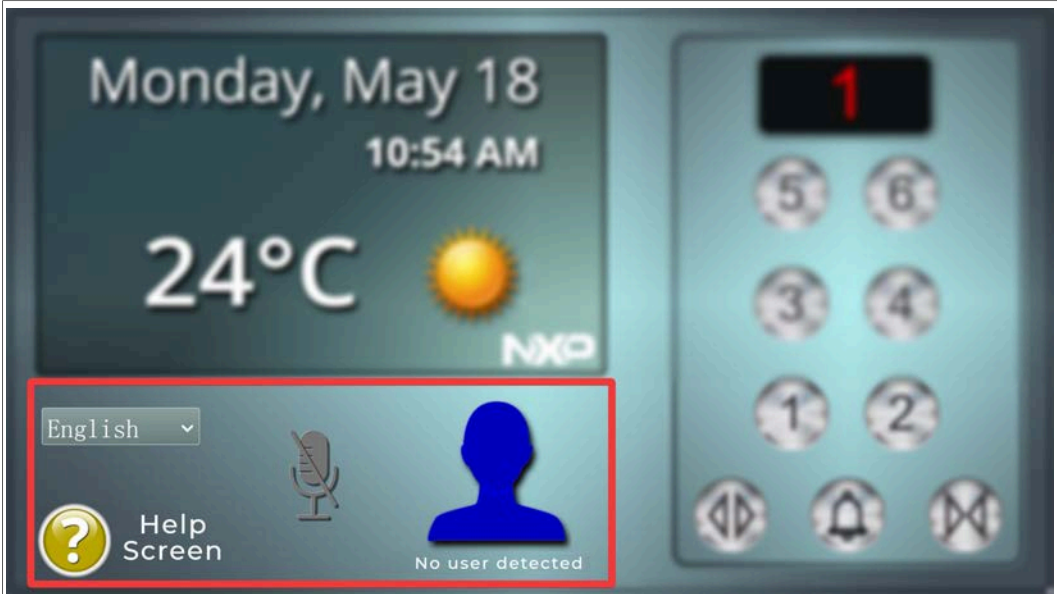
Figure 30. Voice, face, and recognition status icons

5.3.2.1 Recognition status icon

By default, the recognition status icon is blue. The blue color indicates a default state, which means no face is detected yet.
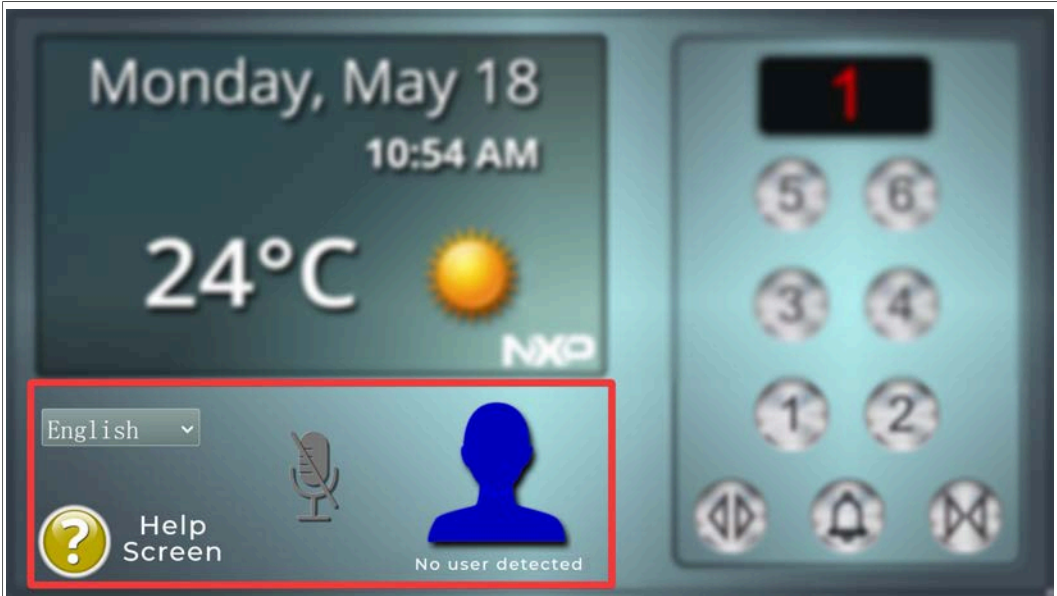
Figure 31. No user detected

The icon turns red when a face is detected but is not registered. This state indicates that the following floor can be associated with the face detected by saving a new user profile.
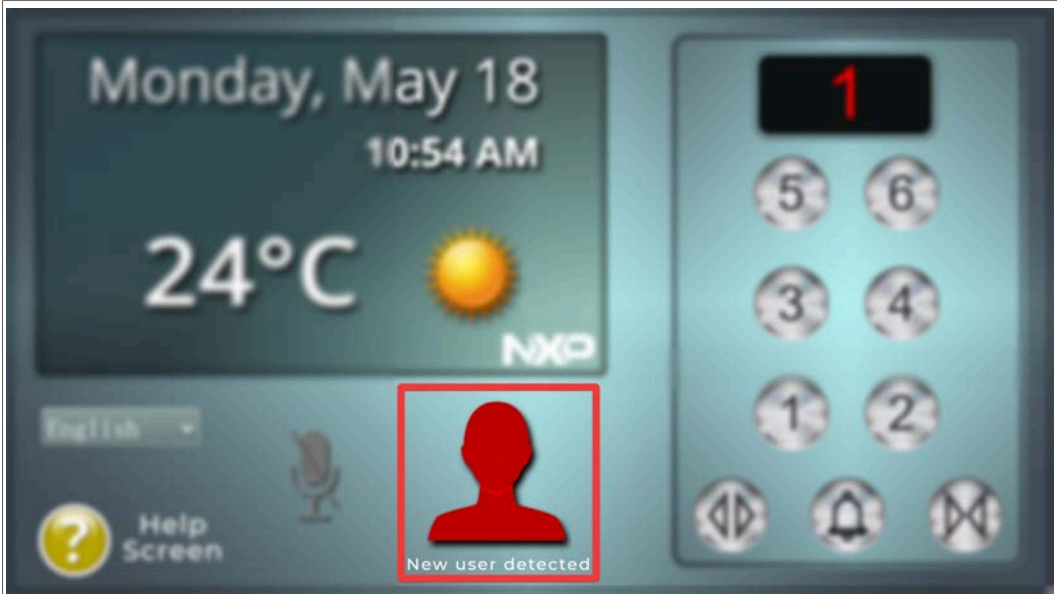
MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

