Platform for Learning and Virtual Reality in Animal Husbandry

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Abstract: - Nowadays, digital technologies are extensively used in the field of education. Virtual and augmented reality and 3D technologies are entering the field of education at all educational levels. They are a prerequisite for the application of new approaches in the presentation of the educational content and its easier perception and assimilation by the learners. The paper presents an integrated platform for open science and educational resource sharing, as well as an environment for distance learning and data analysis in animal husbandry derived from the learning resources of a given course in the system. The research is aimed at developing a computer-aided framework in the field of digitized education and creating new educational resources for distance learning in animal husbandry.

Key-Words: - 3D modeling, Animal Husbandry, Educational Resources, Learning System, Virtual Reality

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1 Introduction

Modern education has rich and varied tools for developing learning content. Thanks to developments in digital and information technologies, virtual tools for the visualization of learning content are becoming increasingly important.

Modern society is building a digital world that is based on innovative information and communication technologies, a connected network of smart devices, and strives to become an intelligent society. This direction of its development imposes new requirements on the education and training of adolescents so that they can be fully integrated into it. A transition is needed from the traditional approach of memorizing content and ready-made algorithms for solving problems to developing abilities and skills for analyzing and evaluating information, creative and critical thinking, and applying the acquired knowledge in solving practical tasks.

It is of primary importance to organize and conduct modern and appropriate training aimed at specialists employed in animal husbandry.

Modern young people aspire to more open and accessible education and science. Open education combines, on the one hand, the established tradition of the exchange of good ideas between educators and sharing and interaction. Educators, learners, and other stakeholders from around the world are joining their efforts to create more accessible and effective education.

There are deficits in the creation of learning resources in the field of animal husbandry that are both freely and easily accessible and visualize learning material in a modern and comprehensible way. It is unthinkable to impose and develop intelligent animal husbandry without guaranteeing an open and modern education.

The work presented in this paper aims to conduct research and analyze systems, methodologies, and tools for the digitalization of education and the development of new educational resources in the area of animal husbandry. Examples include tools and opportunities to develop new educational resources based on augmented reality and virtual reality, as well as the use of three-dimensional (3D) models to visualize learning content.

The paper is structured as follows. Educational resources based on advanced technologies and the digitalization of education are discussed in Section 2. Section 3 presents a learning platform for animal husbandry. The proposed workflow for interactive 3D visualization in virtual reality is explained in Section 4. Some discussion of the results of this study is concluded in Section 5.

2 Related Works

2.1 Educational Resources Based on Advanced Technologies

Immersive learning is a novel concept that uses cutting-edge tools and technologies to build learning

environments where students can experience new worlds and learn through various senses and perceptions, [1].

The objective is to expose the learner to novel circumstances or settings that provide a range of emotions and experiences as well as possibilities for more engaging and inspiring learning. Through the use of mobile devices, helmet-style gadgets, smart glasses, and virtual reality and augmented reality products, immersive learning can be accomplished.

Virtual and augmented reality technologies create a learning space that offers new manners to acquire knowledge and skills through the active participation of learners in ongoing processes, [2]. In the digital (virtual reality) and hybrid (augmented reality) environments, dynamically changing information is supplemented to each learning object. Depending on specific actions with the objects, learners receive additional information resources, i.e. content is context-sensitive. Each new interaction with objects from the real and virtual world elicits a different response that is a source of new knowledge, [3]. In addition, augmented reality helps learners conduct research in the physical world. They are trained in an authentic environment and provided with an authentic real-world experience, [4], [5].

Learners absorb learning content more easily and quickly and understand abstract and complex theories and concepts because they can apply their research approach through virtual and augmented reality technologies. They are given the opportunity to interact, experiment and deeply explore the objects, phenomena, and processes from different perspectives, which is not always possible or safe in the real research process, [6]. Technologies ensure the active participation of learners in learning activities and working with learning content. Their inherent interactivity enhances their interest and commitment to learning new knowledge.

