Development of Software for Developing Information Systems Design Skills Considering Issues for Visually Impaired People Inclusion

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Abstract. The article is devoted to the problem of development information systems design skills considering issues for visually impaired people inclusion. It is established that the known training tools for information systems design are based on the principle of visualization. This makes it impossible to study the design of information systems for visually impaired people and requires the search for new means of education for the design of information systems. The information system has been developed for improving the design skills of the information systems for people with visual impairments.

Keywords: Inclusive Education, Vocational Training, Design of Information Systems, Information Systems Design Skills, Software.

1   Introduction

The important problem of modern education is the fight against stereotypes regarding the capabilities and potential of people with visual impairments and discriminatory views in relation to them. Social exclusion and barriers created by the lack of an appropriate educational space do not allow them to fully participate in the activities of the society and realize themselves as individuals.

Let look at statistics: The World Health Organization estimates that more than 1 billion people have some form of disability, accounting for almost 15% of the world's population. In Ukraine, more than 2 million 800 thousand people are disabled. And nearly 80 percent of people with disabilities are people of working age. The number of persons with disabilities among students of institutions of higher education in Ukraine is 12788 [1].

The analysis of the practice of training students with visual impairments in Ukrainian universities shows that they can successfully study on a common basis in a typical student group. However, one of the problems faced by students in the learning process is the orientation of educational information on visual perception. The solu-

tion of this problem is a prerequisite for the success of the educational process and the further professional activities of students with visual impairments.

According to this, there are contradictions between: the need to improve training tool in the inclusive space of higher education and insufficiently developed theoretical approaches of this tool; the need for modern training tools for the design of information systems and the mismatch of existing training tools with the conditions of the education in the inclusive university.

The purpose is to analyze the process of developing the skills of designing information systems for people with visual impairments; to develop a software application for getting the designing information systems skills for people with visual impairments.

2 Literature Review

Inclusive education is one of the processes of transformation of education, based on the understanding that disabled people in modern society can be involved in society [2]. Today, there is an increasing number of people with disabilities, including young people, who need quality higher education. This requires universities to concentrate their efforts on creating the conditions for support for students with special needs [3], [4]. Unfortunately, in the study of Russian scientists, it is noted that the inclusive educational environment is characterized by the lack of functional and technological attractiveness [5].

The effective way of solving the problem of providing quality educational services to visually impaired people in inclusive universities is the use of computer and tiflo technologies [2]. Support of ICT in inclusive education covers issues that are relevant to the range of potential learning needs [6],[7]. For the successful mastery of ICT technologies for the visually impaired and blind user, the following software and hardware are available: screen magnification programs, screen access programs, and speech synthesizers [2]. People with visual impairments need special devices and applications to translate text into alternate formats. There are: JAWS, Cobra, NVDA, Win-dow-Eyes, Thunder, etc.

The study of scientific articles devoted to the problem of ICT technologies for visually impaired and blind persons confirms the special attention of researchers to the introduction of assistive technologies. P. Sinitsyn's work deals with the solution of the problem of adaptation web pages for blind and visually impaired Internet users [8]. Article [9] is devoted to the problem of how user voice interfaces can support inclusive education, especially for visually impaired students.

Scientists pay attention to the audio support of the process of training people with visual impairments [10], [11]. There are works that use the transformation of color space to sound space [12]. However, the problem of developing skills of the design information systems for the visually impaired people is not well researched.

3 Analysis of Automated Systems for Information Systems Design

Today there are many automated systems for designing information systems. As a rule, automated systems for designing information systems include tools for constructing UML diagrams [13]. The software market has a huge selection of software for building UML diagrams. We have analyzed over 40 software, after this, we made a list of the 10 most popular [14]. The following programs were considered: IBM Rational Rose, Borland Together, LucidChart, StarUML, Umbrello, Draw.io, UMLet, yEd, Dia, ArgoUML.

