RX72N Group

Voice recognition / speech and LCD solution using RX72N Envision kit

Introduction

RX72N Envision Kit is equipped with LCD, Capacitive Touch Interface, Voice Interface and Various communications, and is the best kit for HMI, IoT development of RX72N. This Application note shows HMI solution which is realized Voice recognition / speech and LCD with Touch function by using RX72N.

This Application Note has executable files of trial version that you can download and experience in Kit. The trial version has a specification limit that accepts voice commands only for 5 minutes after switching screens. If that time has passed, please switch to the other screen.

If you would like to obtain the sample source code, please contact Renesas dealer or Renesas sales representative.

The demo software described in this Application note is configured using the following libraries.

- Voice recognition: Voice recognition middle ware “AmiVoice®”, hereinafter referred to as “AmiVoice®”.
- Noise reduction: “Zoom Voice Software”, hereinafter referred to as “Zoom Voice”.
- LCD : GUI library and tool provided by SEGGER “emWin”, hereinafter referred to as “emWin”.
- Audio output: Renesas ADPCM compression / decompression library “M3S-S2-Tiny”, hereinafter referred to as “M3S-S2-Tiny”.
- OS: Amazon FreeRTOS (v10.0.4), hereinafter referred to as “FreeRTOS”.

AmiVoice® is a product of Advanced Media, Inc. and is a registered trademark in Japan or other countries.

Zoom Voice is a product of Techno Mathematical Co., Ltd..

Development using AmiVoice® and Zoom Voice requires contract separately with each developer.

Target Device

RX72N Group (RX72N Envision Kit)

There is a remote development environment that can be evaluated online even without Envision Kit board.

Renesas Lab on the cloud ： https://www.renesas.com/labonthecloud

Release of this solution on the “Lab on the Cloud” is scheduled for 2021.

Contents

1. Overview of the System

1.1 System Overview Diagram

Figure 1-1 shows System Overview Diagram.
The microphone for voice recognition uses the microphone installed in the RX72N Envision Kit. Speakers for speech need to be prepared separately. You can also control Voice recognition parameters by connecting to a PC via USB and sending commands from the PC, similar to test environment of the Lab on the cloud.

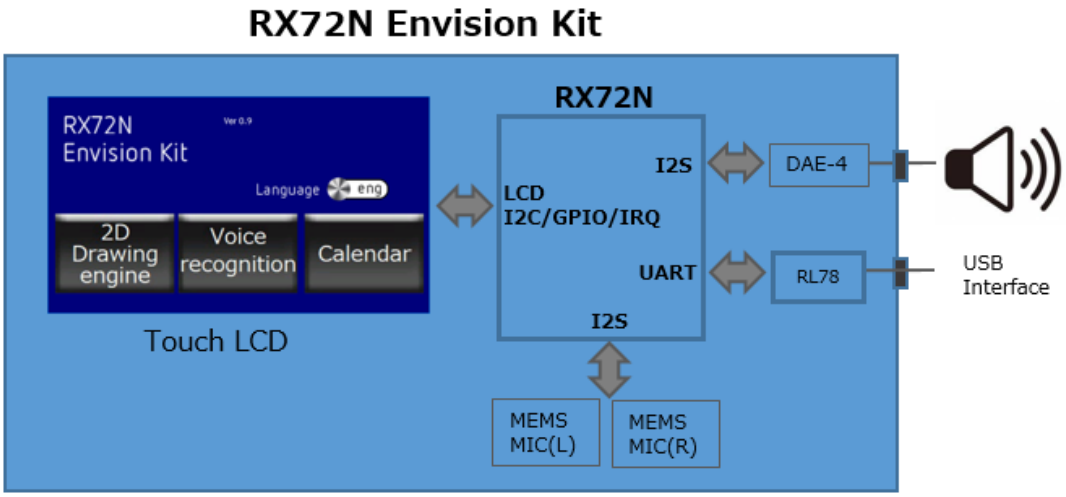

Figure 1-1. System Overview Diagram

1.2 Demo Overview

There are 3 types Demo in this software.