Virtual and augmented reality support practical skills procurement through simulations and learning in a mixed environment. Through the relevant applications, learners can evolve their knowledge by creating, processing, and visualizing virtual objects and 3D models of real objects. Through them, various situations and practical tasks can be recreated, the solution of which leads to the accumulation of experience and practical knowledge.

Because students are required to be active participants in digital learning, educators are looking for ways to make traditional knowledge transfer tools more interactive and engaging, [7]. Through modern technologies, reading can become an active activity, allowing learners to interact with the content, consider it in different aspects, and challenge and create situations that will be a source of new knowledge, [8].

Using information technologies during the development of textbooks turns them into interactive e-books. A new direction in the development of interactive textbooks is the use of augmented reality technology, through which reading turns from a passive and one-way process into an interactive and engaging experience. Technology enriches printed materials with visual multimedia information, 3D objects and animations, interactive and game elements, test questions, and more, that facilitate learning content to perceive and more interesting for learners. Augmented reality textbooks allow interaction with the virtual content, exploration, and experimentation, which ensures active learning and a better understanding of the learning content, especially for complex and abstract concepts.

3D technologies are entering the field of education at all educational levels. They are a prerequisite for the application of new approaches in the presentation of the educational content and its easier perception and assimilation by the learners.

The usage of printed 3D models supports faster knowledge and skills acquisition. Physical interaction is a key factor in the acquisition of specific skills in various domains, [9]. Using 3D printing in education allows virtual objects and models from computer programs to be transformed into real, physical-world objects and available for physical manipulation by students. There are opportunities for studying the objects in detail, viewing them from different perspectives, and conducting experiments. Theoretical and abstract concepts are transformed into the physical world, and can be seen, touched, and acted upon and these are new ways of active learning and learning, higher engagement, and motivation, [10].

The use of a computer-generated virtual simulator is highly applicable in the field of natural and biological sciences. It can be used to explain significant processes in animal husbandry. The technology to create this computer-generated reality is increasingly available.

A cloud platform for animal husbandry is presented in [11]. The platform utilizes the two-wing, multi-level cloud-side architecture, which is divided into three sections: a platform for data centers, a platform for resource sharing, and a platform for cloud services.

A web-based platform called ANIPHI for learner-centered teaching of farm animal welfare is presented, [12]. With embedded films showing various animal husbandry techniques utilized in various livestock types and nations, ANIPHI can be

used by educators in a classroom setting, online, or a mix of the two.

Based on the concepts of experiential learning, an educational tool for computer-assisted learning (CAL) has been created, [13]. Its goal is to enhance veterinary students' capacity to evaluate critically the consequences of animal husbandry practices discovered during their work on sheep farms. The CAL includes lectures, concept maps, multiple-choice questions, movies of animals in various husbandry situations, and open-ended questions.

2.1.1 Digitalization and Analysis of Education

The analysis and prediction of learning, as well as the development of new types of educational materials, is a research area that poses a new challenge to analyze a large number of educational resources as well as learner-generated data as efficiently and meaningfully as possible. Nowadays, many researchers are focused on learning analytics and proposed different approaches to the learning process. Centralized learning systems represent the most widely used data source for digitalization of education and learning analysis, as well as most commonly used techniques are prediction and classification, [14]. Learning analytics is used in recommender systems. Recommendations are generated for implementing learning impact analysis on learning, such as focusing on learning impact by extending existing practice.

Every educational organization has a Learning Management System (LMS) that supports the core-training process. The LMS generates data based on various activities and educational resources, such as student activity logs, course activity logs, course content, or student assessment results. This data needs to be analyzed and the results are taken into account to improve student learning outcomes. This type of system allows transferring knowledge of any type - static, dynamic, interactive, logical, etc. There is an effective system for managing users, evaluating activities and knowledge, and in general, a comprehensive organization of the learning process. In this way, an opportunity to train future specialists in the field of animal husbandry is provided.

Most data mining techniques are well suited for learning analysis and prediction. Some basic data mining techniques such as clustering, statistics, association rules, and regression are most used for learning analysis and prediction. Other techniques, such as text mining, pattern mining, causal inference, and scoring are not often used because obtaining attributes is complex, [15].

