APPLICATION USED FOR ACCEPTING AND RESPONDING TO VOICE COMMANDS USED IN THE MATLAB PROGRAMING LANGUAGE, ADJUSTED FOR STUDENTS WITH CEREBRAL PALSY

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Abstract: By introducing accessibility tehnologies used for people with disabilities, allowing them the same conditions for education. One of the ways to effectively help people with special needs is using the technology of speech recognition. Speech recognition can be defined by the ability of a machine or program to identify spoken words and phrases, and convert them to a format readable by the machine. This paper will cover the subject of creating an application using C# and COM (Component object model) framework, that will accept and respond to voice commands used for the MATLAB programming language, specially adjusted for students suffering for cerebral palsy. It will also cover the worlds most helpful trends in helping students suffering from cerebral palsy..

Keywords: MATLAB, COM, C#, celebral palsy

1. INTRODUCTION

Providing for the needs of special education students will certainly is one of greatest challenges as a professional educaton. These students demand more of time and patience; so, too, will they require specialized instructional strategies in a structured environment that supports and enhances their learning potential.

For example students with celebral palsy very often have trouble with typing on keyboard. Sometimes the solution is using special keybords for people with disability. Alternative keyboard and mice for someone are good solution but there are a large number of students with special needs which are also have problems with using it. Belgrade Metropolitan University (BMU) has certain experience with students who have cerebral palsy and this is a reason which they are a central figure. At BMU students often use MATLAB program for solving mathematical and programming problems, so in this paper we adapt MATLAB software for students with special needs. [1]

The main concept of this paper is creating an application using C# and COM (Component object model) framework that will accept and respond to voice commands used for the MATLAB programming language, specially adjusted for students suffering for cerebral palsy. It will also cover the world's most helpful trends in helping students suffering from cerebral palsy..

2. COMPUTER SPEECH RECOGNITION

The introduction of accessibility technology for people with special needs has given them an equal chance of education. One of the ways to aid these people is implementing a way for the computer to recognize their voice (computer speech recognition).

Computer speech recognition (also known as automatic speech recognition) is a way of transforming voice signals into a series of words with the help of an algorithm implemented in a computer program.

Voice recognition can be explained as a process which attempts to identify a person on behalf of something that person has said, and taking that into account, that is what separates speech recognition and voice recognition. One of the uses of speech recognition is using voice for selecting, voice calling and forwarding, simple data inputs(for example, using words for communicating with the computer, as shown in this project), voice and audio content-based searching (upon saying the word, the computer begins the search).

Speech recognition systems use microphones that are connected to the computer and can be used for creating a text file (like e-mails, browsing the internet, moving around applications and menu's, or using a program).

The technology used for speech recognition is commonly connected to the Markovljevs hidden model, dynamic programing, neuron network based approaches etc.

The performance of a speech recognition system is based on precision and speed. The precision is determined by the rate of wrong words, while the speed is determined by the real-time factors. The best success for voice recognition is achieved in controlled environments

3. APPROACH TOWARDS COMPUTER SPEECH RECOGNITION

The most common approach is based on Markovljes model, the model that almost all modern systems are based on. It is a static model which generates a series of symbols and quantities. The reason why the Markovljes model in speech recognition systems lies in the fact that the voice signal can be observed in parts of stationary signals, or a short stationary signal, for example, it can be presumed that speech can be seen as a stationary process in an interval of 10 miliseconds.

The second reason lies in the fact that Markovljes model can be "trained" automatically, which makes it really simple and practical for uses in computers. If the need arises for solving more complicated tasks for speech recognitions, neural networks can be used, but they will not produce the same quality of vocabulary results compared to the Markovljes model.

That type of speech recognition is used when the quality of voice input is low or loud… speech recognition based on a dynamic curve is used when using voice inputs at a different speed.

The dynamic time curve is an algorithm for measuring similarities between these two series of voice inputs that can vary in time and speed.

Knowledge based speech recognition also exists, and it uses embedded databases and commands that compare simple word to those existing in the database.

4. SPEECH RECOGNITION SYSTEMS

When speech recognition patents are in question, Microsoft and Alcatel-Lucent are the holders of the speech recognition patent, and are in a law dispute since 2.mar.2007. The most commonly known speech recognition system is embedded into the Windows operating system and it is called "Windows speech recognition").

The basic functions of this systems are:
- Using commands that will produce a computers response or using voice for text input;
- Voice recognition can also be used for controlling the computer and interacting with Windows, this is achieved by transforming speech into a series of commands.

- Text editing and input is also possible, this is achieved by transforming voice into a text file corresponding to the words spoken.

At this moment, Windows speech recognition is available only in the following languages: English, French, Espanol, German, Japanese, Simplified and Traditional Chinese.

