Cyberon DSpotter SDK v2.2.x (32-bit IC Edition)

Programming Guide

Version: 1.1.5

Date of issue: July 16, 2020

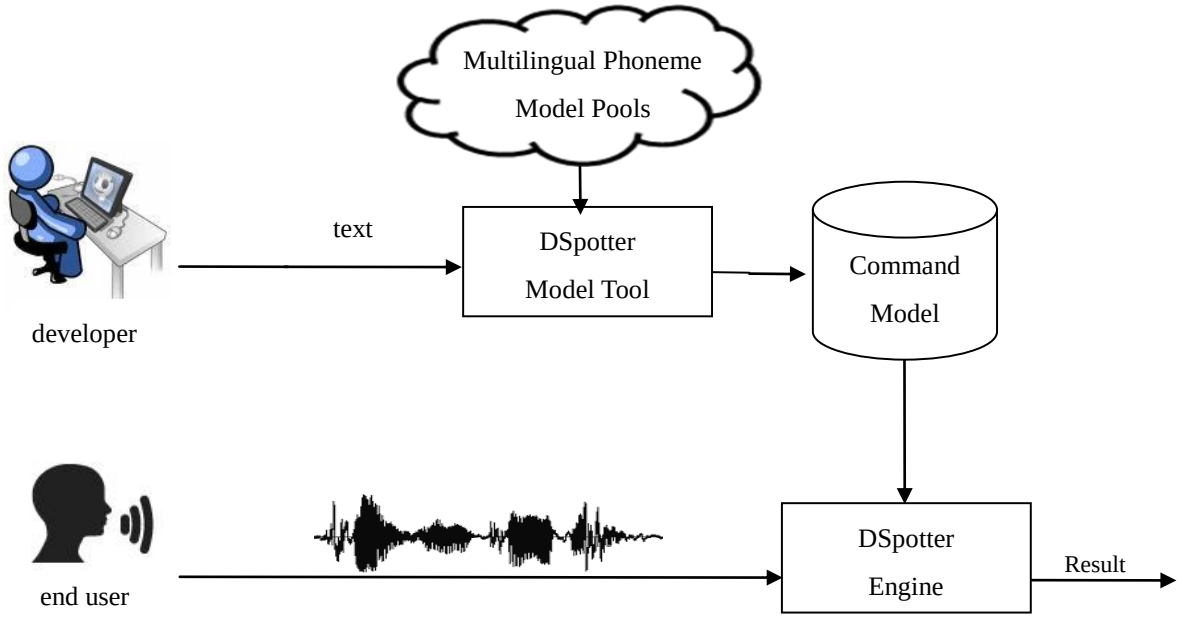
Leading Speech Solution provider

http://www.cyberon.com.tw/

Table of Contents

1. About Cyberon DSpotter SDK

DSpotter SDK is Cyberon's flagship high-performance embedded voice recognition solution specially optimized for mobile phones, automotives, smart home devices, consumer products, and interactive toys. Based on phoneme acoustic models, it enables developers to create applications of speaker-independent (SI) voice recognition capability without requiring costly data collection process for specific commands. With Win32-based DSpotter Model Tool, developers can easily and quickly create their own voice command models simply by text input. Other important features include always-on keyword-spotting capability, highly noise immune, adjustable sensitivity, voice quality assessment, and more than 30 commonly used language versions available.



2. Release History

Date	Version	Author	Description
2019/04/11	1.0.0	Roger	**Purpose:** First release
2019/08/01	1.0.2	Roger	**Purpose:** Update API
2019/10/14	1.0.3	Roger	**Purpose:** Update Spec / API
2019/10/24	1.0.4	Roger	**Purpose:** Update Spec
2019/11/25	1.0.5	Roger	**Purpose:** Update Spec
2019/12/12	1.0.6	Roger	**Purpose:** Update Spec
2020/02/20	1.0.7	Roger	**Purpose:** Update Spec for v2.1.0
2020/03/05	1.0.8	Roger	**Purpose:** Update Error code table
2020/03/26	1.0.9	Roger	**Purpose:** Update Spec / API
2020/04/16	1.1.0	Roger	**Purpose:** Update Error code table/Support Languages
2020/04/29	1.1.1	Roger	**Purpose:** Update Bin format
2020/05/14	1.1.2	Roger	**Purpose:** Update Error code table
2020/05/19	1.1.3	Roger	**Purpose:** Update Spec for v2.2.4
2020/06/02	1.1.4	Roger	**Purpose:** Update API

2020/07/16	1.1.5	Roger	**Purpose:** Update Bin format / API

3. DSpotter Specifications, Related Files and Tools

3.1. Specifications

DSpotter algorithm is available for 32-bit IC platforms. The core engines can be ported to a variety of platforms with architectures. Here lists DSpotter specifications ported to some popular platforms. For 32-bit DSP32, the standard versions of DSpotter algorithms given n_c, the number voice commands, each of which is 4 syllables in average, the technical specification is listed in the following table:

Algorithm	DSP32
IC Architecture	32-bit, fixed-point ALU
Sample Rate	16kHz
Feature Dimension	23
Code size	26KB
Data size	Level 0:100KB + 28B*n_c Level 1:165KB + 28B*n_c
RAM size	Level 0:40KB + 116B*n_c Level 1:45KB + 116B*n_c
Ported Platforms	ARM M3, M4 Tensilica HiFi 3, HiFi Mini
DMIPS request	Level 0: 45MIPS Level 1: 60MIPS

For 32-bit DSP32A, the advanced version of DSpotter algorithm equipped with voice tag training function, given n_c, the number voice commands, the technical specification is listed below:

Algorithm	DSP32A
IC Architecture Requirement	32-bit with fixed-point ALU
Input Sample Rate	16kHz
Feature Dimension	23
Code size	34KB
Data size	Level 0:100KB + 340B + 400B*n_c Level 1:165KB + 340B + 400B*n_c
RAM size	Level 0:75KB + 116B*n_c Level 1:80KB + 116B*n_c
Ported Platforms	ARM M3, M4 Tensilica HiFi 3, HiFi Mini

Note that code size listed in this document is for DSpotter core engine only, and codes for recording, playback, voice compression, data communication, and application main function are not included. Code and RAM sizes listed in the tables of this document are estimated with DSpotter 2.2.4 version.