- 2D Drawing Engine Demo
  You can confirm the performance of the "2D drawing engine" installed in the RX72N. You can do it the difference in processing speed between using and not using the "2D drawing engine" function and the CPU resource usage rate digitally.
- Voice Recognition Demo
  You can confirm the reaction speed, voice recognition accuracy, and noise reduction effect of voice recognition. The LCD can be switched by voice command. The LCD panel also displays AmiVoice®, Zoom Voice parameters and CPU resource usage.
- Calendar demo
  You can check the response speed in voice recognition using the Calendar display sample, which is one of the variations.
-

The language supports Japanese and English.
The demo selection works with both voice recognition and touch function on the LCD.

2. Preparation for operation

2.1 Download Executing File

At first, use Renesas Flash Programmer to download " rx72n_voice_demo.mot" attached to this Application Note to RX72N Envision Kit. Obtain the Renesas Flash Programmer from the following.

https://www.renesas.com/software-tool/renesas-flash-programmer-programming-gui

The connection at the time of download is as follows.

Figure 2-1. The connection at the time of download

When writing an executable file, set SW1 to 1ch: OFF and 2ch: OFF.

Connect the USB connector to your PC with a USB cable. Once connected, the USB connector will power the RX72N Envision Kit. Then starting the Renesas Flash Programmer.

Download “rx72n_voice_demo.mot” to the RX72N via Renesas Flash Programmer.

After downloading, close the Renesas Flash Programmer and disconnect the USB cable.

After that, change the SW1 setting to 1ch: OFF, 2ch: ON.

For SW3, set 1ch: OFF and 2ch: OFF.

2.2 Starting the demo

Figure 2-2 shows the connection when the demo is started.

Connect your speakers to the Audio Jack.

When you connect either the USB connector or the Power Supply Jack to power it, the initial demo screen will appear on the LCD. Keep the LCD panel upside when the demo is running.

The Zoom Voice used in the demo software emphasizes and collects the sound from the target direction while suppressing ambient noise. The RX72N Envision Kit is designed to emphasize the sound from the MIC Left direction to the MIC Right direction.

Talk in the direction of the arrow in Figure 2-2.

In addition, USB I/F is prepared as a function of option. See 6.Communication Protocol for details.

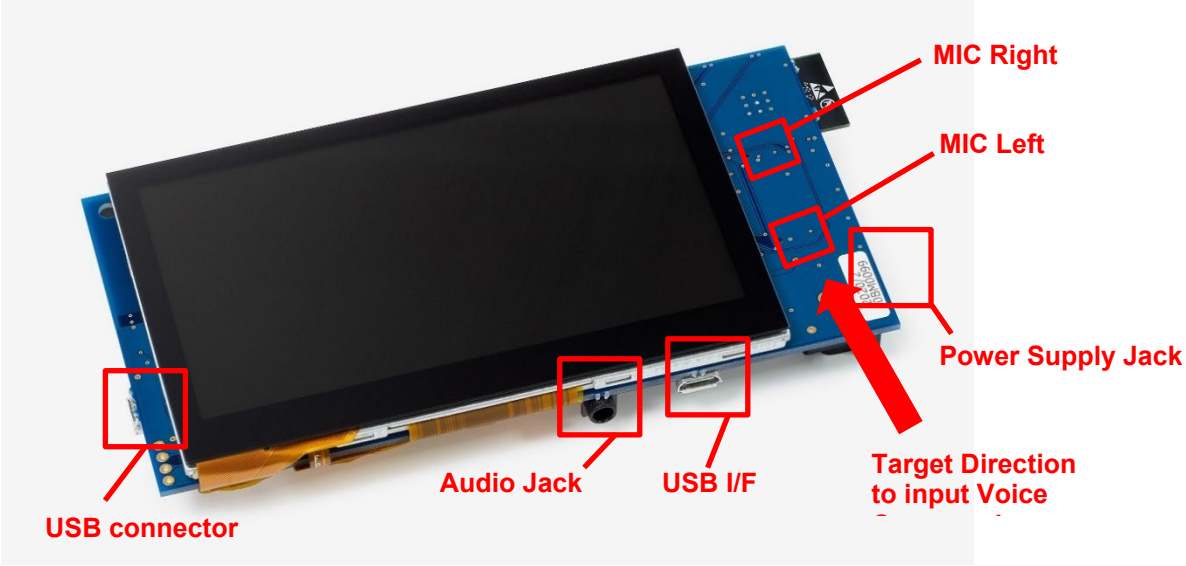

Figure 2-2. When the demo starts

3. Operation method

3.1 Main Menu

When the power is turned on, the main menu screen is displayed. On the main menu screen, you can select 3 types of demos and select the language (English, Japanese). Figure 3-1 shows the menu screen, and Table 3.2 shows the voice commands that can be accepted in the main menu.