Software developers are often used for design information systems such diagrams as "Use case diagram", "Class diagram" [15]. We were interested in UML tools in terms of their use in the educational process of an inclusive university. The following parameters were selected for the analysis of UML tools: Use case diagram, Class diagram, Open source, Audio accompaniment, Ability to save a diagram, Command interface, Graphical interface, Platform / OS. The results are presented in Table 1.

Table 1. Characteristics of UML tools

Name	Use case diagram	Class diagram	Open source	Ability to save a diagram	Audio accompaniment	Command interface	Graphical interface	Platform / OS
IBM Rational Rose	+	+	-	+	-	-	+	Windows, Linux, Unix
Borland Together	+	+	-	+	-	-	+	Cross-platform
LucidChart	+	+	-	+	-	-	+	Windows, MacOS, Linux, Solaris
StarUM L	+	+	-	+	-	-	+	Windows, Macos, Linux
Umbrello	+	+	+	+	-	-	+	Cross-platform
Draw.io	+	+	+	+	-	-	+	Cross-platform
UMLet	+	+	+	+	-	-	+	Windows, Linux, MacOS
yEd	+	+	+	+	-	-	+	Windows, Linux, FreeBSD, Mac OS X
Dia	+	+	+	+	-	-	+	Cross-platform
ArgoUML	+	+	+	+	-	-	+	Cross-platform

Program analysis showed that all programs have only a graphical interface and none of them has an audio interface. Working with design tools requires a compulsory visual perception of the information. On the one hand, this makes it impossible to study the design of information systems for visually impaired people, on the other, it

requires the search for new training tools for the design of information systems for visually impaired people.

4 Requirements for a Training Tool for Information Systems Design for Persons with Visual Impairments

The training tool for the information systems design in the inclusive university must meet the following requirements: suitability for the education of both ordinary and visually impaired students; the presence of a command interface that has all the same capabilities as the graphical interface; multiple media output - graphics and audio.

Let's take a look at the requirements for the training tool.

1. Ability to create, edit and delete UML chart elements. The editor should keep a general index of all the elements, which makes it possible to conveniently view the list of relations between these entities. The main graphical elements for diagrams that should be supported by the software application: Actor; Use case; Class; Interface; Object; Package; Attribute; Operation; Dependency; Realization; Generalization; Association; Aggregation; Composition.

2. Ability to save and download the project.

3. Ability to export created diagrams in raster format. For example, in PNG.

4. The presence of a user interface for visually impaired users.

5. The modern user interface. With the help of different visual elements, the user can learn and change diagrams much faster.

6. Independence from the operating system. It would be desirable if the editor worked in any of them.

7. Free development and execution environment.

Analyzing the given data, we outlined the stages of development: creation of a graphical interface; implementation of CRUD project implementation operations; implementation of operations of execution of CRUD of UML elements; implementation of editing of UML elements; saving and downloading the project; an export of diagram in graphic format (SVG, PNG); implementation of command interface; providing voice guidance for user actions. The web application architecture was chosen to develop the training tools for the design of information systems.

5 Algorithm and Software

UML activity diagram for information systems design for persons with visual impairments is shown in Fig. 1.

The developed tool is intended to solve the problem of the unadaptability of modern means of designing information systems for the visually impaired. It has several advantages over other graphic constructors: - a convenient system for creating diagrams, by dragging the finished stencils from the stencil window to the workspace. At the same time, all stencils are in front of the eyes, easy switching between libraries, all actions are visual and minimized; - the presence of a command interface that has

all the same capabilities as the graphical interface; - multiple outputs - graphics and audio. The following document formats are supported: own JSON based format; PNG (PNG) format.