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31 / 51

Figure 32. New user detected

The icon turns green when a face is recognized and already has a floor number associated with it.
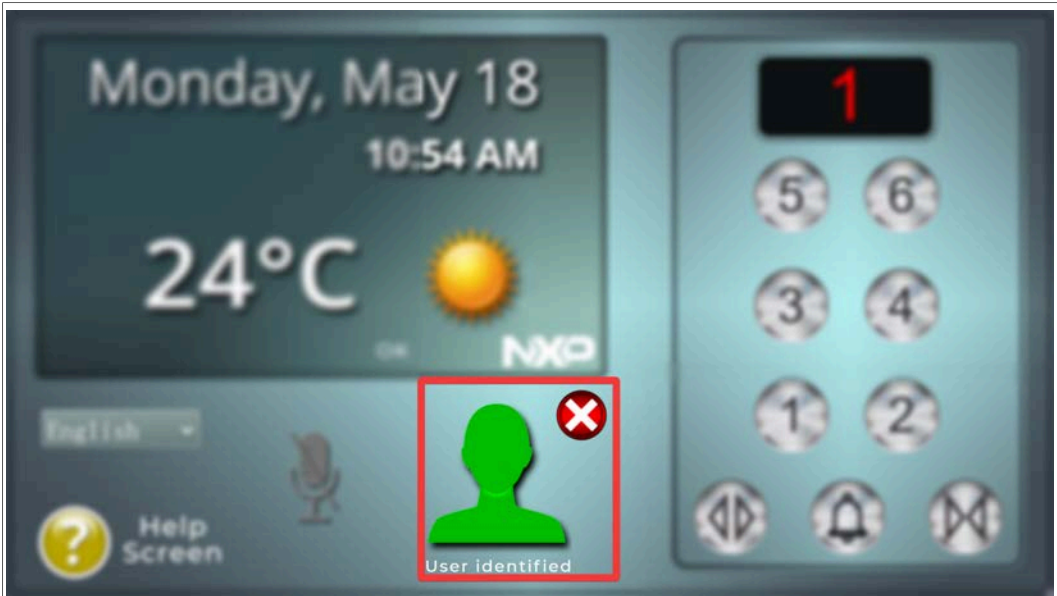
Figure 33. User identified

5.3.2.2 Selecting a floor

The application has six default floors that can be chosen with either voice or touch, simulating a real elevator which can travel to different floors.

Touch controls simply require pressing the floor number associated with the floor you desire to travel to.

MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

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32 / 51

To use voice commands instead, speak the name of the floor you desire to travel to. For example, "Second floor" updates the floor number to two. The help screen provides a list of available commands.

Before a command can be recognized, the voice recognition engine must be "awoken" to do so. A green microphone icon indicates that voice command recognition is activated.
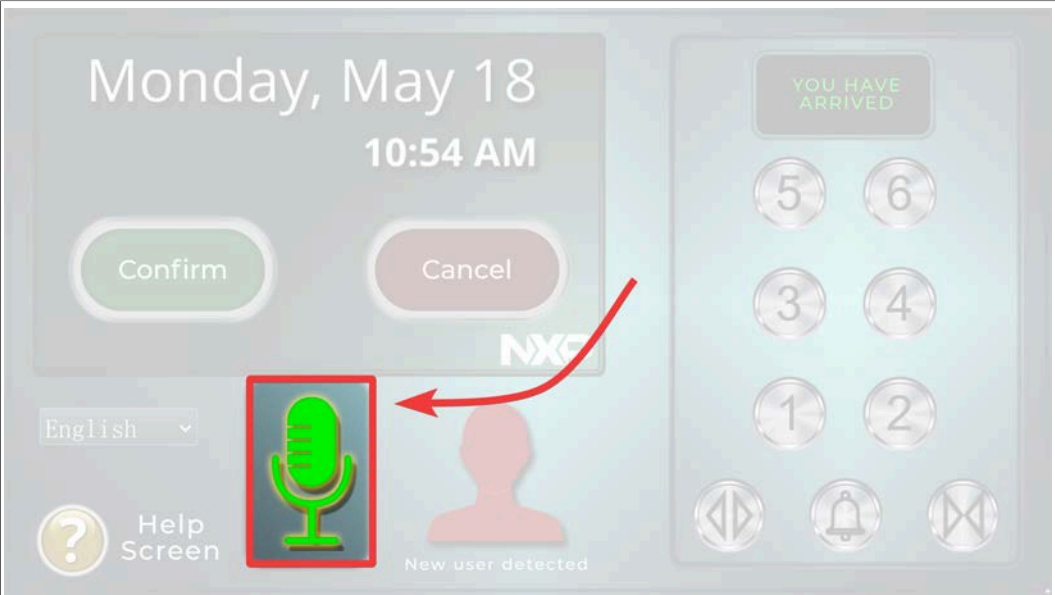
Figure 34. Voice recognition engine

If the microphone icon is grey, use the "Hey NXP" wake word, or wake word associated with your preferred language to enable voice command recognition. A confirmation tone and a green light confirm when a command is heard.

While in transit, the button associated with the floor you selected is highlighted in yellow. The application then simulates going to a floor by playing sounds for each intermediate floor and updating the floor number which is displayed.
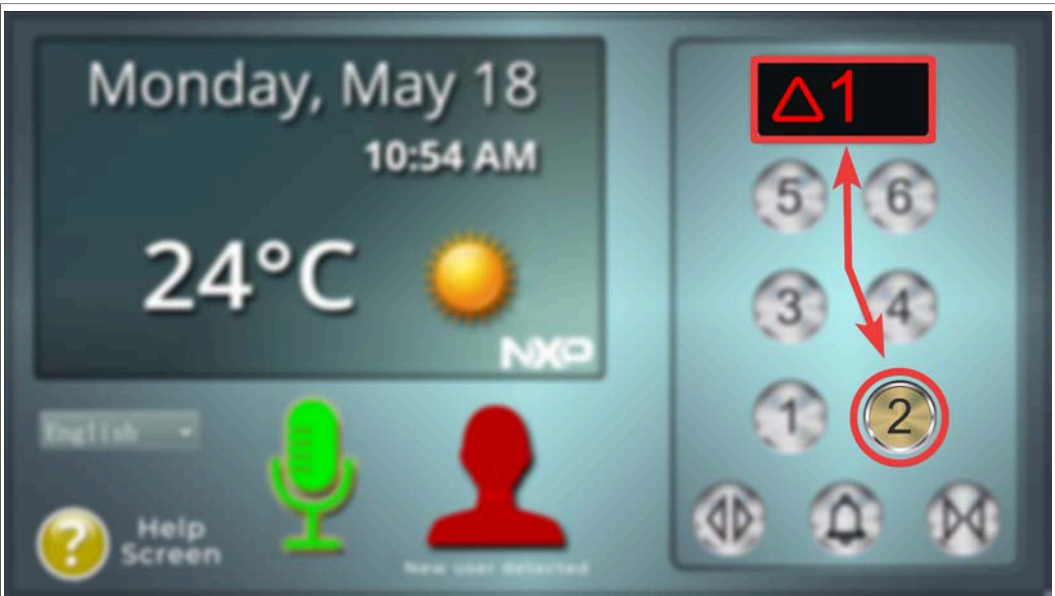
Figure 35. Selecting a floor