The demo can be selected by voice command or LCD touch. Select the language with the slide switch on the LCD. The language selected here will be the valid language for each demo. Languages cannot be switched in each demo.

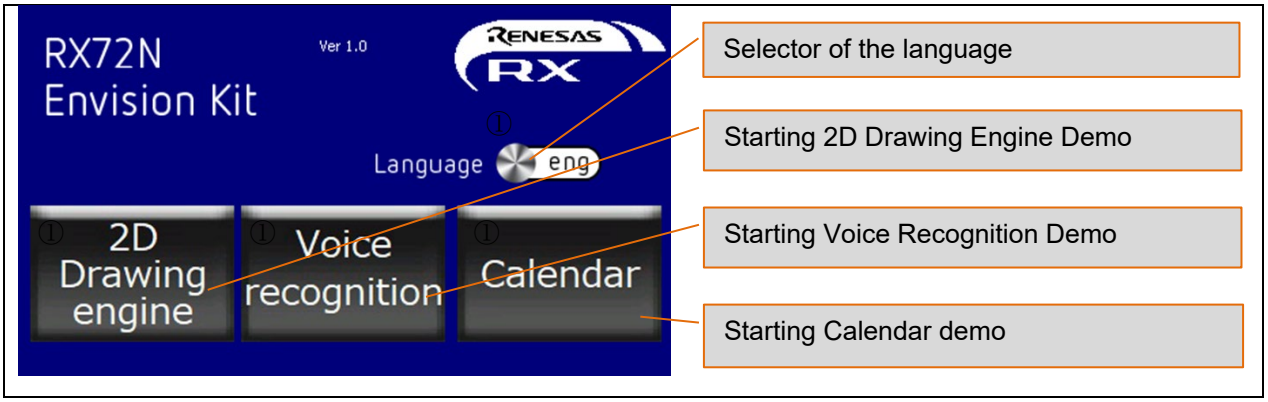

Figure 3-1. Menu screen

Table 3.1 Acceptable voice commands

Operation	Voice commands (English)	Voice commands (Japanese)
Starting 2D Drawing Engine Demo	2D Drawing engine	つーでぃーえんじん。
Starting Voice Recognition Demo	Voice recognition	おんせいにんしき。
Starting Calendar demo	Calendar	かれんだー。

3.2 2D Drawing Engine Demo

In the 2D drawing engine demo, you can see the improvement for display speed and the reduction in CPU load when using the 2D drawing engine (DRW2D) installed in RX72N. DRW2D can be turned ON / OFF with the slide switch on the LCD screen. Also, by touching the RX mark on the screen to move it, you can put more load on the processing.

Figure 3-2 shows a demo screen of the 2D Drawing engine. The numbers in the upper right corner of the screen shows the CPU resource usage (%) due to the main functions.

- Voice: CPU resource usage rate for voice recognition processing
- LCD: CPU resource usage rate of LCD processing
- IDLE: CPU resource usage rate of IDLE task (indicates the state where CPU is not used)

There are no voice commands that can be accepted in this demo.

Touch LCD Home to return to the main menu.