The best known speech recognition project on Serbian is AlfaNum, that was created by the faculty of technical sciences in Novi Sad.

The projects results yielded 2 systems:

- AlfaNumASR which recognizes continuous speech, so it can be used for recognition of whole sentences, not only words. It can work independently from the user and does not need to be specially trained for recognizing new users.

- AlfaNumTTS is a system for speech synthesis. Compared to other languages, the Serbian language is a bit easier to synthesize because the words are written as they are spoken, but it cannot comprehend how the words are accented, that makes synthesized speech uncomfortable for listening.

5. CREATING A VOICE RECOGNATION SOFTWARE IN C# PROGRAMMING LANGUAGE

In order to create voice recognition software in C# programming language we are using Visual Studio 2015 RC. In that application we will call MATLAB functions from C# client, so we must use COM (Component Object Model).

To create a program with speech recognition in C# System.Speech library must be used.

SpeechRecognitionEngine class is available in .NET 4.5, 4, 3.5, 3.0 and .NET 4 Client Profile.The tutorial for creating C# software for speech recognition is used from the code project site [2]

Training for speech recognition engine

Following the tutorial, after coding, the speech recognition engine must be trained. Unfortunately, this is impossible to accomplish from the code itself. It can only be done using the Windows Speech Recognition:
- Open Control Panel
- Go to Ease of Access
- Choose Speech Recognition
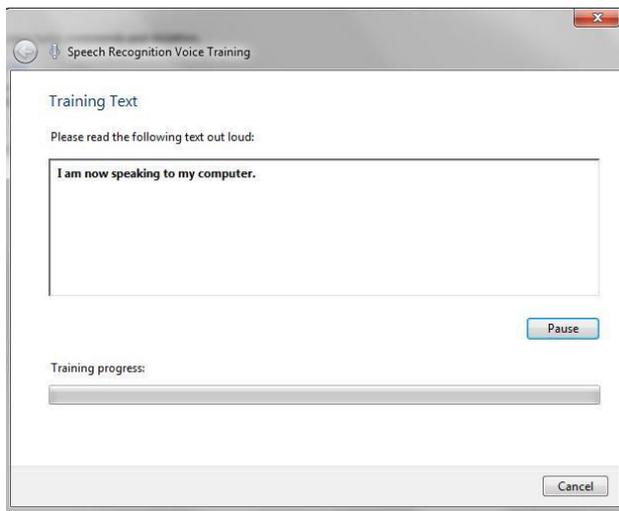- Then choose "Train your computer to better understand you"

Figure 1. Form for text reading

COM (Component Object Model)

COM (Component Object Model) is a Microsoft framework designed for Windows platforms for developing and integrating software components introduced by Microsoft in 1993. [3]

The most powerful idea around component-based software, is that components can be implemented by a programmer and reused by others without having knowledge of the source code. Components are binary packages that can be deployed and further integrated with others written on different programming languages. As component selection and integration is usually an easy and well-known process, components are also called COTS (Commercial Off-The-Shelf).

A component may be implemented with a high specialized language suitable for specific

tasks and used by clients written on more general languages. For example, we could be interested on implementing a specialized component in Matlab, and integrating it into a GUI written on Visual Basic or Tcl/Tk. This situation may be comparable to software written on assembly language (specific and low-level) and linked into C programs using libraries or object code.

COM+ are COM based services first developed for Windows 2000. They extend COM technology with advanced services to manage resource pools, disconnected applications and event publication.

A COM component is an instance of the component object class that runs on the COM server and is accessible from a variety of clients. There are several platforms that can serve COM objects and many clients that can use them.

Matlab COM components are very useful to integrate tasks implemented on this language and exported to other applications. These components can be used later in Microsoft Office Applications (for example Microsoft Excel), Microsoft Visual C++, C#, VB, Tcl/Tk, or even other Matlab clients, in local or distributed applications.

MATLAB COM server

Matlab COM server is included in the default software installation. With COM enabled, developers can implement COM components and use other COM objects. Developers may insert Matlab applications on web (html code) pages or use Microsoft Excel spreadsheets to present numerical results.

Integration of COM Matlab objects can also be distributed, so components may be run from remote machines. This is mainly used for developing parallel solutions, which are typical on many engineering applications, specifically in digital signal processing. The next sections will explain how Matlab COM server works. Furthermore, COM objects are illustrated with some real examples.

5. "MATLAB VOICE" APPLICATION

The "MATLAB Voice" application was develepoed with a goal to allow usage of the MATLAB programming language by using only voice commands. The application itself is not meant to replace MATLAB's development enviorment, but to demonstrate the abilities of this approach. The application allows the execution of virtually all MATLAB commands (calculations, drawing etc.)

