New methods for the study of hydrometeorological metric data systems: the experience of Kazan Federal University

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Abstract. A new technology is analysed: a mobile application that allows one to process images and recognize various objects of hydrometeorological metric data systems. As an example, the results of real image processing by the application are shown. Recommendations for the use of this method in different focus areas of hydrometeorology are given.

1. Introduction

E-learning is the most effective form of education at the moment. It allows one to achieve competent training and to maintain the required level of students' qualification. For students of higher professional education there are many e-learning tools: multimedia manuals, e-courses, webinars, etc. Informational and reference systems stand out from the other types of e-learning tools. They allow one to store, add, and demonstrate information to mentors and students (they include, for example, various academic databases). Information and communication technologies give those of us who wish to increase the educational level and to know something new infinite possibilities to use almost unlimited resources worldwide.

The objective of this research and the electronic educational product developed by the authors is to provide conditions for students' professional growth in different fields of hydrometeorology and personal self-identification.

Naturally, the introduction of new technologies should be carried out with the consideration of the discipline trends. This is especially important for students who study nature and engineering. To obtain competency in these areas, off-campus study is not enough, it is necessary to use additional electronic systems and tools for tutorial verification and control of knowledge. An application program created by the authors belongs to this type of electronic learning tools. It will teach competencies, develop skills; also, after investigating this program students will really know more and will be able to work more efficiently and make fewer mistakes.

Thus, it becomes possible to ensure better quality of training hydrometeorologists at the University. Studying in this electronic multimedia product adapted to hydrometeorological information-measuring systems will allow consolidating the acquired knowledge, skills, and abilities by applying them in educational practice.
2. Methodological basis of research

This electronic educational product is based on the Aurasma application platform. It uses an augmented reality technology to animate magazine pages, photographs, posters, and other objects of mass use, captivating the user and successfully achieving its advertising goal [1]. This informational and search system is especially relevant as an instrument of self-education and self-development.

The Aurasma technology was developed in Cambridge by the Autonomy Corp. and was first shown to the public at MipTV-2011 in Cannes. On May 5, 2011 the mobile version of Aurasma for iPhone was launched, and in June of the same year a version for Android appeared. Since its official launch Aurasma has become the backbone of more than 2,000 applications, and has linked partnerships with 20,000 organizations from more than 100 countries. Among the most famous service applicants are KFC, Marvel Entertainment, Universal Pictures, Tesco, and others.

Aurasma's principle of operation is similar to the widely used technology for recognizing QR codes [2]. The application uses a phone camera, GPS, Bluetooth, Wi-Fi, an accelerometer, and a horoscope to identify various objects from the surrounding space. Then these objects broadcast on the device screen with overlaid pictures, video or other files called auras.

The creator of the label by which Aurasma will recognize the object configures the display result and the broadcast time. To help users in their initiatives, the creators of Aurasma have included a package of ready-made auras. However, it is assumed that the users themselves will create them all.

Availability is the primary advantage of the Aurasma technology. Unlike Goggle Glass, Aurasma demonstrates the same augmented reality for less money. Another advantage of the program is its wide applicability. It can be used not only in advertising business ventures, but also to support various social initiatives, such as classroom technologies in education.

First you need an account. When you fill out the questionnaire, your application will be reviewed and processed within 24 hours. Further details will be sent to you via e-mail. If you become a partner of the program and will use Aurasma in non-commercial way, you will get free access to the databases. You can get an account and fill out the questionnaire on the web-site: https://studio.aurasma.com/register.

A user with a non-commercial account could create an unlimited number of auras in a special application. With the help of Aurasma Studio (Figure 1) partners could create any tool they want online. This approach allows content to be loaded through the web-site. Aura that links images to video via click through URL (network) allows it to download and go live.

In Aurasma you can create Auras (AR) by choosing one of the two approaches [3]:
1. Create examples from pre-installed application.
2. Use the existing ones on your mobile device.

![Figure1. Creating an Aura by using Aurasma Studio.](image-url)
1. Become a partner.
2. Create a trigger (startup, operation).
3. Create cross-links.
4. Create channels.
5. Create AURAs from created channels.

Please note that Aurasma refers to the channel when searching. They [channels] are used as folders storing the collection of auras. Users can browse and find channels in the Aurasma app for further unblocking and viewing. The more keywords you enter, the easier the search will be. To download sketches, enter channel names and content descriptions distinctly.

What you need to work with Aurasma:
1. SPe, tablet PC or phone with build-in camera.
2. Operating system: Android or IOs.
3. Internet access.

How can you use the application? Step-by-step procedure:
1. Download the application from special app store (GoogleMarket) or official site.
2. Install the application.
3. Start the application.

If the previously created visualization objects are already stored in the database, it is sufficient to point the camera at the desired object. The camera catches the object, compares the picture with the data in the database and displays information about the current object on the screen (Figures 2 and 3).

Figure 2. Using the Aurasma application at the Meteorological Observatory site at University.

It is better to register and to get an account, if you wish to create your own visualization objects manually. Otherwise, all manually created objects will be available only to one user of this device. You can register on the following website: https://studio.aurasma.com/register. Registration makes it possible to upload personal created objects to the global network, making them public. Thus, any
manually created visualization objects can be made available to all owners of the current application. Additional opportunities open up in creating and finding the necessary layers when working in the Aurasma application.

Figure 3. Aurasma application workflow.