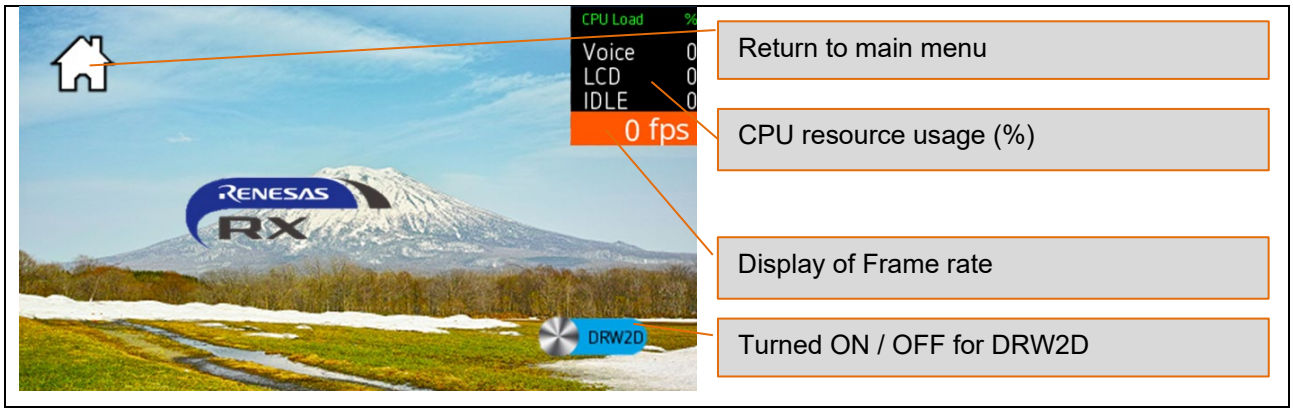

Figure 3-2. Demo screen of the 2D Drawing engine

3.3 Voice Recognition Demo

In the voice recognition demo, can executing AmiVoice®, Zoom Voice for high-speed and high-precision voice recognition, emWin for LCD switching, and utterance response of RX72N Envision Kit. You can select with or without utterance response with the slide switch (Audio playback) on the LCD screen. The numbers in the upper right corner of the screen shows the AmiVoice® and Zoom Voice setting parameters.

Symbol	Name of parameter	Meaning	Setting range	Initial value
BF	Beam Forming level	Beamforming reduction amount of Zoom Voice	1~7*1	3
NS	Noise Suppressor level	Noise suppressor reduction amount of Zoom Voice	1~7*2	4
CF	AmiVoice® Confidence	Voice Recognition threshold of AmiVoice®	0~255*3	100
TH	AmiVoice® Threshold	Confidence threshold of AmiVoice®	0~15000*3	10000

Note 1: The larger the value, the higher the directivity.
Note 2: The larger the value, the less noise.
Note 3: The larger the value, the higher the detection threshold, and the fewer false positives.

AmiVoice® and Zoom Voice setting parameters can be set from a PC via USB.

In addition, the slide switch (para / load) can be used to switch the setting parameter display to the CPU resource usage rate (%) display by the main function. This display is the same as the 2D Drawing engine demo.

Figure 3-3 shows the Voice recognition demo screen, and Table 3.2 shows the voice commands and responses that can be accepted.