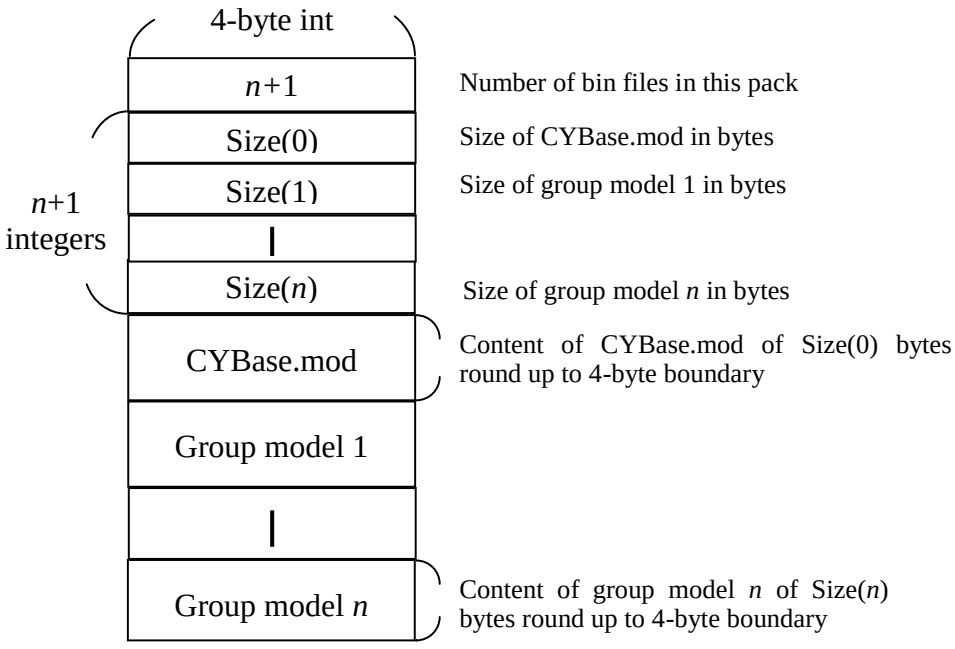
3.2. Related Files and Tools

Library

- **DSpotterSDK_16k23d_XXXX.lib**, the library for DSpotter standard version, where XXXX is the name of the IC platform running the DSpotter engine, 16k and 23d stand for 16kHz sampling rate input and 23-dimensional feature vectors respectively.
- **DSpotterSDK_16k23d_XXXX_A.lib,** the library for DSpotter advanced version.

Data

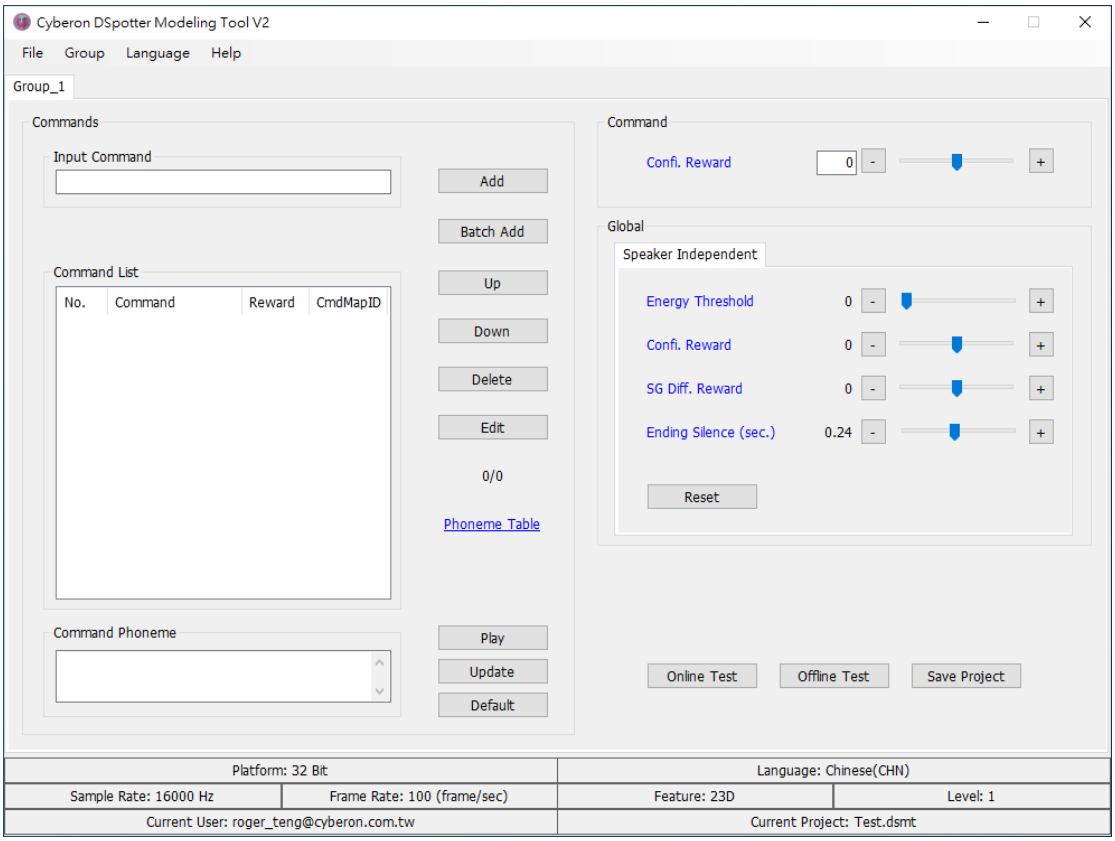
- **CYBase.mod**: the DNN(Deep Neural Networks) model. The file name CYBase.mod is reserved for DSpotter Model Tool, and should never be changed.
- **XXXX.mod**: the command group model (or called command model). "Group_*n*" is the default name for the *n*-th group of commands in a project when created with DSpotter Model Tool, and can be renamed. All the command group models share the same CYBase.mod in a project.
- **XXXX_MapID.bin**: the command ID mapping bin for "Group_*n*".
- **CYTrimap.mod:** the phoneme map model. The file name CYTrimap.mod is reserved for DSpotter Model Tool, and should never be changed.
- **XXXX_pack.bin**: the binary file that packs all command group models together with the shared CYBase.mod in a project, where XXXX is the project name assigned by developer when creating it with DSpotter Model Tool. Before using the models in the packed binary file, developers need to unpack it. For a DSpotter project of *n* group models, the packing format is shown in the diagram below. Note that this packing file is 4-byte aligned in Little-Endian manner.



