

Integrated Circuit Solutions for Voice-Controlled Applications

IN ORDER TO USE SPEECH to control consumer electronics, there is a need to package the technology for speech recognition and language understanding into a small and inexpensive solution. This case study contains an overview of the different solutions together with a comparison of their benefits and drawbacks.

Overview

There are three ways to put speech recognition and language understanding in consumer electronics:

- Multi-purpose processors intended for embedded applications.
- Customized integrated circuits for speech recognition and language understanding.
- Implementing the speech recognition and language understanding as part of a larger integrated circuit in the device

Multi-purpose Processors

The multi-purpose processors are available from a number of manufacturers like Motorola, Intel, Advanced Risc Machines (ARM), and Hitachi. They run software-based programs and can be used for a number of different tasks, for

example speech recognition and language understanding. A multi-purpose processor must be fast, and thus expensive, to meet the demands of computationally heavy tasks like speech recognition.

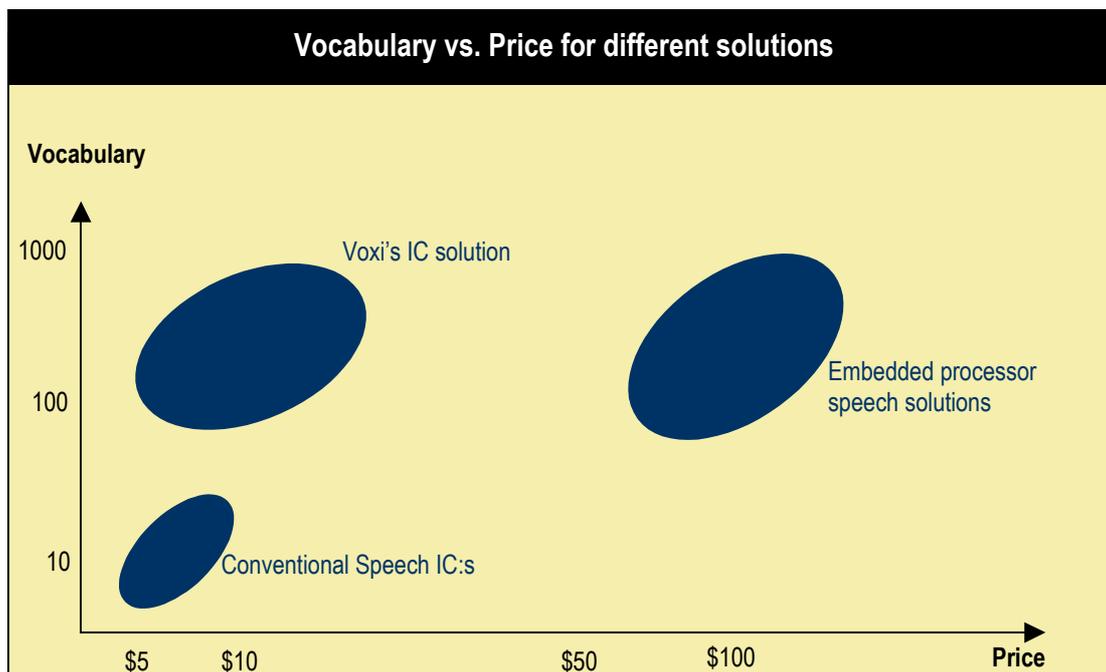
Customized Integrated Circuits

Customized integrated circuits can be adapted and streamlined for their tasks. This makes it possible to use cheaper hardware to solve a computationally heavy task.

Voxi's Integrated Chip Solution

Voxi's chip solution contains both speech recognition and language understanding. It is basically Voxi's software platform implemented on silicon. The solution gives developers advantages that are similar to using a multi-purpose processor, but at a price comparable to the integrated circuit solutions.

The chip design can be realized on either a chip technology called FPGA or as an ASIC. The FPGA makes it possible to produce small quantities at a low fixed cost. FPGAs are used for small quantities, and ASICs are used for larger production series.



Product	Type	Vocabulary	Unit Cost	Type of interaction
Philips HelloIC	IC	< 15 words	< \$5	Menu based
Simon SR 3000 from Information Storage Devices	IC	Up to 50 commands	~ \$5	Menu based
Philips VoCon software	Embedded processor	"Not limited by the platform"	~ \$100	Language understanding with keyword spotting
Voxi dedicated chip	IC	Hundreds of words	\$10-\$20	Natural language understanding
Voxi design on product ASIC	IC	Hundreds of words	\$2-\$10	Natural language understanding

Comparison

Conventional integrated circuits for speech recognition are very limited in their capabilities. They have on average a vocabulary of 20-50 words, of which only 10-20 can be recognized at any given time. This gives no room for natural language understanding. To support more advanced speech interfaces with conventional technology, a multi-purpose processor is needed.

In the comparison table above, the solutions are compared with respect to the following parameters:

- The *type* of solution. An integrated circuit or a solution based on a multi-purpose processor.
- Size of *vocabulary*. The size can range from tens of words to thousands of words. The more words in an application, the more computational power, and thus more expensive hardware, will be needed.
- The approximate hardware cost per unit. For embedded processors and Voxi's solution, there will be additional cost for external memory to store the larger vocabulary and other data.

- The means of *interaction* with an application. The alternatives range from menu-based applications reminding of automatic phone systems to natural language where the user says exactly what he or she would say to a person.

Summary

Voxi's solution combines the advantages of both the customized integrated circuits and the multi-purpose processors.

The chip is inexpensive, but yet powerful enough to handle natural language speech interfaces. Furthermore, the chip design is equipped with Voxi's platform for Intelligent Speech Interfaces™ which provides developers with a solid foundation to build advanced user-friendly speech interfaces.

With Voxi's unique approach, previously unachievable solutions are possible. 

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