The program is built on HTML5 and Javascript web standards, supported by all new browsers such as Google Chrome, Firefox, Safari and Internet Explorer 8+.
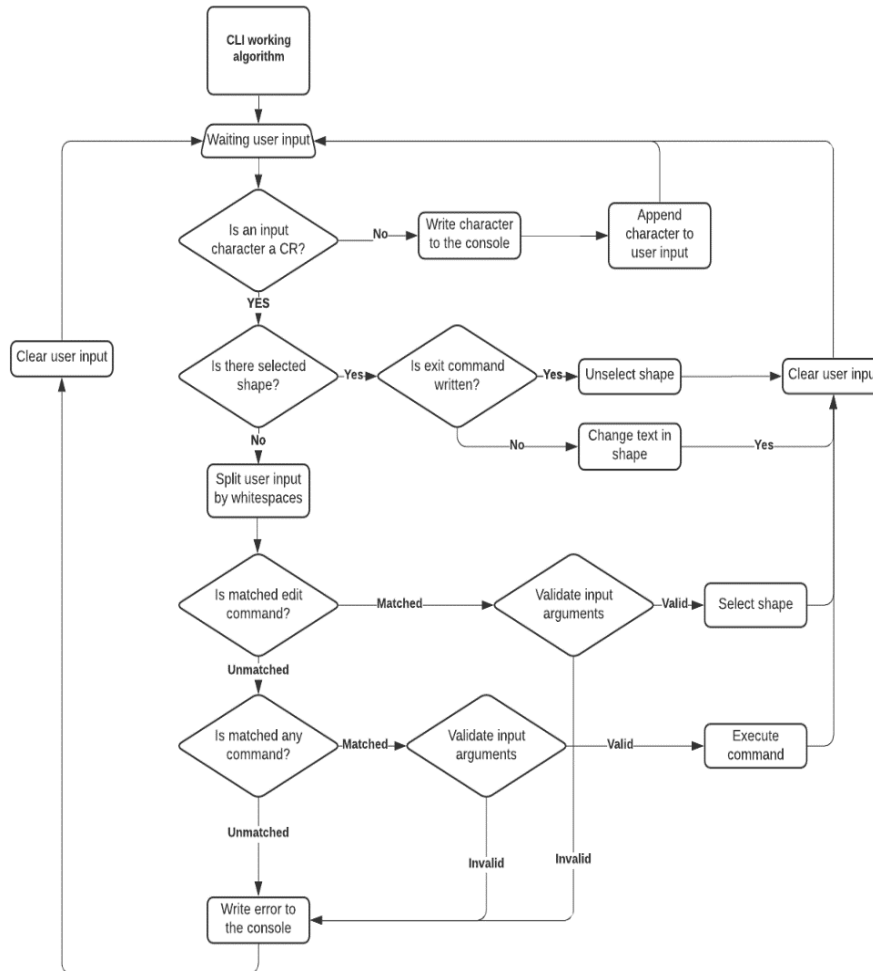

Fig. 1. UML activity diagram for information systems design for persons with visual impairments

Most document element operations can be performed in two ways: graphical and text interfaces. Because the text interface is intended for users who cannot, for one reason or another, perceive graphical information, commands, results, and errors are voiced using a voice assistant built into the operating system.

The list of commands, their functional description and an example of use are given in table 2.

Table 2. List of software commands

Command	Functional description of the command	Example
USECASE	Creates a Use case diagram. Takes two numerical parameters - coordinates	USECASE 50 50
ACTOR	Creates an Actor chart. Takes two numerical parameters - coordinates	ACTOR 50 50
PACKAGE	Creates an element Package. Takes two numerical parameters - coordinates	PACKAGE 50 50
CLASS	Creates an element Class. Takes two numerical parameters - coordinates	CLASS 50 50
INTERFACE	Creates an element Interface. Takes two numerical parameters - coordinates	INTERFACE 50 50
OBJECT	Creates an element Object. Takes two numerical parameters - coordinates	OBJECT 50 50
DELETE	Removes an item. Accepts one parameter - the ID of the item to be deleted	DELETE 1
SELECT	The multifunctional command. It has 4 uses. GET with attribute name allows you to get an attribute value. CLEAR with attribute name - remove attribute text. ADD with attribute name and text allows you to add text to the selected attribute. CHANGE with attribute name - Go to edit mode. You can exit it using the OK.	SELECT 1 GET name SELECT 1 CLEAR name SELECT 1 ADD name Class SELECT 1 CHANGE name
CONNECT	It allows you to establish a relationship between the two elements. It accepts three parameters - two identifiers of elements and a link type	CONNECT 1 2 ARROW
MOVE	Moves the chart to a new location. Accepts three parameters - identifiers of elements and coordinates on the sheet	MOVE 1 100 100
LIST	Displays a list of all elements with their identifiers	LIST
SAVE	Saves and uploads the document to your computer	SAVE
CLEAR	Clears the command window	CLEAR