- **AllGroup_MapID_pack.bin**: the binary file that packs all command ID mapping bins together.
- **XXXX_pack_withTri.bin**: same as XXXX_pack.bin, append CYTrimap.mod in end of XXXX_pack.bin
- **XXXX_pack_WithTriAndMapID.bin**: same as XXXX_pack_withTri.bin, append AllGroup_MapID_pack.bin in end of XXXX_pack_withTri.bin
- **XXXX_pack_withTxt.bin**: additional append .txt for each group, for DSpotter HL. CYBase.mod/Group_1.mod/.../Group_x.mod/Group_1.txt/…/Group_x.txt
- **XXXX_pack_WithTxtAndMapID.bin**: same as XXXX_pack_withTxt.bin, append AllGroup_MapID_pack.bin in end of XXXX_pack_withTxt.bin
- **XXXX_pack_withTxtAndTri.bin**: same as XXXX_pack_withTxt.bin, append CYTrimap.mod in end of XXXX_pack _withTxt.bin
- **XXXX_pack_WithTxtAndTriAndMapID.bin**: same as XXXX_pack_withTxtAndTri.bin, append AllGroup_MapID_pack.bin in end of XXXX_pack_withTxtAndTri.bin

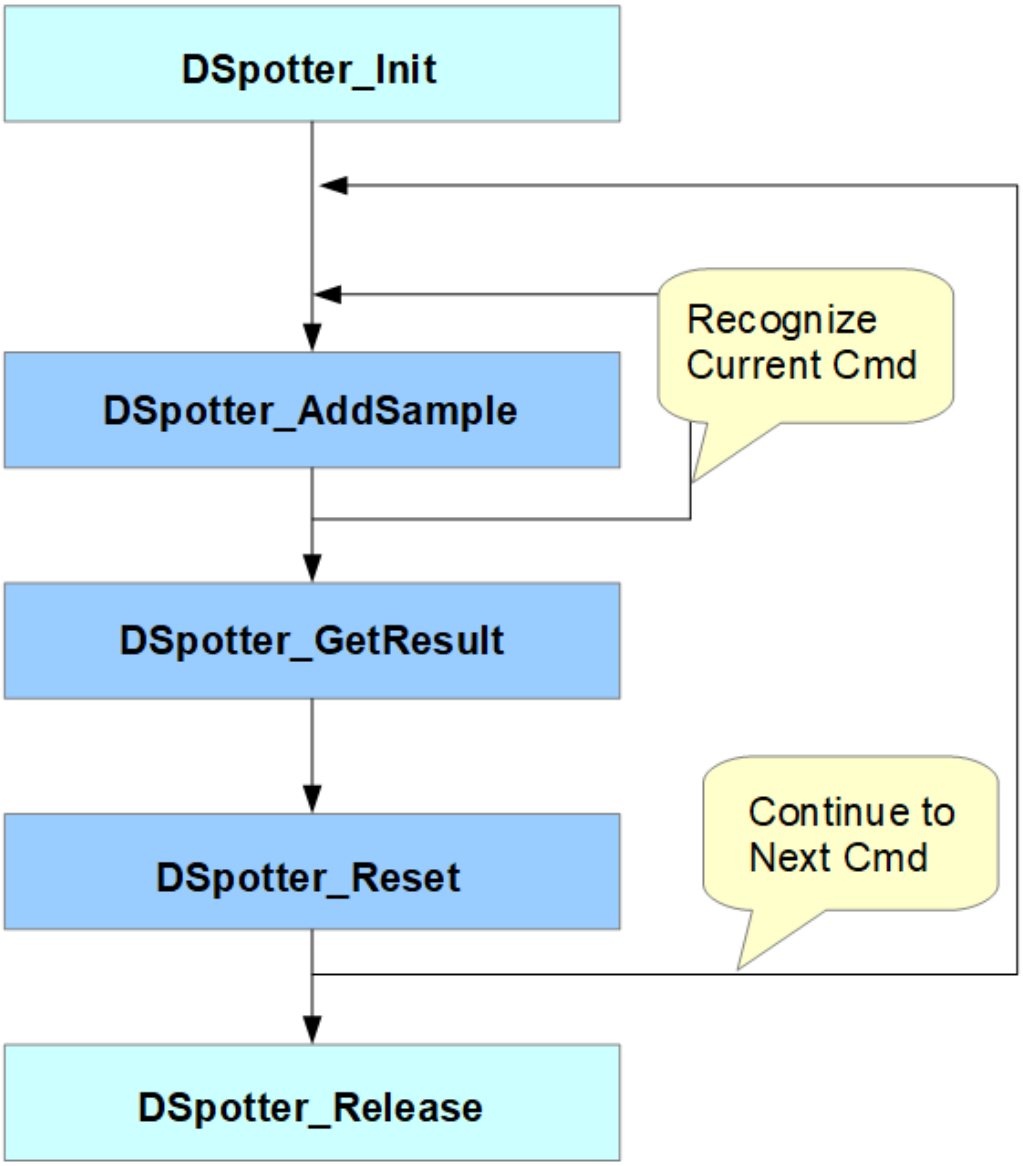
Tools

- **DSpotter Model Tool**, a Microsoft Win32-based tool for developers to create command models for DSpotter recognition engine. Prior registration is required before developers can use DSpotter Model Tool. Contact with Cyberon if you are new to DSpotter.



4. DSpotter SDK API Standard Version

4.1. Calling Flow Chart of Standard API



4.1. Initialize, Reset, and Release

DSpotter_Init_Multi

Purpose

Create a recognizer for recognizing multiple groups of commands simultaneously.

Prototype

HANDLE DSpotter_Init_Multi(BYTE *lpbyCYBase, BYTE *lppbyModel[], INT nNumModel, INT nMaxTime, BYTE *lpbyMemPool, INT nMemSize, BYTE *lpbyPreserve, INT nPreserve, INT *pnErr);

Parameters

lpbyCYBase(IN): The background model, contents of CYBase.mod.

lpbyModel(IN): The command model.

nMaxTime(IN): The maximum buffer length in number of frames for keeping the status information of commands.

lpbyMemPool(IN/OUT): Memory buffer for the recognizer.

nMemSize(IN): Size in bytes of the memory buffer *lpbyMemPool*.

lpbyPreserve (IN/OUT): Preserve param, give NULL.

nPreserve (IN): Preserve param, give 0.

pnErr(OUT): The return code.