Moodle is a widely used LMS and learning analytics is integrated as it uses a machine learning backend. Specific Moodle data mining tools are developed that apply clustering techniques to classify the students. The classifier shows basic student characteristics in each group and allows the classification of new students.

For some time now, course administration tools like WetCT, Blackboard, Sakai, or Moodle have aided instructors in the process of organizing their courses. An integrated platform for resource management, communication, and assessment is provided by such systems, [16].

Recently, open-source tools for creating online courses have been released. Massive Open Online Courses (MOOCs) and Large Open Online Courses (LOOCs) are being made possible by these platforms. Maintaining student motivation, accurately grading pupils, and developing and overseeing a positive collaborative environment are some of the difficulties, [15].

Educational content corresponding to the curriculum (lectures, seminar and laboratory exercises, practical training), including tasks for independent work for ongoing control of students' work, is published in the digital environment. The learning content is presented as learning resources - files in different media formats (text, audio, video files, presentations, etc.). The developed digital educational resources for learning subjects from curricula with digital educational content are implemented and accessible on a software platform by using its interactive capabilities in different media formats:

- Electronic textbook - structurally divided into lessons and sections, accompanied by interactive materials, examples, facts, etc.
- Interactive materials – animated images, three-dimensional models to allow better exploration of objects, models, animations and interactive simulations, graphs, tables, images, text files, presentations in appropriate electronic format, audio or video lectures, e-mail, and video conferencing.
- Virtual elements – hypertexts, hyperlinks, links to files and sources on the Internet.
- Electronic tests, including an exam procedure for intermediate and final control, questions and tasks that cover the learning material with instructions for its completion, amount and type of questions included, time to solve them, need to use aids, the evaluation algorithm, and other instructions.

3 Platforms for Learning in Animal Husbandry

A solution is proposed for an integrated platform for open science and open access to research results and an environment for distance learning and data analysis in animal husbandry derived from the learning resources of a given course in the system. The platform integrates methods and tools for integration, preprocessing, storage, analysis, and visualization of animal husbandry data. The main layers and elements of the platform architecture are shown in Fig. 1.