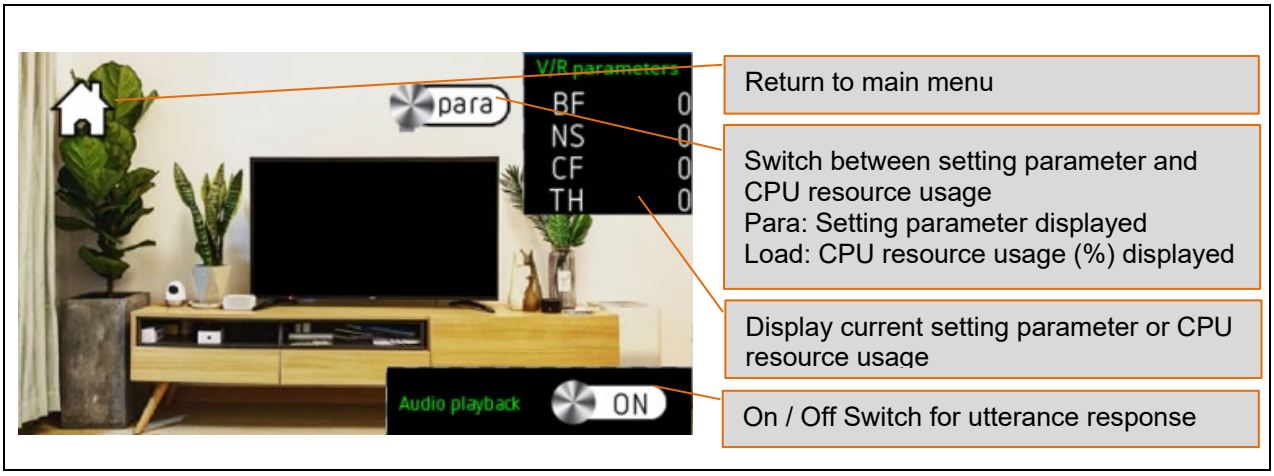

Figure 3-3. Voice recognition demo screen

Table 3.2 The voice commands and responses

Operation	Voice Commands (English)	Voice Response (English)	Voice Commands (Japanese)	Voice Response (Japanese)
Turn on the light	Turn on the light	I turn on the light	でんきをつけて。	電気を点けました。
Turn off the light	Turn off the light	I turn off the light	でんきをけして。	電気を消しました。
Turn on the TV	Turn on the TV	I turn on the TV	てれびをつけて。	テレビを点けました。
Turn off the TV	Turn off the TV	I turn off the TV	てれびをけして。	テレビを消しました。
Channel up	Channel up	I proceeded to the channel	ちゃんねるあっぷ。	チャンネルを進めました。
Channel down	Channel down	I back on channel	ちゃんねるだうん。	チャンネルを戻しました。
Return to the main menu	Main menu	I return to the main menu	めいんめにゅー。	メインメニューに戻ります。

3.4 Calendar Demo

In the calendar demo, you operate the emWin demo sample of RX72N Envision Kit by voice. The calendar used in this demo is provided as a library and is free of charge for the RX72N Envision Kit purchasers. Figure 3-4 shows the calendar demo screen, and Table 3.3 shows the voice commands that can be accepted.

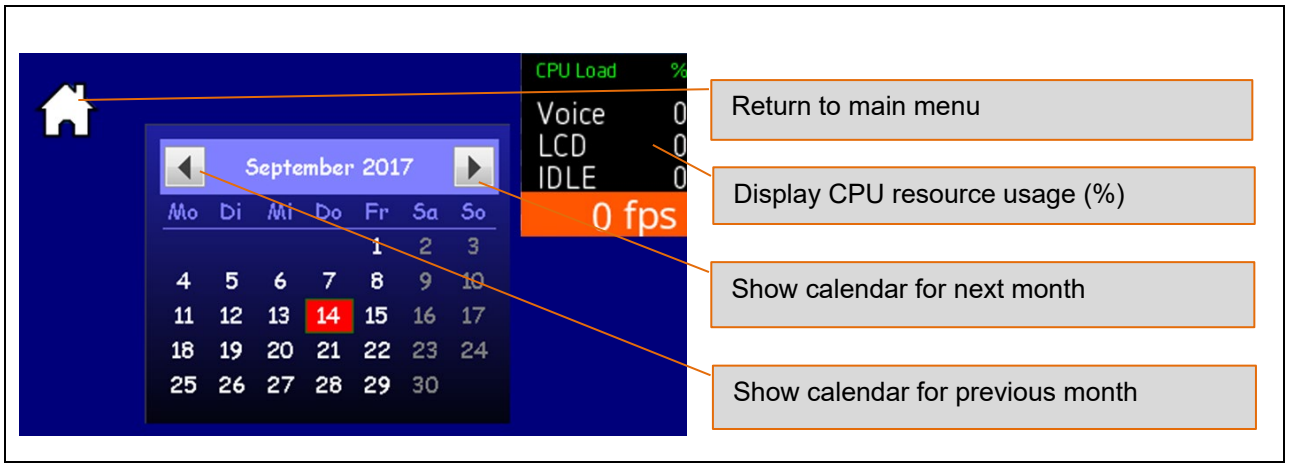

Figure 3-4 shows the calendar demo screen

Table 3.3 Voice commands

Operation	Voice Commands (English)	Voice Commands (Japanese)
Show calendar for next month	Next	つぎ。
Show calendar for previous month	Back	もどる。
Return to main menu	Main menu	メインメニュー。

4. Confirmed Conditions of the Operation

4.1 Confirmed Conditions of the Operation

The sample code of this application note has been confirmed to work under the conditions shown in Table 4.1.

Table 4.1. Confirmed Conditions of the Operation

Items		Conditions
MCU used		R5F572NDHDFB 144pin LQFP
		Internal ROM 4Mbyte, Internal RAM 1MByte
Operating frequency		Main clock oscillator: External 16MHz (Internal: 240MHz)
Power supply		USB connecter: 5V Input
		Power IC: 5V Input, 3.3V Output
		External power supply jack: 5.0V Input (Φ2.1mm)
IDE (Integrated Development Environment)		Renesas e² studio 2020-10
C compiler		CCRX V3.02.0
Free RTOS		v10.0.4
Debugger		E2 emulator Lite (On-board emulator circuit)
Parts of Demo	Target board	RX72N Envision Kit (Parts Nome: RTK5RX72N0C00000BJ)
Version of the sample code		Rev1.00

4.2 Memory Size

Memory size used in the sample code are shown next tables for ROM and RAM.