Note: *Only one floor can be selected at a time.*

Once the selected floor has been reached, you may select a new floor to travel to. Additionally, after a ~15 second wait time of no activity (voice commands recognized, touch screen events, etc.), the demo effectively restarts, and the elevator floor number is reset back to one. Voice recognition is disabled until the wake word is spoken again, and the face recognition process begins looking for a face again.

Here, if your floor selection was saved on the previous iteration, your face can now be recognized.

Once the selected floor is reached, the screen displays "You Have Arrived" in green color.
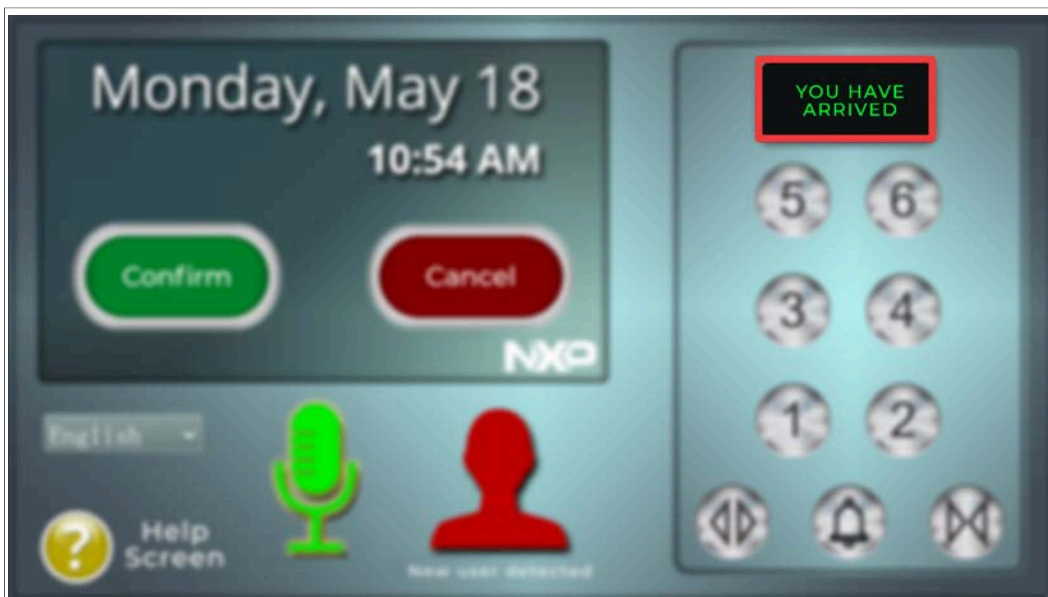
Figure 36. Screen displaying "You Have Arrived"

The kit then reenables the standby screen waiting once again for user interaction to reawaken the kit.

5.3.2.3 Saving floor selection

Users can associate their preferred floor and language settings with their face for the application to reuse their preferences when the camera next recognizes them.

If the recognition status icon is colored red[5] and a floor is selected, the application plays a brief animation which simulates the elevator being in transit as described in the previous section. Afterwards, an onscreen prompt accompanied by some audio asks if you would like to save the floor selection.

---

5 The red color indicates that an unknown face has been detected.

MCU-SMHMI-UG

User guide

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Rev. 0 — 29 September 2022

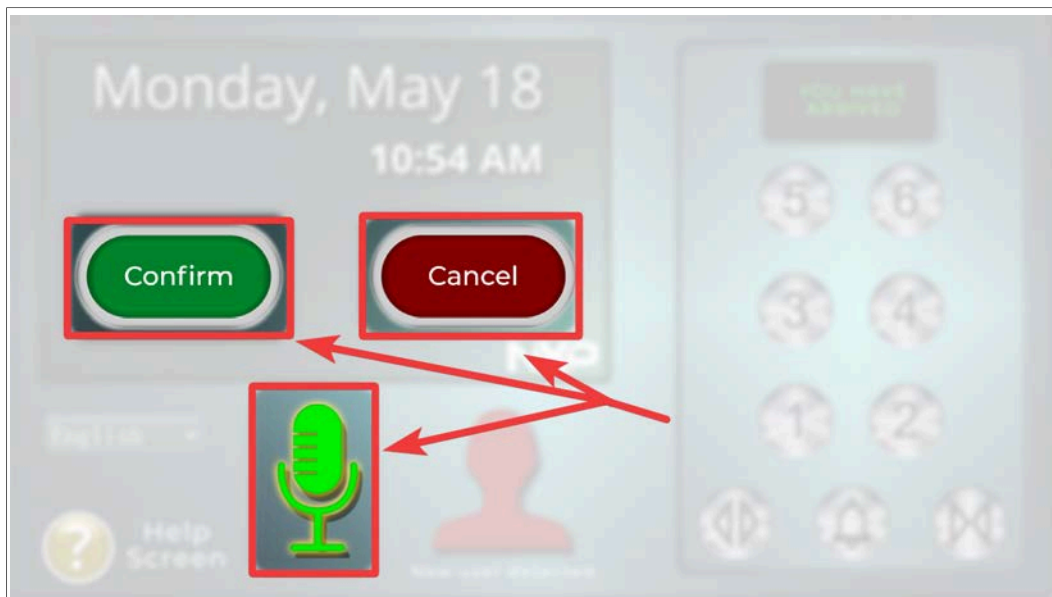© 2022 NXP B.V. All rights reserved.