Return value

Return the handle of a recognizer when success or NULL otherwise.

Remarks

It is highly recommended that the value of *nMaxTime* should be greater than the maximum duration of all commands, and recognizer could keep the status information of commands during recognition. Note that higher value of *nMaxTime* will increase the memory usage.

A statically reserved buffer of memory pointed by *lpbyMemPool* is required to call this function. Developers can get the memory buffer size *nMemSize* in advance by using the command line tool *DSpotter_GetMemoryUsage*. This memory buffer can be recycled and used by other functions when the recognition task finishes after calling *DSpotter_Release(…).*

Pointer *pnErr* receives the return code after calling this function, *DSPOTTER_SUCCESS* indicating success, otherwise a negative error code is returned. This pointer can be NULL, The maximum number of command models is 10.

DSpotter_Reset

Purpose

Reset the recognizer before performing recognition.

Prototype

INT DSpotter_Reset(HANDLE hDSpotter);

Parameters

hDSpotter (IN): Handle of the recognizer.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

DSpotter_Release

Purpose

Release a recognizer.

Prototype

INT DSpotter_Release(HANDLE hDSpotter);

Parameters

hDSpotter (IN): Handle of the recognizer.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

DSpotter_GetMemoryUsage_Multi

Purpose

Get current memory usage.

Prototype

INT DSpotter_GetMemoryUsage_Multi(BYTE *lpbyCYBase, BYTE *lppbyModel[], INT nNumModel, INT nMaxTime);

Parameters

lpbyCYBase(IN): The background model, contents of CYBase.mod

lppbyModel(IN): An array of command models to be recognized simultaneously.

nNumModel(IN): Number of models in array *lppbyModel*.

nMaxTime(IN): The maximum buffer length in number of frames for keeping the status of commands.

Return value

The memory size in bytes or error code.

4.2. Recognition

Functions in this section are designed to perform recognition process for the recognizer. For some platforms with relatively limited RAM, the pseudo codes below demonstrate how to use **union** data type of C language to store memory buffers for DSpotter engine, playback, and functions of developer's application in the same location. DSpotter engine retains the memory buffer pointed by *lpbyMemPool* until *DSpotter_Release(…)* is called, after which the buffer is released and can be recycled and reused by other functions. The pseudo codes below show the calling sequence for always-listening voice recognition:

```
// Declare shared memory using data type union in C.
union ShareMem {
	BYTE lpbyMemPool[N];
	// N can be obtained with function DSpotter_GetMemoryUsage_Multi(...).
	SHORT lpsPlayBuffer[…];
	<Other buffers used by application>
} ShareMem;


DoVR(…)
{
	// Create a recognizer
	hDSpotter = DSpotter_Init_Multi(…, ShareMem.lpbyMemPool, N, NULL, 0, …);
	if (hDSpotter == NULL)
		goto L_ERROR;

	<Start Recording>


	while (1)
	{
		<Get PCM samples from recording device>
		if (DSpotter_AddSample(…) == DSPOTTER_SUCCESS)
		{
			nID = DSpotter_GetResult(…);
			DSpotter_GetResultEPD(…);		// Optional
			nScore = DSpotter_GetResultScore(…);	// Optional
			break;
		}
	}

L_ERROR:

	<Stop Recording>

	DSpotter_Release(…);
	// Share memory ShareMem can be used by other functions after DSpotter_Release(…).

	<Play Prompt using memory ShareMem.lpsPlayBuffer >
}
```

DSpotter_AddSample

Purpose

Add voice samples to the recognizer and perform recognition.

Prototype

INT DSpotter_AddSample(HANDLE hDSpotter, SHORT *lpsSample, INT nNumSamples);

Parameters

hDSpotter (IN): Handle of the recognizer.

lpsSample(IN): An array of 16kHz, 16-bit, mono-channel PCM raw data.

nNumSamples(IN): Number of samples in *lpsSample*.

Return value

Result	Comment
DSPOTTER_SUCCESS	A recognition result is concluded, and application can call *DSpotterGetResult(…)* to retrieve the result.
DSPOTTER_ERR_NeedMoreSample	Recognition result has not been found yet, and need to call this function again to add more samples to the recognizer.
DSPOTTER_ERR_Rejected	A rejected result is concluded, and application can call *DSpotterGetResult(…)* to retrieve the result.
Other negative error code	

Remarks

Application should call this function repetitively to add recorded PCM raw data into the recognizer for recognition to proceed until a recognition is found, at which moment this function returns *DSPOTTER_SUCCESS*, and the application can then call *DSpotter_GetResult(...)* to retrieve the recognized result. The recommended length of the input array of samples *lpsSample* is 480 samples (= 960 bytes).

DSpotter_GetResult

Purpose

Get the recognition result from the recognizer.

Prototype

INT DSpotter_GetResult(HANDLE hDSpotter);

Parameters

hDSpotter (IN): Handle of the recognizer.

Return value

Return the zero-based command ID when success or negative error code otherwise. If there are more than one command models being recognized simultaneously, the command ID is enumerated in order. For example, if there are 2 models containing n_1 and n_2 commands respectively, the ID for the third command in the second model is n_1+2.

DSpotter_GetResultEPD

Purpose

Get the boundary information of the current recognition result.

Prototype

INT DSpotter_GetResultEPD(HANDLE hDSpotter, INT *pnWordDura, INT *pnEndSil, INT *pnNetworkLatency);

Parameters

hDSpotter (IN): Handle of the recognizer.

pnWordDura(OUT): Duration of the result in number of samples.

pnEndSil(OUT): Ending silence length in number of samples.

pnNetworkLatency (OUT): Model delay length in number of samples.

Return value

Return the command ID when success, or negative error code otherwise.

Remarks

EPD stands for end-point detection. DSpotter determines the completion of an input voice command by counting the length of the ending silence. This function retrieves the command duration and length of the ending silence. Developers can also calculate the command start time if necessary. In the application, number of added samples is recorded with variable *nTotAddSample*. Then the start time *nStartTime* is

*nStartTime = nTotAddSample - *pnWordDura - *pnEndSil - *pnNetworkLatency*;

DSpotter_GetResultScore

Purpose

Get the reliability score of the current recognition result.

Prototype

INT DSpotter_GetResultScore (HANDLE hDSpotter, INT *pnConfi, INT *pnSGDiff, INT *pnFIL);

Parameters

hDSpotter (IN): Handle of the recognizer.