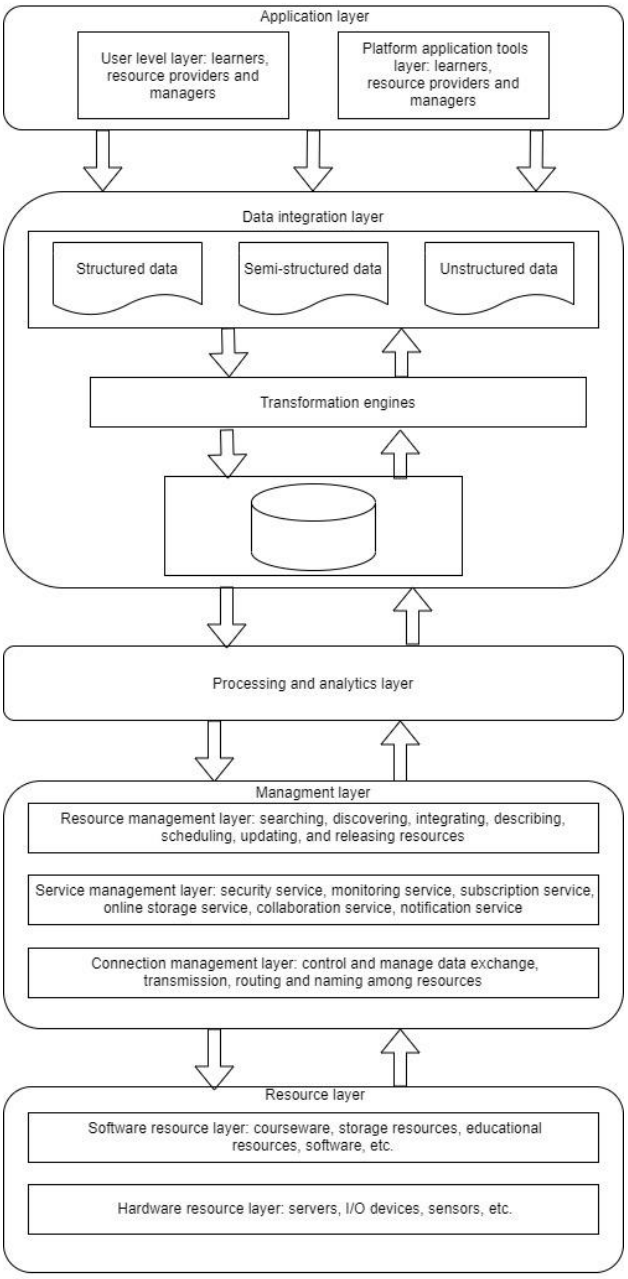

Fig. 1. Open science and resources sharing platform architecture

The architecture of the platform follows the concept of discovering knowledge from datasets and covers the following: (1) data selection, integration, and preparation, (2) processing and analysis of the selected data sets, and (3) visualization and interpretation of the results (Fig. 2).

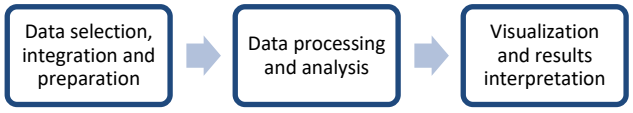

Fig. 2. Workflow for knowledge discovery from educational data

The platform architecture consists of four layers as follows: a data layer containing structured, semi-structured, and unstructured data, a layer for data searching and integration from different sources and in different formats, data preprocessing – selection, cleaning, and filtering, data analytics, and results visualization layer.

The data integration layer implements modules for extracting and storing data collected from various sources such as learning management systems and educational resources. Datasets are stored in a developed open repository for providing educational resources. Analytics Engine performs data processing and analysis for predictive modeling based on the data in the repository and predefined rules.

The proposed platform is directed toward intelligent data management, analysis, and visualization. The research work is aimed at developing a computer-aided system in the field of digitized education and creating new educational resources for distance learning in animal husbandry.

4 Workflow for Interactive 3D Visualization in Virtual Reality

The workflow for interactive 3D visualization in virtual reality includes the processing of multidimensional images of animal anatomical organs, obtained from for example computed tomography or nuclear magnetic resonance, to create 3D reconstruction (Fig. 3). The resulting 3D reconstruction can be exported as a 3D model and imported to interactive visualization software.

If necessary, before importing the images into the reconstruction software, they can be pre-processed to improve the characteristics of the images and potentially improve the quality of the reconstructed 3D model. Images are loaded into data representation

software and reconstructed as a three-dimensional model from multidimensional images. The proposed workflow is verified through Slicer3D software, [17], [18], used in the development of the workflow.

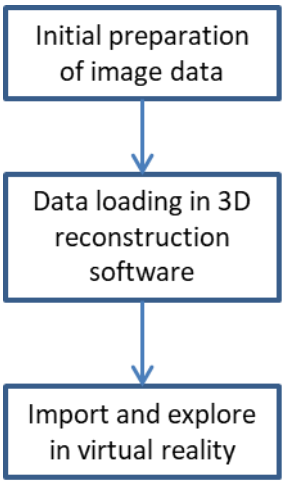

Fig. 3 Workflow for 3D models reconstruction from images in virtual reality

Slicer3D is open-source software, developed primarily for scientific purposes that allows the import of various medical data and the construction of 3D reconstructions from them. Slicer3D is software for solving advanced computational imaging challenges.

Fig. 4 and Fig. 5 show multidimensional image data loaded into the 3D Slicer. Fig. 4 shows a three-dimensional visualization of a mouse skull created from the loaded data, while Fig. 5 is a rendered 3D rendering of a gorilla skull.

3D Slicer also has a rich ecosystem of plugins, including a virtual reality visualization and exploration plugin, [19], that provides standard functionalities such as changing viewpoints, snapping objects, and using intersecting planes to explore the interior of models.

In case additional capabilities are required for the research being performed, it is necessary to export the models from the reconstruction software and import them into a virtual reality software supporting the required capabilities.