34 / 51

Figure 37. Confirm or cancel prompt

Notice that when a prompt check is enabled, the microphone icon changes to green indicating voice command recognition is enabled (without the need to first say the wake word).

Saying "Confirm" associates the face recognized with the chosen elevator floor so that it can be used in the future to help more quickly select the proper floor number.

Saying "Cancel" does not associate the detected face with the selected floor number and deletes any record of the face.

After responding to the prompt with either "Confirm" or "Cancel," a new floor can be selected. Or, after a 15 seconds timeout with no activity detected, the demo resets the floor number back to a default state and once again allow recognizing saved faces and saving new faces.

Note: *Currently the only way to associate a different floor with an existing user is to delete that user and save them as a new user.*

5.3.2.4 Automatic floor selection

If a user is recognized and the elevator is on a floor different from the user's saved floor, an onscreen prompt is displayed. An audio clip accompanies this prompt asking the user if they would like to travel to their preferred floor.

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User guide

Rev. 0 — 29 September 2022

35 / 51

Figure 38. Confirm or cancel floor selection prompt

Notice that when a prompt check is enabled, the microphone icon changes to green indicating voice command recognition is enabled (without the need to first say the wake word).

Saying "Confirm" (or the equivalent for your configured language) automatically takes you to your saved floor.

Saying "Cancel" (or the equivalent for your configured language) allows you to choose a different floor from the one currently associated with your face.

If the elevator is already on the user's preferred floor, the elevator demo asks the user which floor they would like to go to instead.

5.3.2.5 Deleting a saved face

If the application recognizes a face, the user may delete it using either a voice command or onscreen touch control. This process permanently deletes the face and the floor number associated with it.

To deregister a face, use the "**Delete User**" or equivalent voice command in your configured language. Alternatively, press the red **X** in the top-right corner of the screen. Once the application recognizes the **Delete User** command or the user presses the **X** icon, it permanently removes the currently recognized face and the associated floor number from the local database.
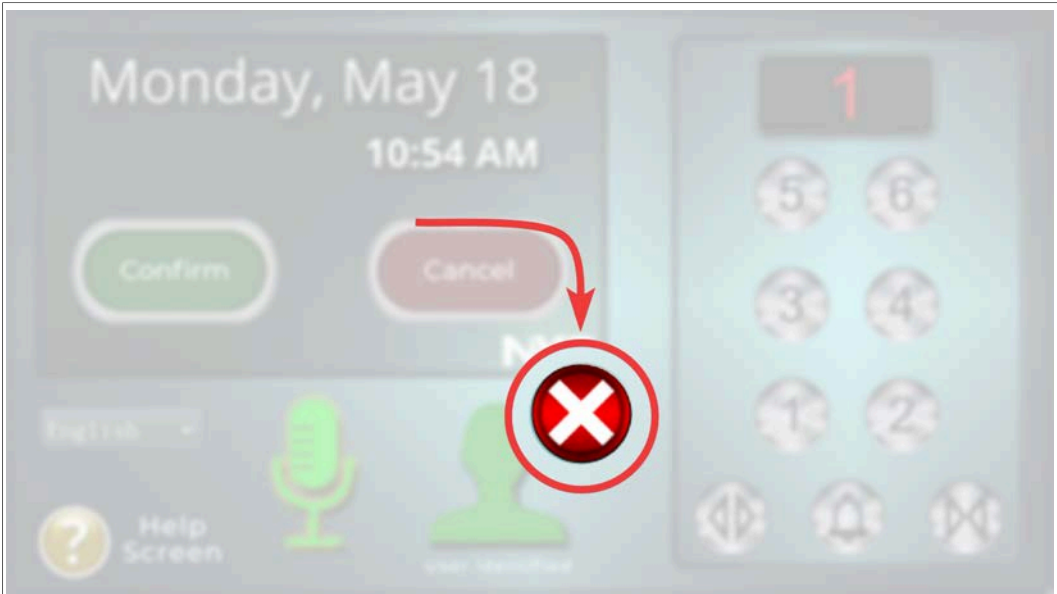
Figure 39. Deleting a saved face

Note: *If a face is deleted, saving a new face requires power cycling the board, or waiting ~15 second for the demo to time out and reset the application back to a default state.*

5.3.2.6 Face recognition debugging information

To activate debugging information that can help with debugging issues recognizing your face, tap the face icon next to the NXP logo icon 3 times.

Figure 40. Enabling debugging messages

After tapping the icon three times, debugging messages appear to the left of the NXP logo.

MCU-SMHMI-UG

User guide **Rev. 0 — 29 September 2022**

37 / 51
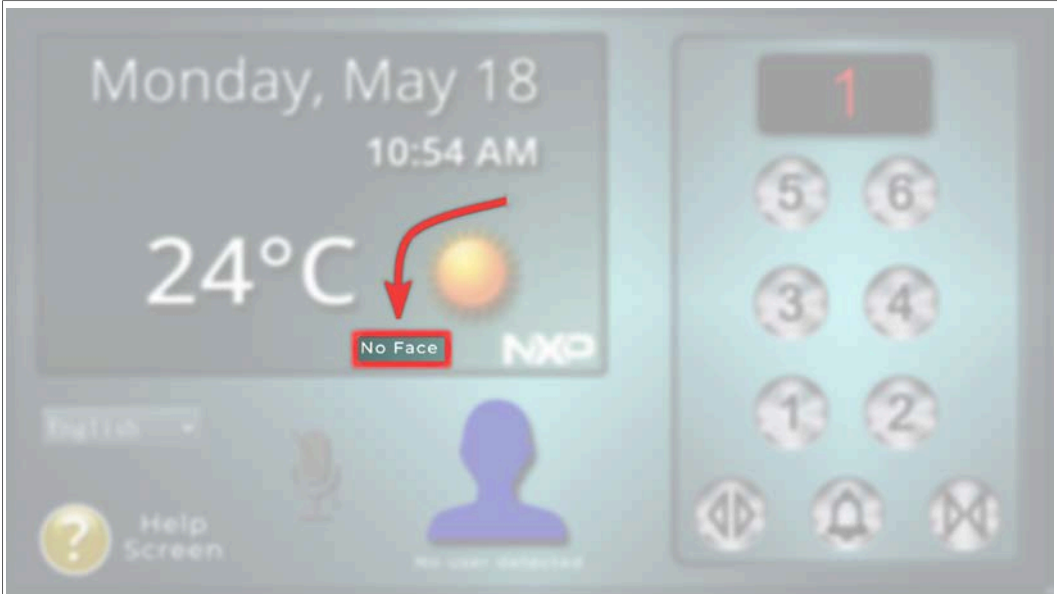
Figure 41. Debugging messages

For more information on debugging messages and their meaning, see the <u>Section 6.1.2</u> section.