*pnConfi(OUT): Score of Confi.

*pnSGDiff (OUT): Score of SG Diff

*pnFIL (OUT): Score of Fil

Return value

Return the non-negative reliability score of the recognition result when success, or negative error code otherwise.

Higher confidence score means voice is more similar to command model.

Higher SG Difference score means voice is more different from Silence/Garbage.

Higher Fil score means voice is more different from Filter model.

DSpotter_GetCmdEnergy

Purpose

Get the energy of recognition result in RMS value from the recognizer.

Prototype

INT DSpotter_GetCmdEnergy(HANDLE hDSpotter);

Parameters

hDSpotter (IN): Handle of the recognizer.

Return value

Return the energy of recognition result in RMS value when success, or negative error code otherwise

DSpotter_GetNumWord

Purpose

Get the number of commands in the input model.

Prototype

INT DSpotter_GetNumWord(BYTE *lpbyModel);

Parameters

lpbyModel(IN): The command model.

Return value

Return the number of commands when success, or negative error code otherwise.

DSpotter_SetEndSil

Purpose

Set group ending silence.

Prototype

INT DSpotter_SetEndSil(HANDLE hDSpotter, INT nEndSil);

Parameters

hDSpotter (IN): Handle of the recognizer.

nEndSil (IN): Ending silence. The range is [0, 16], lower value will make the engine quicker to return a result, Set 1 is 0.03s, The default is 8(0.24s).

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

The ending silence is a global attribute that applies to the entire model. It defines the duration of silence after the voice input for the engine to determine the end of a voice command. Though a longer ending silence makes the engine slower or more "picky" to respond to user's voice input, it can usually give more stable recognition results with less false triggers.

Set value by this API will overwrite all values set by *DSpotter_SetCmdEndSil(..)*.

DSpotter_SetCmdEndSil

Purpose

Set command ending silence.

Prototype

INT DSpotter_SetCmdEndSil(HANDLE hDSpotter, INT nCmdIdx, INT nEndSil);

Parameters

hDSpotter (IN): Handle of the recognizer.

nCmdIdx (IN): Command index.

nEndSil (IN): Response time. The range is [0, 16], lower value will make the engine quicker to return a result, Set 1 is 0.03s, The default is 8(0.24s).

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

The ending silence is a attribute that applies to the command. It defines the duration of silence after the voice input for the engine to determine the end of a voice command. Though a longer ending silence makes the engine slower or more "picky" to respond to user's voice input, it can usually give more stable recognition results with less false triggers.

Set value by this API will overwrite value set by *DSpotter_SetEndSil(…)*.

DSpotter_GetCmdEndSil

Purpose

Get command ending silence.

Prototype

INT DSpotter_GetCmdEndSil(HANDLE hDSpotter, INT nCmdIdx);

Parameters

hDSpotter (IN): Handle of the recognizer.

nCmdIdx (IN): Command index.

Return value

Return value if successful, or negative error code otherwise.

Remarks

DSpotter_SetConfiReward

Purpose

Set group confidence reward.

Prototype

INT DSpotter_SetConfiReward(HANDLE hDSpotter, INT nReward);

Parameters

hDSpotter (IN): Handle of the recognizer.

nReward (IN): Confi Reward. The range is [-100, 100], lower reward will make the engine more "picky" to return a result.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

Confidence score means voice is how much similar to command model.

The group confidence reward is a global threshold that applies to the entire model. A lower reward makes the engine more "picky" to return a result. It is recommended to perform sufficient amount of field tests from different users if the rejection level is changed from its default value.

DSpotter_GetConfiReward

Purpose

Get group confidence reward.

Prototype

INT DSpotter_GetConfiReward(HANDLE hDSpotter, INT *pnErr);

Parameters

hDSpotter (IN): Handle of the recognizer.

pnErr (IN/OUT): *DSPOTTER_SUCCESS* if successful, or negative error code otherwise.

Return value

Return value.

Remarks

DSpotter_SetCmdConfiReward

Purpose

Set command confidence reward.

Prototype

INT DSpotter_SetCmdConfiReward(HANDLE hDSpotter, INT nCmdIdx, INT nReward);

Parameters

hDSpotter (IN): Handle of the recognizer.

nCmdIdx (IN): Command index.

nReward (IN): Confi Reward. The range is [-100, 100], lower reward will make the engine more "picky" to return a result.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

Engine will add group and command confidence reward as confidence score offset.

DSpotter_GetCmdConfiReward

Purpose

Get command confidence reward.

Prototype

INT DSpotter_GetCmdConfiReward(HANDLE hDSpotter, INT nCmdIdx, INT *pnErr);

Parameters

hDSpotter (IN): Handle of the recognizer.

nCmdIdx (IN): Command index.

pnErr (IN/OUT): *DSPOTTER_SUCCESS* if successful, or negative error code otherwise.

Return value

Return value.

Remarks

DSpotter_SetSGDiffReward

Purpose

Set group SG difference reward.

Prototype

INT DSpotter_SetSGDiffReward(HANDLE hDSpotter, INT nReward);

Parameters

hDSpotter (IN): Handle of the recognizer.

nReward (IN): SG Difference Reward. The range is [-100, 100], lower reward will make the engine more "picky" to return a result.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

SG Difference score means voice is how much different from Silence/Garbage.

The group SG difference reward is a global threshold that applies to the entire model. A lower reward makes the engine more "picky" to return a result. It is recommended to perform sufficient amount of field tests from different users if the rejection level is changed from its default value.

DSpotter_GetSGDiffReward

Purpose

Get group SG difference reward.

Prototype

INT DSpotter_GetSGDiffReward(HANDLE hDSpotter, INT *pnErr);

Parameters

hDSpotter (IN): Handle of the recognizer.

pnErr (IN/OUT): *DSPOTTER_SUCCESS* if successful, or negative error code otherwise.

Return value

Return value.

Remarks

DSpotter_SetEnergyTH

Purpose

Set the energy threshold of recognition result in RMS value.

Prototype

INT DSpotter_SetEnergyTH(HANDLE hDSpotter, INT nEnergyTH);

Parameters

hDSpotter (IN): Handle of the recognizer.

nEnergyTH (IN): Command energy in RMS value. The range is [0, 32767].

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

DSpotter_GetEnergyTH

Purpose

Get the energy threshold of recognition result in RMS value.