Considering COM components and their integration with computer speech recognition, as well as integration of MATLAB with C# - not much was done with combinations like these. This work is specific with its intent to help disabled people (eg. People suffering from cerebral palsy) be able to use the MATLAB enviorment. [4][5][6]

Program development

Basic technical characteristics of the software development process:

- Programing language: C#
- Development Environment: Visual studio 2010
- Development time: 4 weeks
- Number of classes: 6
- Number of lines: around 1100 lines of code
- Testing: White box and Black box

After the development phase, the code went through testing using both white box, as well as black box. After all the Unit tests have been completed, it can be said that the version 1.0 has been created. Image 2 shows the look of the class diagram.
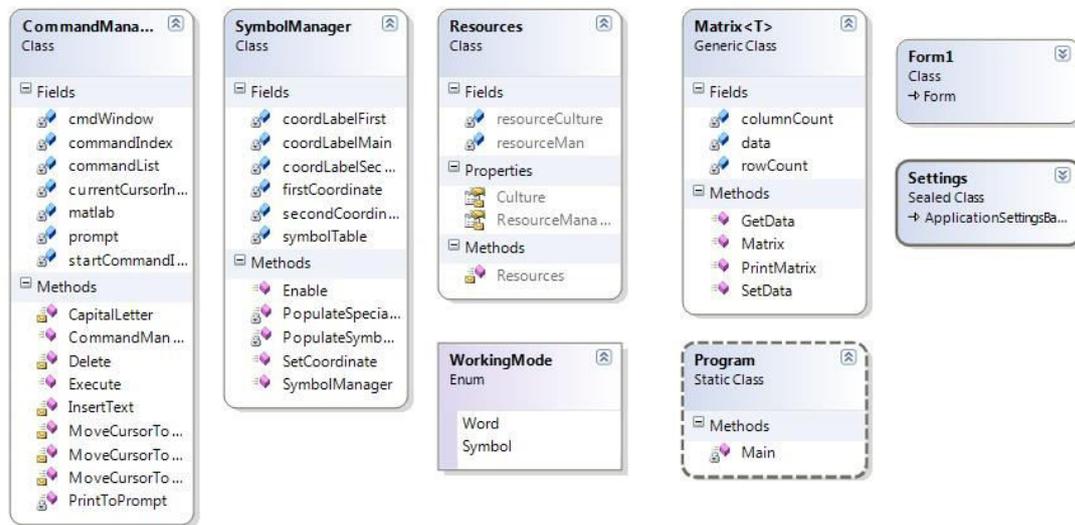
Figure 2. Class diagram for "MATLAB Voice"

Technical requirements needed to run the program:

- Windows 7 or higher
- Net Framework 4.0
- MATLAB

Input of complex data into MATLAB, using the C# client

The most important and hardest point in creating this software is connecting C# and MATLAB.

This example shows the process of data creation in the C# program client, as well as input of this data into MATLAB. The matrix is then returned in the C# program. The reference to the MATLAB library for C# input is:

```
MLApp.MLApp MATLAB = new MLApp.MLApp();
```

Using the C# client, project references are added directly into the MATLAB COM object.
For example: A project is opened in the Microsoft Visual Studio, a reference is added by selecting the "Add reference" option in the project menu. Then, the "COM" tab is selected in the "add reference" window, after that, the MATLAB application is selected.

The complete example is given:

```
using System;
namespace ConsoleApplication4
{
class Class1
{
[STAThread]
static void Main(string[] args)
{
MLApp.MLApp MATLAB = new MLApp.MLApp();

System.Array pr = new double[4];
pr.SetValue(11,0);
pr.SetValue(12,1);
pr.SetValue(13,2);
pr.SetValue(14,3);

System.Array pi = new double[4];
pi.SetValue(1,0);
pi.SetValue(2,1);
pi.SetValue(3,2);
pi.SetValue(4,3);

MATLAB.PutFullMatrix("a", "base", pr, pi);

System.Array prresult = new double[4];
System.Array piresult = new double[4];

MATLAB.GetFullMatrix("a",     "base",     ref
prresult, ref piresult);
}
}
}
```

Calling MATLAB functions using C# client

This example shows a way to call a user-defined MATLAB function, called "myfunc" from the C# programing language.

First, we create a MATLAB function, in the folder C:\temp\example

```
function [x,y] = myfunc(a,b,c)
x = a + b;
y = sprintf('Hello %s',c);
```

After that we create a C # application:

```
using System;
using System.Collections.Generic;
using System.Text;

namespace ConsoleApplication2
{
    class Program
    {
        static void Main(string[] args)
        {
            // Create the MATLAB instance
            MLApp.MLApp    MATLAB    =    new
MLApp.MLApp();

            // Change  to  the  directory
where the function is located
MATLAB.Execute(@"cd c:\temp\example");

            // Define the output
            object result = null;

            // Call  the  MATLAB  function
myfunc
MATLAB.Feval("myfunc", 2, out result, 3.14,
42.0, "world");

            // Display result
            object[]  res  =  result  as
object[];

            Console.WriteLine(res[0]);
            Console.WriteLine(res[1]);
            Console.ReadLine();
        }
    }
}
```

Add references from the C# project in MATLAB COM object using the Microsoft's Visual Studio. Select the "Add reference" option in the Project menu. Select the COM tab in the "Add reference" window, then Select the MATLAB application.