5 Conclusion

The work presented in this paper is aimed at research and analysis of systems, methods, and tools for the digitalization of education and the creation of new educational resources in the field of animal husbandry such as tools and opportunities to create new educational resources in the field of animal husbandry based on augmented and virtual reality, and using three-dimensional (3D) models to visualize learning content.

The proposed platform provides a variety of ways to access and share educational resources through digital technologies and a repository to provide access to free online courses and learning content.

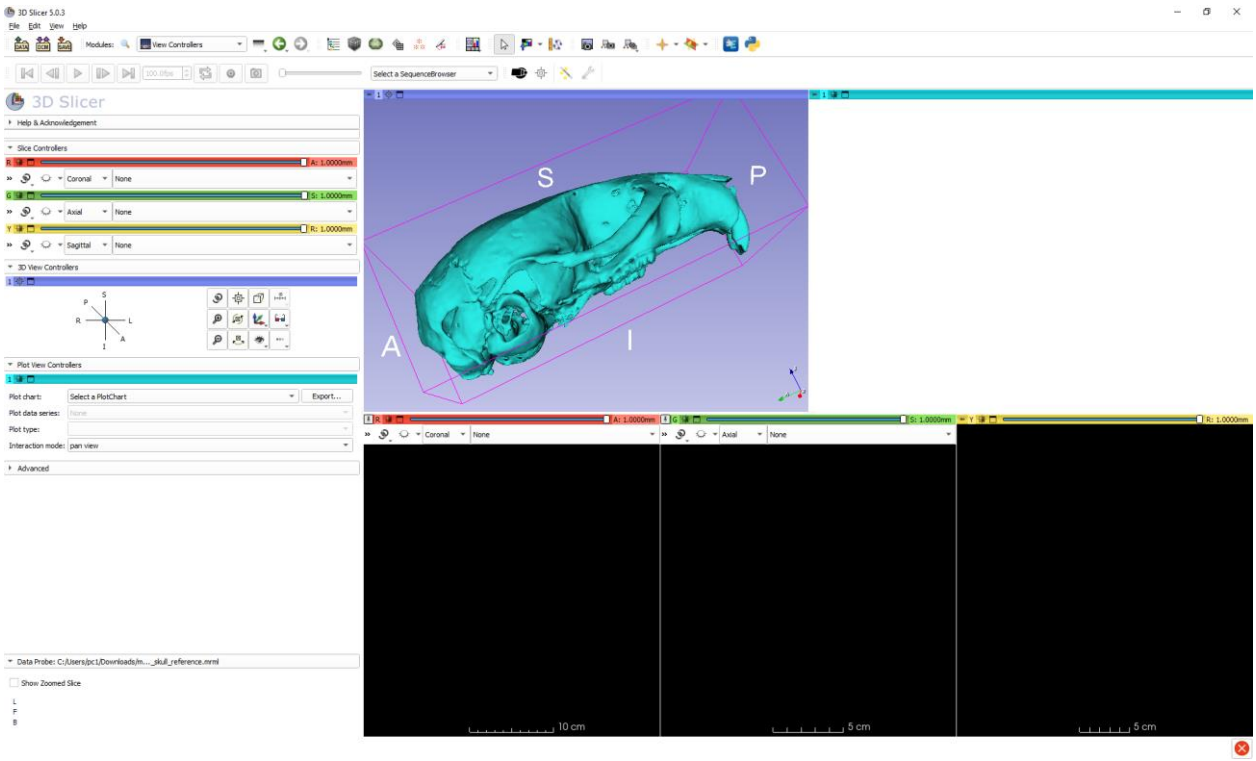

Fig. 4. 3D rendering of a mouse skull

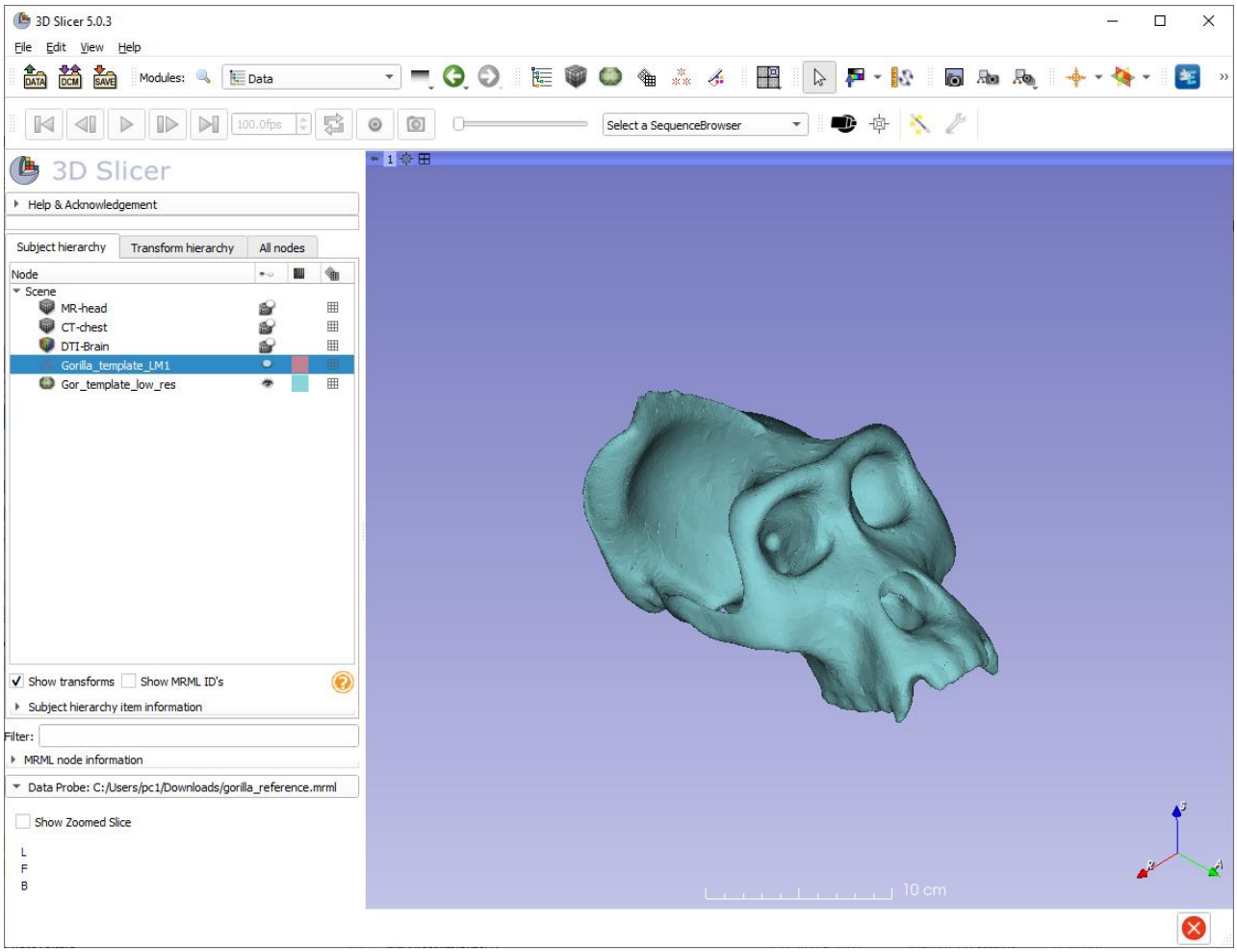

Fig. 5. 3D rendering of a gorilla skull

To build a three-dimensional reconstruction, a procedure that incorporates intermediate image processing, such as computed tomography or nuclear magnetic resonance, has been designed. Through the usage of the virtual reality plugin, an interactive visualization has been created using the 3D Slicer platform.

The resulting three-dimensional reconstruction can then be exported as a three-dimensional model and imported into interactive visualization software.

The educational resources developed are suitable for use in expanding existing or creating new digital repositories for open science and education in the area of animal husbandry.

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Conflict of Interest

The authors have no conflicts of interest to declare.