5.3.3 Help screen

The help screen is a useful reference tool to retrieve a list of the available voice commands.

To enable the help screen, simply press the **Help Screen** button in the lower left-hand corner of the home screen.
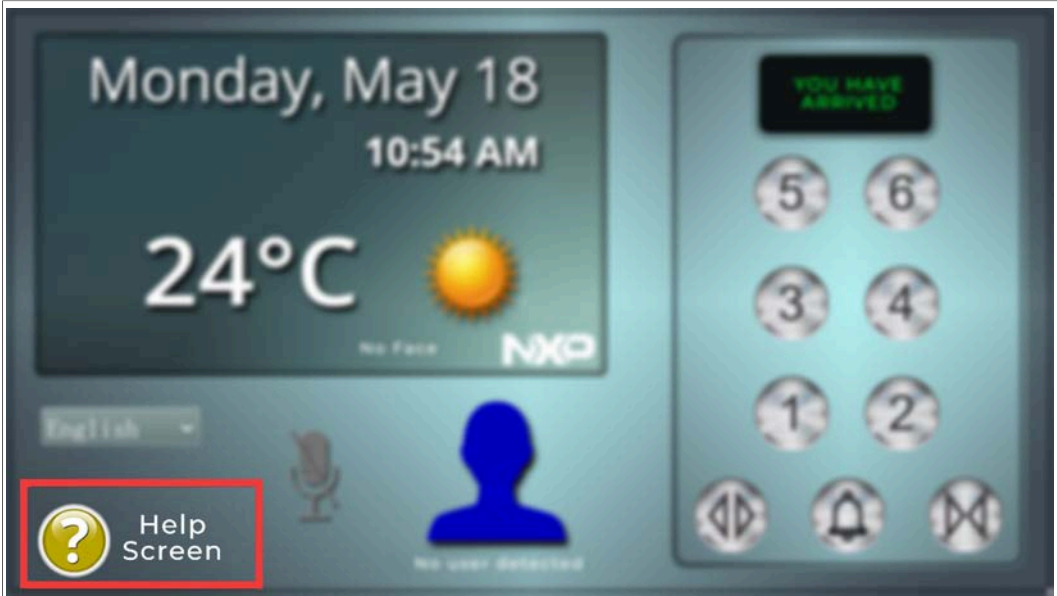
Figure 42. Enable help screen

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User guide

Rev. 0 — 29 September 2022

38 / 51

Once enabled, the help screen shows a list of the available commands for the currently selected language, as well as a reminder to use the "Hey NXP" wake-up command to enable recognition of voice commands.
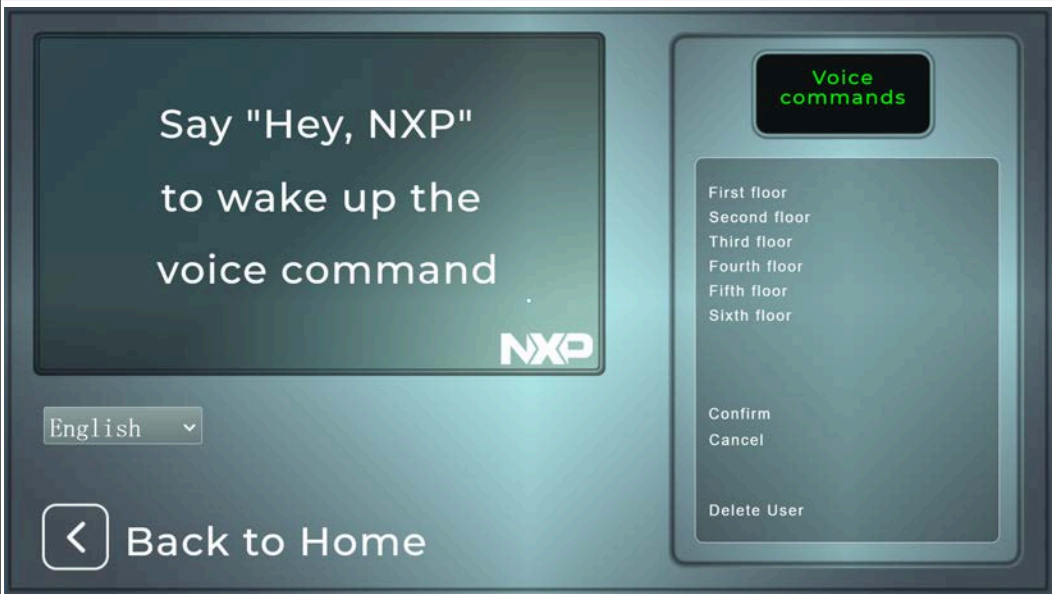
Figure 43. Help screen

To return to the home screen, simply press the **Back to Home** button in the bottom left-hand corner of the help screen.

5.3.4 Voice commands

The elevator application supports over a dozen commands in four languages to enable a hands-free demo experience.

The system language used for both the UI and voice commands can be configured in several different ways:

- In Standby mode, the default Cyberon Automatic Speech Recognition (ASR) engine listens for one of four different wake words to determine which language to use. For example, waking the board using "Hey NXP" configures the system language to English, while "Salut NXP" configures the system language to French.
- On the home screen, the system language can be configured using the onscreen language selector drop-down menu.

The following sections provide a list of each of the support commands in each of the available languages.

Note: As discussed in the Voice Library Limitations section, the default out-of-box software uses the Voice Seeker AFE and Cyberon ASR libraries as evaluation versions. As a result, the AFE and ASR cease to function after 25 hours and 100 voice commands, respectively. To reset the ASR and the AFE, power cycle the board.