Prototype

INT DSpotter_GetEnergyTH(HANDLE hDSpotter);

Parameters

hDSpotter (IN): Handle of the recognizer.

Return value

Return value if successful, or negative error code otherwise.

Remarks

DSpotter_SetResultMapID_Sep

Purpose

Set single command Mapping ID bin to engine.

Prototype

INT DSpotter_SetResultMapID_Sep(HANDLE hDSpotter, BYTE *lpbMapID);

Parameters

hDSpotter (IN): Handle of the recognizer.

lpbMapID (IN): The command mapping ID bin.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

The command mapping ID bin is created by DSMT, user could set multi commands to one index with command mapping ID bin.

DSpotter_SetResultMapID_Multi

Purpose

Set multi command Mapping ID bins to engine.

Prototype

INT DSpotter_SetResultMapID_Multi(HANDLE hDSpotter, BYTE *lppbMapID[], INT nNumMapID);

Parameters

hDSpotter (IN): Handle of the recognizer.

lppbMapID (IN): The command mapping ID bins.

nNumMapID (IN): number of command mapping ID bins

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

nNumMapID must same as nNumModel which used in DSpotter_Init_Multi.

DSpotter_GetResultMapID

Purpose

Get the mapping recognition result from the recognizer.

Prototype

INT DSpotter_GetResultMapID(HANDLE hDSpotter);

Parameters

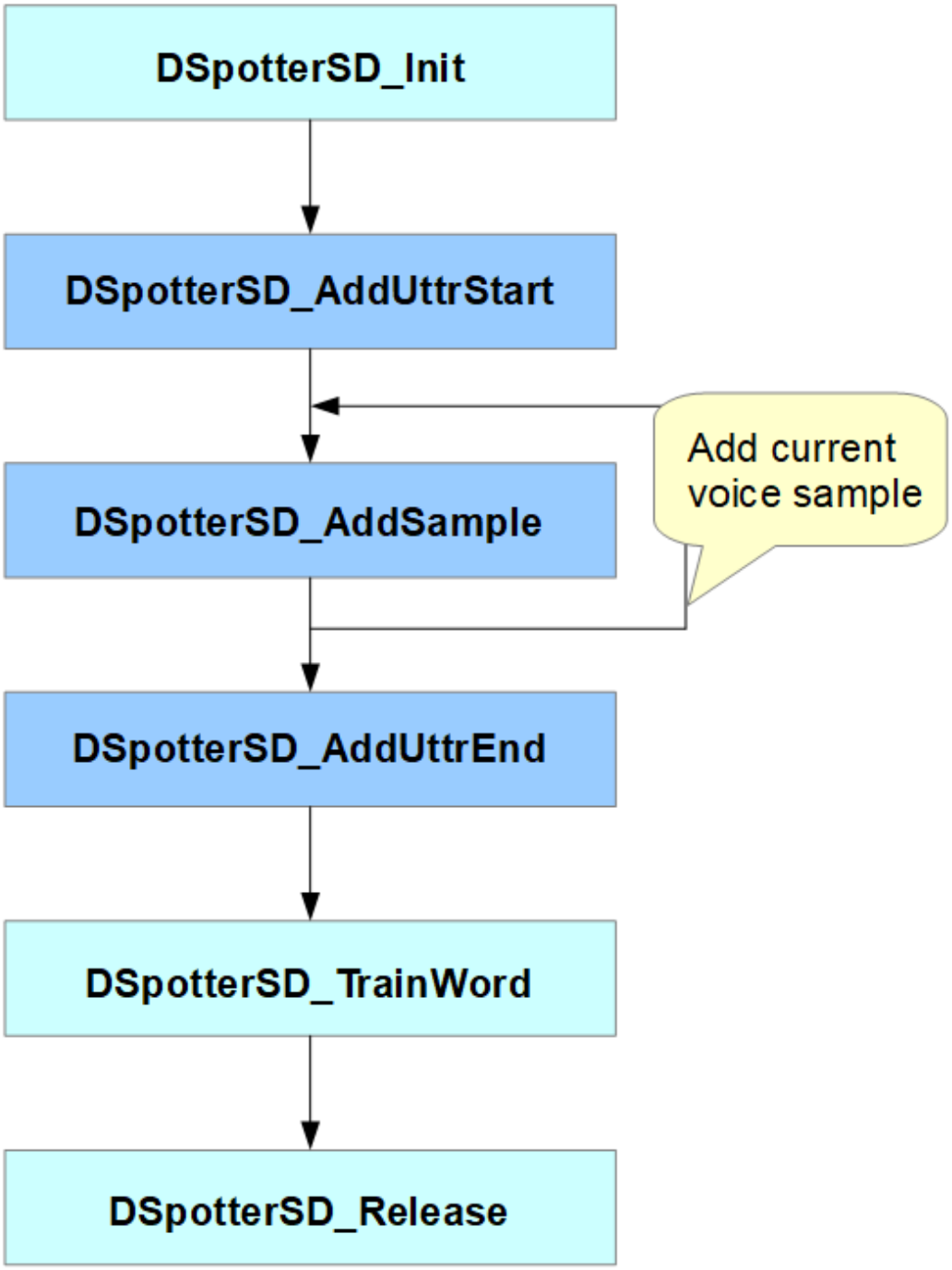
hDSpotter (IN): Handle of the recognizer.

Return value

Return the zero-based mapping command ID when success or negative error code otherwise.

5. DSpotter SDK API Advanced Version

5.1. Calling Flow Chart of Advanced API



5.2. Initialize and Release

DSpotterSD_Init

Purpose

Create a DSpotter voice tag trainer.

Prototype

HANDLE DSpotterSD_Init(BYTE *lpbyCYBase, BYTE *lpbyTrimap, BYTE *lpbyMemPool, INT nMemSize, INT *pnErr);

Parameters

lpbyCYBase(IN): The background model for trainer, contents of CYBase.mod

lpbyTrimap (IN): The phoneme map model for trainer, contents of CYTrimap.mod

lpbyMemPool(IN/OUT): Memory buffer for the trainer

nMemSize(IN): Size in bytes for memory buffer *lpbyMemPool*.

pnErr(OUT): The return code.

Return value

Return the handle of a trainer when success or NULL otherwise.