User interface

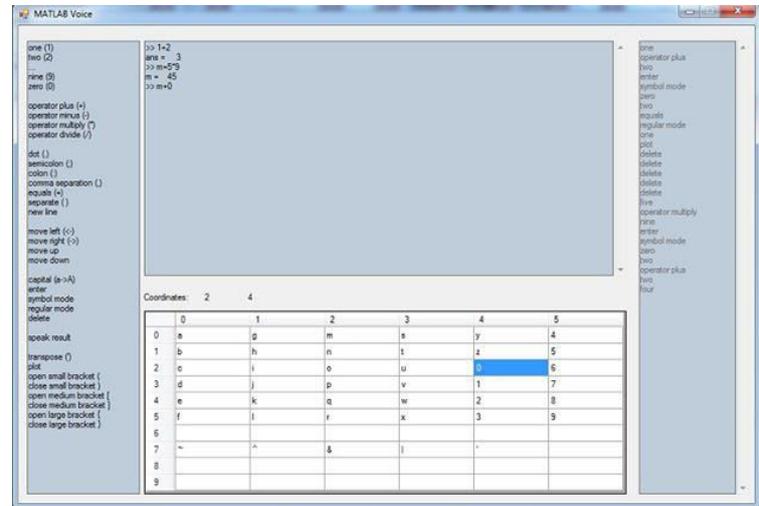In Figure 3 shows the look of the „MATLAB Voice's" user interface

Figure 3. "MATLAB Voice" main window

The main window consists of 4 separate windows

1.   The window that is used like command prompt (To show given commands as well as their results)
2.   Window used as a reminder for basic commands
3.   Window used for textual presentation of given commands (History)
4.   Window used as a virtual keyboard. The point of this virtual keyboard is to ensure the ability to input text that does not contain a word, for example: The user wants to name the variable asd. Seeing as asd is not a word of the English language, such command could not be recognized by the speech recognition algorithm. Besides that, some letters may sound alike, so the virtual keyboard would allow the input of these kinds of letters.
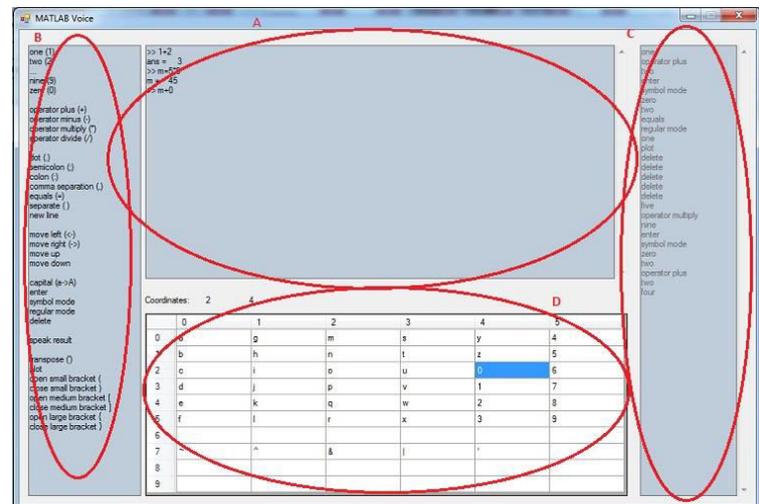

Figure 4. Parts of the "MATLAB Voice" main window

Case scenario for using "MATLAB voice"

After executing the application, the main window is shown to the user. The user could give a MATLAB command using his voice, while looking at the basic commands he could use, shown in window 2.

If the command the user wants is not on the list, the user could switch to using the virtual keyboard by saying the command "symbol mode", and input the wanted command "Letter by letter" by referencing 2 coordinates for each symbol.

The user could close the virtual keyboard using the "regular mode" command. It's important to note that the difference between symbol and regular modes is only seen in the interpretation of spoken numbers.

In the first case, the numbers are interpreted as the symbol's coordinates in the table, while in the second case they are interpreted in their original meaning – commands.

For the successful use of this application, extensive knowledge of the MATLAB programming language is required.

5. CONCLUSION

In this paper, we have created the application using C# and COM framework that is used to accept and respond to voice commands used for MATLAB programming. This software is specially adjusted for students suffering from cerebral palsy, in order to help them while using the MATLAB programming language, which is necessary if they are students of BMU.

ACKNOWLEDGMENT

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