5.3.4.1 English

Table 7. Voice commands in English

Voice Commands	Description
"Hey NXP"	**Wake word** for the board

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User guide

Rev. 0 — 29 September 2022

39 / 51

Table 7. Voice commands in English...*continued*

Voice Commands	Description
"Main Lobby"	Sets elevator current floor to the main lobby (floor one)
"Floor one"	Sets elevator current floor to floor one
"Floor two"	Sets elevator current floor to floor two
"Floor three"	Sets elevator current floor to floor three
"Floor four"	Sets elevator current floor to floor four
"Floor five"	Sets elevator current floor to floor five
"Floor six"	Sets elevator current floor to floor six
"Confirm"	1 of 2 responses used for answering prompts
"Cancel"	1 of 2 responses used for answering prompts
"Delete User"	Removes floor selection from associated face and deletes face from database; available only while green face icon and red **X** are present

5.3.4.2 French

Table 8. Voice commands in French

Voice Commands	Description
"Salut NXP"	**Wake word** for the board
"Entrée Principale"	Sets elevator current floor to the main lobby (floor one)
"Premier Etage"	Sets elevator current floor to floor one
"Deuxième Etage"	Sets elevator current floor to floor two
"Troisième Etage"	Sets elevator current floor to floor three
"Quatrième Etage"	Sets elevator current floor to floor four
"Cinquième Etage"	Sets elevator current floor to floor five
"Sixième Etage"	Sets elevator current floor to floor six
"Confirmer"	1 of 2 responses used for answering prompts
"Annuler"	1 of 2 responses used for answering prompts
"Supprimer préférence"	Removes floor selection from associated face and deletes face from database; available only while green face icon and red **X** are present

5.3.4.3 German

Table 9. Voice commands in German

Voice Commands	Description
"Hallo NXP"	**Wake word** for the board
"Hauptlobby"	Sets elevator current floor to the main lobby (floor one)
"Etage eins"	Sets elevator current floor to floor one

MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

40 / 51

Table 9. Voice commands in German...*continued*

Voice Commands	Description
"Etage zwei"	Sets elevator current floor to floor two
"Etage drei"	Sets elevator current floor to floor three
"Etage vier"	Sets elevator current floor to floor four
"Etage fünf"	Sets elevator current floor to floor five
"Etage sechs"	Sets elevator current floor to floor six
"Bestätigen"	1 of 2 responses used for answering prompts
"Abbrechen"	1 of 2 responses used for answering prompts
"Abmelden"	Removes floor selection from associated face and deletes face from database; available only while green face icon and red **X** are present

5.3.4.4 Chinese

Table 10. Voice commands in Chinese

Voice Commands	Description
″你好恩智浦″	**Wake word** for the board
″大堂″	Sets elevator current floor to the main lobby (floor one)
″一楼″	Sets elevator current floor to floor one
″二楼″	Sets elevator current floor to floor two
″三楼″	Sets elevator current floor to floor three
″四楼″	Sets elevator current floor to floor four
″五楼″	Sets elevator current floor to floor five
″六楼″	Sets elevator current floor to floor six
″确定″	1 of 2 responses used for answering prompts
″取消″	1 of 2 responses used for answering prompts
″取消注册″	Removes floor selection from associated face and deletes face from database; available only while green face icon and red **X** are present

5.3.5 Shell commands

The elevator out-of-box FW provides additional configuration options via a shell interface hosted over a USB virtual COM connection.

To connect to the shell interface, use a Serial Terminal Emulator program like PuTTY, Tera Term, or Minicom and configure the serial connection settings as shown below. Make sure to use the COM port corresponding to your kit:

- Speed: 115200
- Data: 8 bit
- Parity: none
- Stop bits: 1 bit
- Flow control: none

The shell commands for the coffee machine application are listed below:

- `help`
  Lists all the registered commands
- `version oasis`
  Gets the version of the current oasis library
- `version`
  Gets the version of the current software
- `info`
  Gets the system information
- `reset`
  Resets the board
- `del -n <username>`
  Deletes a user by user name
- `del -i <id>`
  Deletes a user by id
- `del -a`
  Deletes all the users
- `list`
  Prints a list of all users currently saved in the face database
- `list -c`
  Prints the number of users currently saved in the face database
- `volume <value>`
  Volume of the speaker. Value should be between 0 (muted) and 100 (max)
- `language`
  Prints the currently configured system language
- `serial_number`
  Prints the device serial number

6 Troubleshooting

6.1 Unable to save a face

This section describes the steps that can be taken to help debug potential points of failure when attempting to perform face registration and recognition. If the issue still persists, head over to the section of the NXP forum dedicated to the SLN-TLHMI-IOT kit to reach out for additional assistance.

6.1.1 Adjust face proximity and position

Because face recognition uses *face identifiers* to determine the face being looked at, it is important that the cameras can see these identifiers. Often, an improper face angle and/or the proximity to the camera can cause registration to fail. Shown below are a few examples of improper usage.
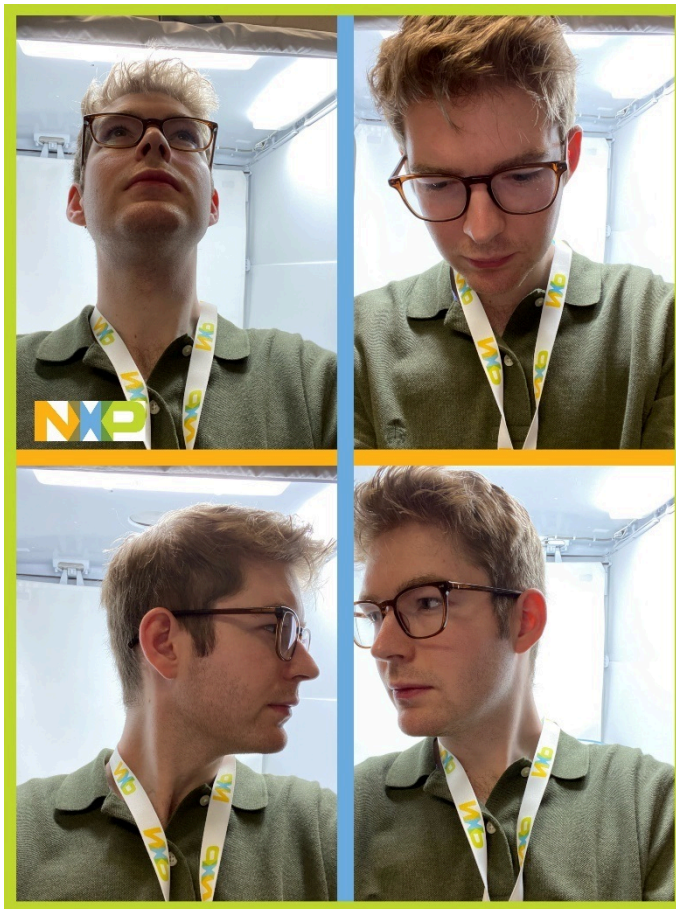
Figure 44. Adjusting face