Remarks

A background model CYBase.mod is required to train a voice tag. The trainer extracts parameters from the input CYBase.mod/Group_x.mod/CYTrimap.mod, and using the training utterances provided by the user to create new command. Models sharing the same CYBase.mod, including the speaker-independent (SI) ones created from DSpotter Model Tool and the speaker-dependent (SD) voice tags trained here, can be put together and recognized by DSpotter engine simultaneously.

A statically reserved buffer of memory pointed by *lpbyMemPool* is required to call this function. This memory buffer can be recycled and used by other functions when the training task ends after calling *DSpotterSD_Release(…)*.

Pointer *pnErr* receives the return code after calling this function, *DSPOTTER_SUCCESS* indicating success, otherwise a negative error code is returned. This pointer can be NULL.

DSpotterSD_GetMemoryUsage

Purpose

Get current memory usage of training.

Prototype

INT DSpotterSD_GetMemoryUsage(BYTE *lpbyCYBase, BYTE *lpbyTrimap);

Parameters

lpbyCYBase(IN): The pointer of background model, contents of CYBase.mod.

lpbyTrimap (IN): The phoneme map model for trainer, contents of CYTrimap.mod

Return value

The memory size in bytes or error code.

Remarks

Function will return memory usage or error code.

DSpotterSD_Release

Purpose

Release the trainer.

Prototype

INT DSpotterSD_Release(HANDLE hDSpotter);

Parameters

hDSpotter(IN): Handle of the trainer.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

5.3. Training

Functions in this section are designed to perform training process for SD voice tag. The pseudo codes below show the calling sequence for training an SD voice tag:

```
// Declare shared memory using data type union in C.
union ShareMem {
	BYTE lpbyMemPool[N];
	// N can be obtained with function DSpotterSD_GetMemoryUsage(...).
	<Other buffers used by application>
} ShareMem;

DoVR_train(…)
{
	<Prepare storage (possibly in flash) for utterance buffer>

	// Create a trainer
	hDSpotter = DSpotterSD_Init(…, ShareMem.lpbyMemPool, N, …);
	if (hDSpotter == NULL)
		goto L_ERROR;

	// Preparation stage: adding utterances to train a voice tag
	if (DSpotterSD_AddUttrStart(…) != DSPOTTER_SUCCESS)
		goto L_ERROR;

	<Start Recording>

	while (1)
	{
		<Get PCM samples from recording device>
		if (DSpotterSD_AddSample(…) != DSPOTTER_ERR_NeedMoreSample)
			break;
		// Use DSpotterSD_GetUttrEPD(…) to get the starting point of the input
		// utterance, and then start to compress it and write to data flash. (Optional)
		// if (DSpotterSD_GetUttrEPD(…) == DSPOTTER_SUCCESS)
		//	<Compress recorded voice data and write it to data flash>
	}

	<Stop Recording>

	if (DSpotterSD_AddUttrEnd(…) != DSPOTTER_SUCCESS)
		goto L_ERROR;
	// Use DSpotterSD_GetUttrEPD(…) to get the ending point of the input utterance,
	// and move the compressed voice to external flash of larger size. (Optional)
	// if (DSpotterSD_GetUttrEPD(…) == DSPOTTER_SUCCESS)
	//	<Move the compressed voice data from data flash to SPI flash>

	// Training stage, and then add voice tag to the model for recognition
	if (DSpotterSD_TrainWord(…) != DSPOTTER_SUCCESS)
		<Error Handling …>

L_ERROR:

	DSpotterSD_Release(…);
}
```

DSpotterSD_AddUttrStart

Purpose

Prepare to add a new utterance for training.

Prototype

INT DSpotterSD_AddUttrStart(HANDLE hDSpotter, SHORT *lpsDataBuf, INT nBufSize);

Parameters

hDSpotter(IN): Handle of the trainer.

lpsDataBuf (IN/OUT): The pointer of data buffer in **DATA FLASH** to store voice input.

nBufSize(IN): Size in bytes of the data buffer *lpsDataBuf*.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

The data buffer *lpsDataBuf* is a pointer to internal data flash, or it can be pointing to external flash through SPI bus, as long as the bus is fast enough with address mapping hardware equipped. Internally in this function, user-implemented functions *DataFlash_Write(…)* and *DataFlash_Erase(…)*, as described in the next section, are employed to access the data flash. If RAM is large enough, developers can also use RAM to simulate data flash when implementing these 2 functions. Note that DSpotter SDK assumes the page size for erasing flash is 4KB. For the consideration of efficiency, pointer *lpsDataBuf* has to be 4KB aligned and *nBufSize* a multiple of 4KB. If *lpsDataBuf* is NULL, this function returns the required size of the data buffer rounded to a multiple of 4KB. Currently the time duration of one voice tag is 3 second, which requires around 16KB data buffer. If given less than 16KB, the maximum length of voice tag shrinks by ratio. ex. 1.5 second voice tag for given 8KB data buffer

DSpotterSD_AddSample

Purpose

Add voice samples to the trainer for training.

Prototype

INT DSpotterSD_AddSample(HANDLE hDSpotter, SHORT *lpsSample, INT nNumSample);

Parameters

hDSpotter (IN): Handle of the trainer.

lpsSample(IN): An array of 16kHz, 16-bit, mono-channel PCM raw data.

nNumSamples(IN): Number of samples in *lpsSample*.

Return value

DSPOTTER_ERR_NeedMoreSample indicates that the caller should call this function again, otherwise *DSPOTTER_SUCCESS* for successfully obtaining a recognition results, or negative error code otherwise.

DSpotterSD_AddUttrEnd

Purpose

Finish the adding process for training a voice tag.

Prototype

INT DSpotterSD_AddUttrEnd(HANDLE hDSpotter);

Parameters

hDSpotter (IN): Handle of the trainer.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

Training utterances are added to the trainer by calling *DSpotterSD_AddUttrStart(...)*, *DSpotterSD_AddSample(...)* repeatedly, and *DSpotterSD_AddUttrEnd(...)*, which constitutes the data preparation stage before training a voice tag.

DSpotterSD_GetUttrEPD

Purpose

Get the boundary information of the currently added training utterance.

Prototype

INT DSpotterSD_GetUttrEPD(HANDLE hDSpotter, INT *pnStart, INT *pnEnd);

Parameters

hDSpotter (IN): Handle of the trainer.

pnStart(OUT): Starting point in samples

pnEnd(OUT): Ending point in samples

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

Usually this function is employed when developers want to store user's voice data for playback purpose. Values of *pnStart* and *pnEnd* are valid only when the function returns *DSPOTTER_SUCCESS.*

DSpotterSD_SetEpdLevel

Purpose

Set the boundary information of the currently added training utterance.