Table 4.2 ROM Size

Size (K Byte)	Contents of use
263.5	Program for emWin
239	Font data for emWin
178	Button switch image for emWin
601	Demo image (room / landscape) for emWin
30.5	Program for AmiVoice® and Zoom Voice
165	Dictionary data (14 words of each English and Japanese) for AmiVoice®
171	Response voice data (ADPCM)
13.5	OS
54.7	Drivers for FIT and others
Total: 1716	Total ROM Size used

Table 4.3 ROM Size

Size (K Byte)	Contents of use
256	Display buffer 1 (480 x 272 x 16bit)
256	Display buffer 2 (480 x 272 x 16bit)
102	lcd_task heap area
102	ami_task heap area
31	the other heap area
81	emWin work
8	Zoom Voice work
8	DMA buffer for audio playback
26	DMA transfer buffer (10 sets)
102	OS heap area
13	Stack
8	Global variables, etc.
Total: 993	Total RAM Size used

5. Software

5.1 Software Hierarchy

Figure 5-1 shows the DEMO software hierarchy of this application note.

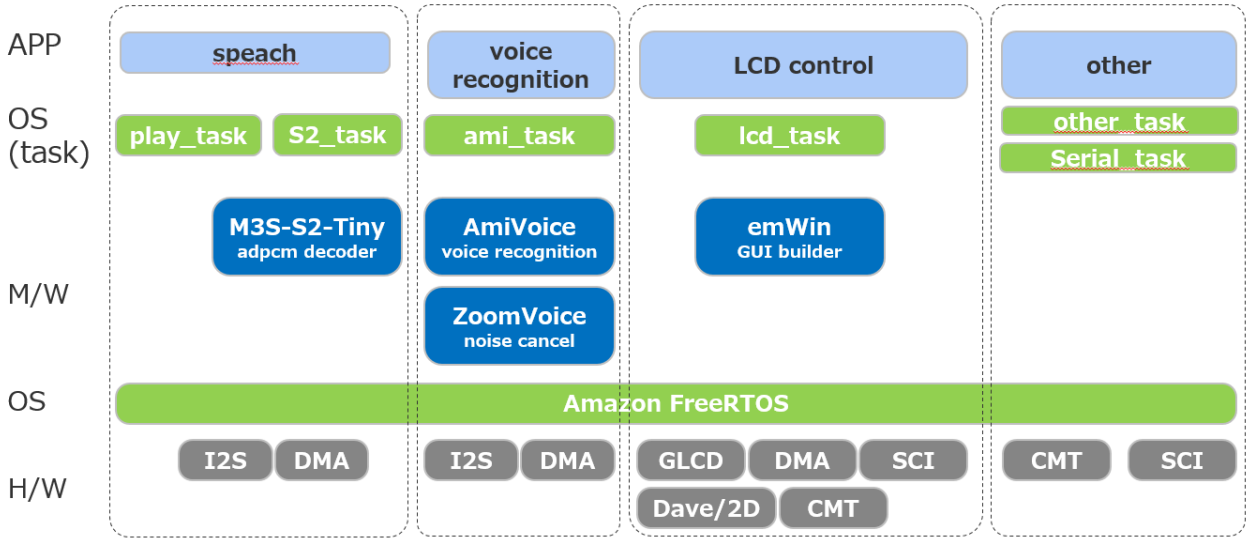

Figure 5-1. Software Hierarchy

5.2 Flowchart

This demo software uses FreeRTOS and consists of 6 tasks.

-ami_task: This task that mainly controls AmiVoice®. LCD control is also performed based on the voice recognition result.

-lcd_task: This task that executes the main routine of emWin. Display instructions are given from the other task.

-other_task: This task that calculates CPU load, etc.

-play_task: This task to play PCM.

-S2_task: This task that decompresses ADPCM.

-serial_task: This task that performs serial communication with the outside.

Figure 5-2 shows the flowchart of this demo software.