To detect your face correctly, the face must:

- Take up most of the bounding box
- Be centered inside the bounding box
- Stare straight at the camera
- Move slowly from left to right and up to down to ensure the proper face angle, as shown in Figure 44
- Be under proper lighting conditions, as shown in Figure 45

MCU-SMHMI-UG
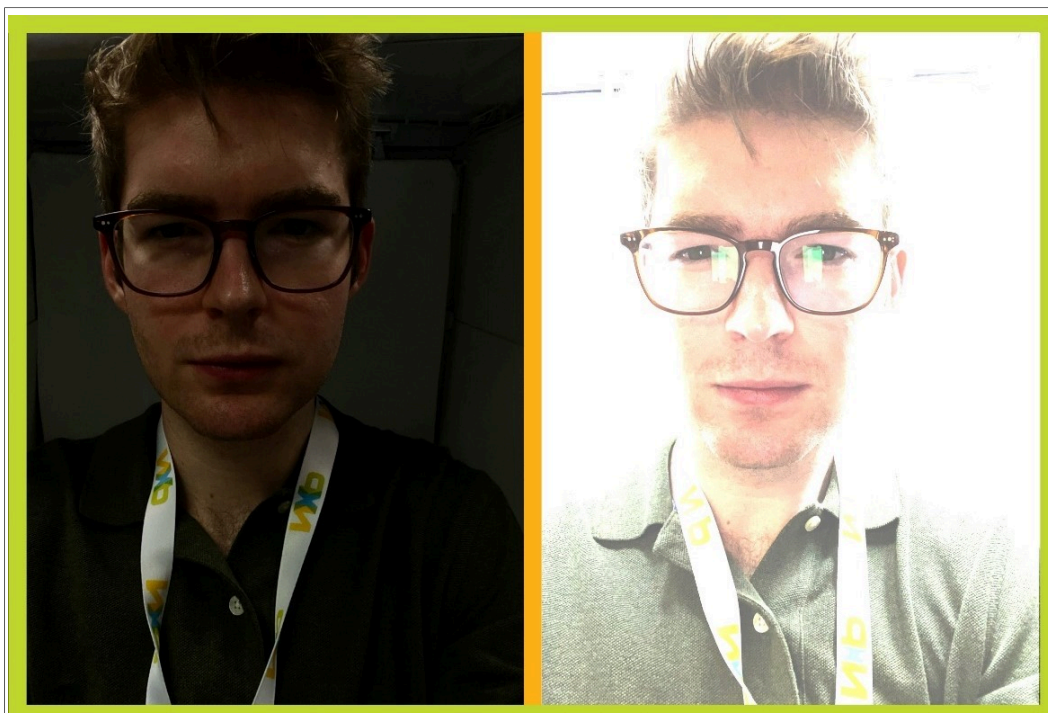
User guide

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Rev. 0 — 29 September 2022

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43 / 51

Figure 45. Different lighting conditions affecting proper face detection

6.1.2 Face recognition debugging information

Both the coffee machine and elevator demos provide onscreen debugging information to help diagnose issues recognizing a face.