Prototype

INT DSpotterSD_SetEpdLevel(HANDLE hDSpotter, INT nEpdLevel);

Parameters

hDSpotter (IN): Handle of the trainer.

nEpdLevel (IN): Rejection level. The range is [0, 50]

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

Set rejection level of training utterance EPD, if engine can't get EPD correctly, may set after engine init.

DSpotterSD_TrainWord

Purpose

Train a voice tag into a command model for recognition.

Prototype

INT DSpotterSD_TrainWord(HANDLE hDSpotter, char *lpszModelAddr, INT nBufSize, INT *pnUsedSize);

Parameters

hDSpotter (IN): Handle of the trainer.

lpszModelAddr(IN/OUT): The pointer of model buffer in **DATA FLASH**.

nBufSize(IN): Size in bytes of the model buffer pointed by *lpszModelAddr*.

pnUsedSize(OUT): Size in bytes of the voice tag pointed by *lpszWordAddr*.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

This function solely constitutes the training stage. Call this function after the data preparation stage consisting of *DSpotterSD_AddUttrStart(...)*, *DSpotterSD_AddSample(...)*, and *DSpotterSD_AddUttrEnd(...)* calls.

Model buffer pointed by *lpszModelAddr* is in the format of an acoustic model containing only user trained voice tags.*lpszModelAddr* can be pointing to internal data flash, external SPI flash with address mapping mechanism supported, or RAM simulating flash. For more information, please see remarks for *DSpotterSD_AddUttrStart(…)*.

nBufSize contains 340B header(H), and 400B for each voice tag(T) times the maximum number(N) of voice tag, Maximum nBufSize is 16KBytes.

$$nBufSize = H + N \cdot T$$

DSpotterSD_DeleteWord

Purpose

Remove a voice tag from the model for recognition.

Prototype

INT DSpotterSD_DeleteWord(HANDLE hDSpotter, char *lpszModelAddr, INT nIdx, INT *pnUsedSize);

Parameters

hDSpotter (IN): Handle of the trainer.

lpszModelAddr(IN/OUT): The pointer of model buffer in **DATA FLASH**.

nIdx (IN): The command index.

pnUsedSize(OUT): Size in bytes of the model pointed by *lpszModelAddr* after removing the voice tag.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remarks

When a command is successfully removed from a model, the command index for the other survival voice tags may be changed.

Parameter *lpszModelAddr* can be pointing to internal data flash, external SPI flash with address mapping mechanism supported, or RAM simulating flash. For more information, please see remarks for *DSpotterSD_AddUttrStart(…)*.

DSpotterSD_SetBackgroundEnergyThreshd

Purpose

Set Energy threshold for SD Trainning.

Prototype

INT DSpotterSD_SetBackgroundEnergyThreshd(HANDLE hDSpotter, INT nThreshold);

Parameters

hDSpotter(IN): Handle of the trainer.

nThreshold (IN):Base RMS value, default is 1200.

Return value

DSPOTTER_SUCCESS for success or negative error code otherwise.

Remark

While training voice tag,Engine will check first 10 frames's average RMS value,if RMS greater than 4 times of Base RMS value, *DSpotterSD_AddSample(...)*,will return DSPOTTER_ERR_NoisyEnvironment.

5.4. User-Implemented Flash Operation Functions

DSpotter trainer needs data flash to store the training utterances to train a voice tag. To optimize the resource usage to the most extent, we leave the flexibility to application developers to and manipulate the data flash. It is therefore developers' responsibility to correctly implement the flash access functions listed in this section. Though these functions are intended for accessing flash, developers can actually use RAM to simulate flash in the implementation if RAM is large enough.

DataFlash_Write

Purpose

Write data into data flash.

Prototype

INT DataFlash_Write(BYTE *lpbyDest, BYTE *lpbySrc, INT nSize);

Parameters

lpbyDest (OUT): The pointer of destination data buffer in **DATA FLASH**.

lpbySrc (IN): The pointer of source data buffer.

nSize(IN): Size in bytes of the source data buffer *lpbySrc*.

Return value

0 for success or negative error code otherwise.

DataFlash_Erase

Purpose

Erase the flash given the starting address and its size.

Prototype

INT DataFlash_Erase(BYTE *lpbyDest, INT nSize);

Parameters

lpbyDest (OUT): The pointer of destination data buffer in **DATA FLASH**.

nSize(IN): Size in bytes of the destination data buffer *lpbyDest*.

Return value

0 for success or negative error code otherwise.

Remarks

Trainer assumed the flash page size is 4KB currently. In other words, the input value of *nSize* is always a multiple of 4KB and pointer *lpbyDest* is 4KB aligned.

6. DSpotter SDK Error Code Table

Error Symbol	Error Code
DSPOTTER_SUCCESS	0
DSPOTTER_ERR_IllegalHandle	-2001
DSPOTTER_ERR_IllegalParam	-2002
DSPOTTER_ERR_LeaveNoMemory	-2003
DSPOTTER_ERR_LoadModelFailed	-2005
DSPOTTER_ERR_NeedMoreSample	-2009
DSPOTTER_ERR_BuildUserCommandFailed	-2013
DSPOTTER_ERR_Rejected	-2020
DSPOTTER_ERR_LicenseFailed	-2200
DSPOTTER_ERR_CreateModelFailed	-2500
DSPOTTER_ERR_WriteFailed	-2501
DSPOTTER_ERR_NotEnoughStorage	-2502
DSPOTTER_ERR_NoisyEnvironment	-2503
DSPOTTER_ERR_VoiceTooShort	-2504
DSPOTTER_ERR_VoiceTooLong	-2505

7. DSpotter Supported Languages

Arabic	Bahasa(IDN)	Bahasa(MYS)
Cantonese(HK)	Chinese(CHN)	Chinese(CHN)/English
Chinese(TWN)	Dutch	English(AU)
English(IN)	English(PHI)	English(SEA)
English(SG)	English(TWN)	English(UK)
English(US)	English(Worldwide)	French
German	Hindi	Italian
Japanese	Korean	Norwegian
Polish	Portuguese(BRA)	Portuguese(EU)
Russian	Spanish(EU)	Spanish(LA)
Taiwanese	Thai	Turkish
Vietnamese		