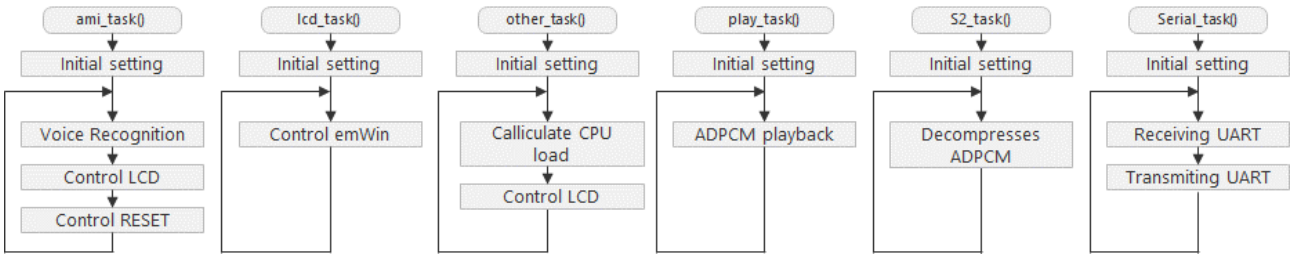

Figure 5-2. shows the flowchart

6. Communication Protocol

You can control voice recognition parameters using the USB I/F virtual COM port included in the RX72N Envision Kit to similar to the test environment in Lab on the cloud. This chapter describes the communication protocol of parameter control.

6.1 Communication Format

Communication format of UART is as follows.

Item	Value
bit rate	115200bps
data length	8bit
stop bit	1bit
Parity	no
flow control	no

RX72N Envision Kit sends data every 50ms. Data receiving is accepted at any time.

6.2 Communication Command Specifications

The communication command specifications are shown below.

{“Parameter name 1”: ”Value 1” [, “Parameter name 2”: ”Value 2”] [, “Parameter name 3”: ”Value 3”] ・ ・ ・} <LF> <CR>

Communication commands enclose in "{}".

Communication commands are a set of parameter names and values.

When sending multiple parameters, separate them with ",". This format can be parsed with a JSON parser.

(Example 1) When sending a value of 165 for a parameter called AMI_CONF {“AMI_CONF”: ”165”} <LF> <CR>

(Example 2) When AMI_CONF sends 165 and VRESP sends "On" {"AMI_CONF": "165", "VRESP": "On"} <LF> <CR>

6.3 Type of Parameter

The list of parameters accepted by the communication command is shown below.

"Upload" is the parameter sent from the RX72N Envision Kit, and "Download" is the parameter received by the RX72N.

Parameter	Range of Value	Meaning	Direction
CPUload	0.0 – 100.0	CPU resource usage rate (Notification)	Up
Voice	2D engine Voice recognition Calendar next back Turn on light Turn off light Turn on TV Turn off TV Channel up Channel down Main menu	Indicates the type of recognized voice.	Up
AMI_CONF	0 – 255	Voice detection threshold of AmiVoice® (Parameter settings)	Down
AMI_TH	0 - 15000	Confidence threshold of AmiVoice® (Parameter settings)	Down
BEAMF	1 – 7	Beamforming reduction amount of Zoom Voice (Parameter settings)	Down
NOISES	1 – 7	Noise suppressor reduction amount of Zoom Voice (Parameter settings)	Down
MAINM	ON	Transition to the main menu (command)	Down
RESET	ON	Software Reset (command)	Down
VMODE	ON OFF	ON: Send the voice of the user PC to the cloud PC OFF: Play the voice from cloud PC	Down
VRESP	ON OFF	Presence / absence of voice response (mode switching) ON: Voice response “ON”, OFF: Voice response “OFF”	Down
LANG_ENG	ON OFF	Language selector ON: English OFF: Japanese	Down
PARAM	ON	Parameter display in Voice recognition demo (display switching)	Down
LOAD	ON	CPU resource usage rate display in Voice recognition demo (display switching)	Down
DRW2D	ON OFF	ON / OFF switching of 2D Drawing engine function	Down

7. Reference documents

User's Manual: Hardware

RX72N Group User's Manual: Hardware R01UH0824EJ0111

(Get the latest version from the Renesas Electronics website.)

User's Manual: RX72N Envision Kit

RX72N Group RX72N Envision Kit User's Manual R20UT4788EJ0100

(Get the latest version from the Renesas Electronics website.)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2021/07/21	–	First Edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

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1. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on
   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
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   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
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   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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(Rev.4.0-1 November 2017)

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