Enabling the face recognition debugging information differs slightly between different applications. In both the coffee machine and elevator demos, simply click the onscreen face icon 3 times.
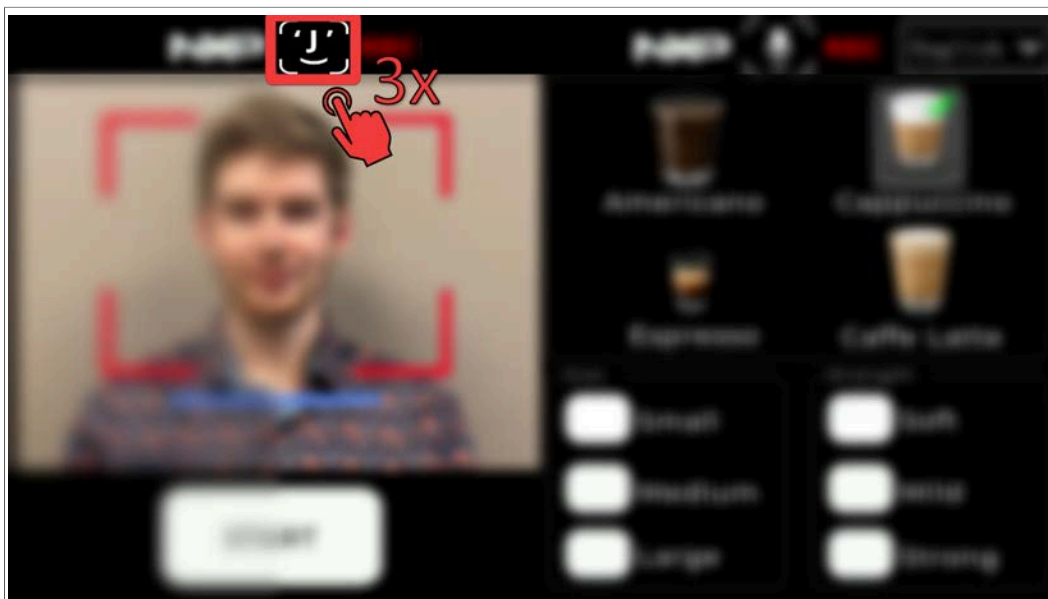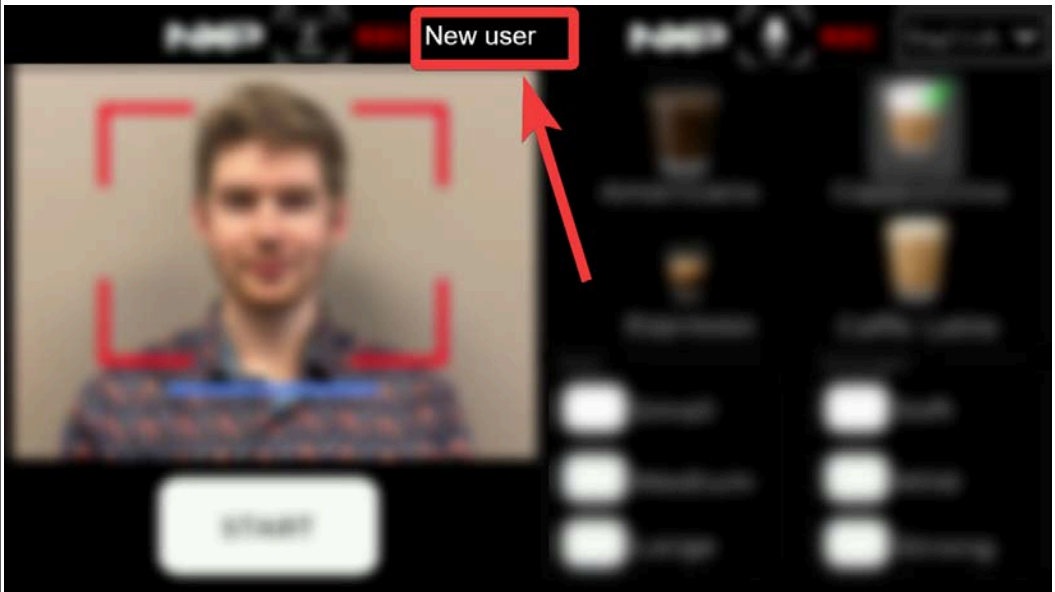
Figure 46. Face recognition debugging information in coffee machine
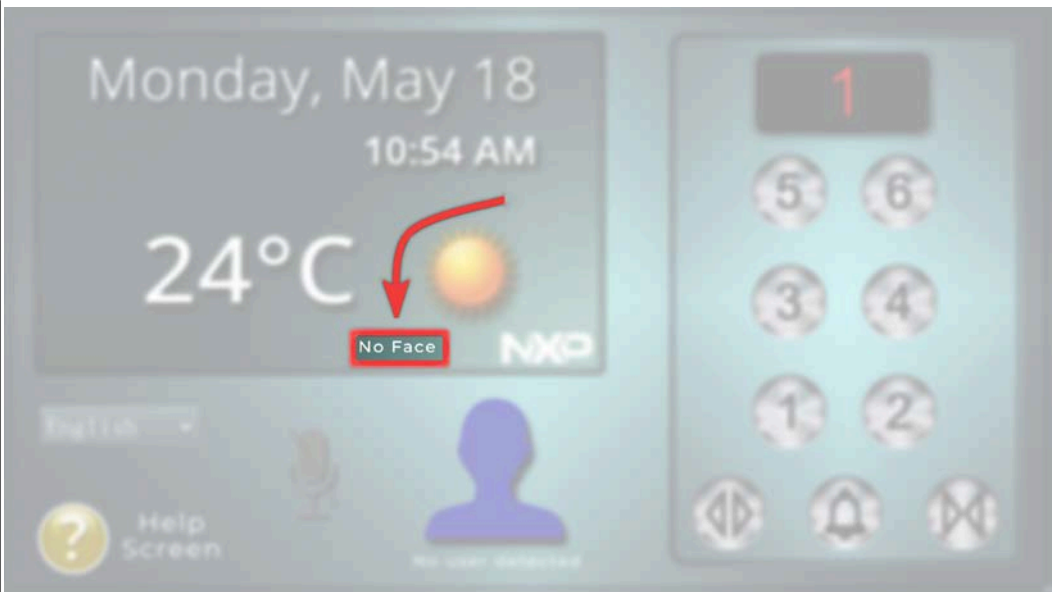
Figure 47. Face recognition debugging information in elevator

Enabling debugging info prints debugging information above the camera preview in the coffee machine demo as shown in Figure 46. Figure 47 shows debugging information printed to the left of the NXP logo in the elevator demo.

To disable the onscreen debugging messages, follow the same procedure used to enable the messages in the first place.

The Table 11 shows each of the possible debugging messages, their meaning, and potential resolution to the problem they describe (if they are describing a problem to be fixed at all).

Table 11. Debugging messages

Message	Meaning	Solution
OK	A face is detected	N/A
Small	Face is too far away	Come closer to camera
Light	Face is too bright	Adjust environment brightness
Dark	Face is too dark	Adjust environment brightness
Blurry	Face is out of focus	Hold still when looking at camera
Side	Face is improperly angled	Look directly at the camera
No Face	No face is detected	N/A
New User	New user is detected	N/A
User_XX	Internal identifier for recognized face	N/A

6.2 Voice commands

This section describes the steps that can be taken to help debug potential points of failure when attempting to perform audio recognition. If the issue still persists head over

to the section of the NXP forum dedicated to the SLN-TLHMI-IOT kit to reach out for additional assistance.

Note: *As discussed in the* Voice Library Limitations *section, the default out-of-box software uses the Voice Seeker AFE and Cyberon ASR libraries as evaluation versions. As a result, the AFE and ASR cease to function after 25 hours and 100 voice commands, respectively. To reset the ASR and the AFE, power cycle the board.*

6.2.1 Speaking clearly

The audio recognition algorithm utilizes phenones to break up the data captured from the mics. This algorithm also compares the data to the saved commands to see if a valid phrase is given. Speaking too fast, slurring the syllables together, or speaking too softly can cause the audio recognition to fail. To help ensure that your command is heard, speak clearly.

There are also occasional problems with recognizing commands given in a strong accent. To account for these issues, see the *Smart HMI Software Development User Guide* for good practices in adding commands.

7   References

Table 12 lists the references.

Table 12. References

Links	Description
MCUXpresso IDE for NXP MCUs | Linux, Windows and iOS | NXP Semiconductors	MCUXpresso IDE Download
MCUXpresso IDE User Guide (nxp.com)	MCUXpresso IDE User Guide
https://www.nxp.com/mcu-smhmi	MCU-SMHMI-SDUG Smart HMI Software Development User Guide
http://www.nxp.com/mcu-smhmi	MCU-SMHMI Home Page
https://github.com/NXP/mcu_smhmi/	MCU-SMHMI GitHub

8   Acronyms

Table 13 lists the acronyms used in this document.

Table 13. Acronyms

Acronym	Definition
TFT	Thin Film Transistor
MIPI	Mobile Industry Processor Interface
HAL	Hardware Abstraction Layer
OoBE	Out of Box Experience
MSD	Mass Storage Device

9   Revision history

Table 14 lists the substantive changes done to this document since the initial release.

Table 14. Revision history

Revision number	Date	Substantive Changes
0	29 September 2022	Initial release

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MCU-SMHMI-UG

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User guide

Rev. 0 — 29 September 2022

50 / 51

Contents

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