Consider in detail the work of the program.

When running the program, the window shown in Figure 2 appears in front of the user. To add a chart element, you must drag the corresponding image from the toolbar to the work area of the application. The same result can be obtained by entering one of the commands to add the chart and its location coordinates in the workspace. Scheme cannot be posted if another scheme is already in this place.

The application allows you to create, edit, save and download Use case diagrams and Class diagrams. In Fig. 2 depicts a class diagram created with the help of a training tool for information systems design. The class diagram includes describing signatures of operations and relationships between classes.

Voice control of user actions in the application is implemented using Web Speech API. The speech Synthesis interface (available in the object window) provides a number of methods that allow you to control speech synthesis.
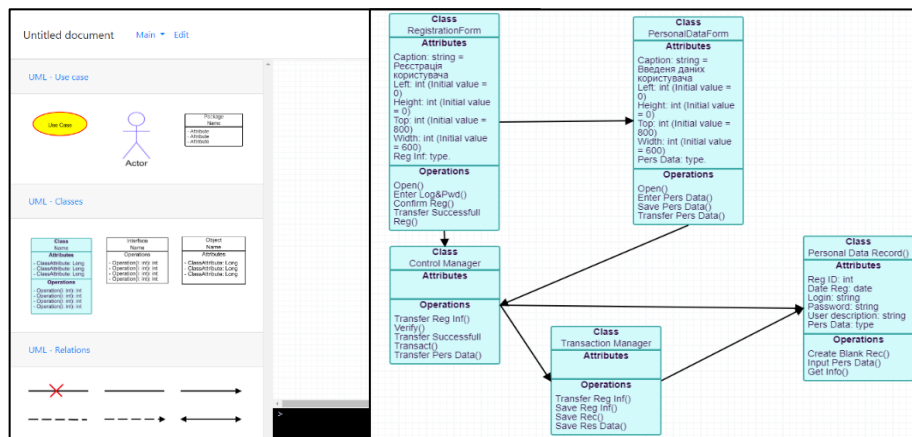

Fig. 2. The main application window

The developed training tool for information systems design solves the problem of forming information systems design skills in an inclusive space of higher education. The application contains a command and graphical interface; It contains several graphic and audio outputs and is therefore suitable for teaching both ordinary and visually impaired students.

6   Conclusions

Inclusive education is one of the processes of education transformation, based on the understanding that disabled people in modern society can be involved in society. The component of the training of a specialist in the field of computer science is the educational component - Design of information systems. The formation of information systems design skills for visually impaired people is impossible without special training tools.

The training tool for information systems design has been developed, which solves the problem of forming information systems design skills in the inclusive higher education space. The application is based on HTML5 and JavaScript web standards, which are supported by all modern browsers. The application allows us to build diagrams of use cases and class diagrams. Also, it contains a command and graphical

interface; several outputs of information - graphic and sound, and therefore suitable for teaching both ordinary and visually impaired students.

The developed system solves the problem of the formation of information systems design skills in the conditions of the inclusive university and is a necessary component of the success of the educational process and the further professional activity of the educational recipients with visually impaired.

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