To build a 3D model is to draw any object in three-dimensional space. In this case, it is necessary to evaluate the full-size volume, scale, visual characteristics of the device from all sides. Thus, a two-dimensional illustration does not show all nuances of the device. For example, if you take a BRS (stationary barometer), you can see what lies on the rear panel of the device. It is easier to see and evaluate characteristics in a three-dimensional model, since the device can be rotated and brought closer. Yes, you can zoom in a picture, but a 3D model has a vector architecture, therefore, quality losses are excluded. The graphics of the measuring systems in the set of auras as such is just a display of uploaded images and electronic documents. If, for example, you take in the application an M82 pillar with an AMC (automatic meteorological complex), you can rotate it, look into the booth, etc., in other words, the model replenishes virtual reality. A 3D model of the meteorological site is shown in Figure 4.

You can build a 3D model or animation in any drawing program. This e-learning resource used the 3dsMax editor, a modeling, animation, and rendering software for game creation and design. This program provides an extensive modeling toolkit for rendering and animating objects by using visual effects.

3. Results and discussion
Students could use this Aurasma application in the module ‘Meteorological physics’ while studying the sections ‘Types and forms of clouds’, ‘Optical phenomena in atmosphere’. Cloud shapes are visualized using a cloud database created according to the international classification in the application under study. In addition to the morphological description, the information provided contains the microstructure and origin of a particular cloud form, based on the specifics of atmospheric processes. With Aurasma it is also possible to determine the amount of cloud coverage by setting the camera to
an appropriate shooting mode covering the entire horizon. This meteorological parameter can only be determined in a sufficiently open space, excluding urban developments.

Optical or light phenomena can also have their own information databases in the application used. Their presence can be determined from a photograph by comparing with the existing images or creation of your own catalog with rare types of the sky, caused by refraction, reflection, and diffraction of light in droplets and cloud crystals. It is possible to use the palette of the blue tint color scale preloaded in the application database for daily meteorological observation of changes in the color of the sky.

Figure 4. 3D model of the meteorological site.

You can also use the Aurasma app to study mixed and solid atmospheric precipitation. To do this, it is necessary to create a database that illustrates each type of crystals supplementing it with the corresponding morphological characteristic and weather conditions of the formation.

It is possible to use the application in determining and analyzing the stage of development of a particular convective phenomenon (for example, a cumulus and cumulonimbus cloud, tornado). In this case, visioning will help predict further development of convection.

Upper-air diagrams showing the state of the atmosphere can also be recognized and analyzed using a database of frequent weather conditions recorded in the presented application.

When students study the ‘Space research methods’ module, they can use Aurasma to analyze space images of cloudiness fields and the state of the atmosphere. They can save in the ‘auras’ the corresponding images of the cloud coverage most typical for a particular synoptic situation in the studied area. Hydrological phenomena such as sea waves, ebb and flow, and approximate heights of waves can also be determined using this application.

In addition to creating three-dimensional images of informational and measuring systems, 3dsMax can create animations of realistic movement of air particles, for students to understand some of the processes in the atmosphere. These include such examples for study as convection, turbulence, air advection, jet flow, etc. The revitalization of existing atmospheric circulation, air movement, changes
in the state of the atmosphere in animated visualization will allow students to better understand the thermodynamics of the process, remember and consolidate the knowledge gained.

As the complexity of the initial data and the multifactorial nature of the environment increases, it is possible to create a full-fledged computer game for students, future hydrometeorologists. Modeling the surrounding area, objects and characters, as well as atmospheric phenomena requires high-quality projection decoration. Otherwise, in comparison to modern computer games, the "picture" will seem very schematic and primitive for experienced players. Of course, the creation of an interesting and at the same time educational computer game for students is a very labor-intensive and time-consuming task that requires knowledge, skills, and large investments from specialists from different areas of expertise. The narrow circle of future users, the complexity of the development of atmospheric processes, lack of demand, motivation for games and learning, as well as possible gambling addiction limits investment and the development of educational technologies in this field.

Gaming technologies in the training of hydrometeorologists were represented not only by electronic educational resources. During practical classes on climatology at Kazan University, a business game named 'In a travel agency' was held with 3rd and 4th year students. The plan of the game is as follows. 'Clients' are selected who apply to a travel agency for help in selecting a tour to a particular country for travel. The rest of the participants are employees of the travel agency. An element of competition is introduced into the educational activities: students are divided into several subgroups representing one or another travel agency. 'Travel agents' compete with each other in providing services to the 'clients'. Depending on the preferences for the climate, season, landscape, the purpose of travel, passive or active recreation, financial capabilities of the 'clients', a certain type of climate, country, region for the intended trip is selected. For entourage, the 'clients' use accessories, appropriate clothing, shoes, and headwear. In order to conduct the game emotionally and cognitively, before the start of the lesson students remain ignorant of the upcoming task. The 'client' should put forward requirements for climatic and natural conditions in accordance with his or her capabilities and desires, and the 'travel agents' should satisfy the needs of the 'client' and bypass the competitors. Students can change roles when the tour is selected. Thus, the tutor grades the knowledge of the students in the field of climatography, as well as communication skills and the ability to work in a team. This game contributes to an increase in interest in classes, improves the professional and personal qualities of students, reveals their hidden and reserve capabilities.

Gaming technologies of business communication in educational activities can be implemented by hydrometeorologists in agroclimatology classes. The lecturer takes on the role of a potential ‘investor’ in agriculture. Students, in return, are ‘entrepreneurs’ presenting their project of growing agricultural plants in a certain type of climate. Trainees explore the agro-climatic conditions of plant growth, taking into account the cost-effectiveness of potential harvest in modern times of climate change. The task for the project ‘Arcadian Hour’ is given in advance, so that students have time to study the characteristics of agricultural plants and calculate agro-climatic indicators based on the available meteorological data. ‘Entrepreneurs’ need to identify the profitability of the business and calculate the profit taking into account the average yield, take into account economic losses, and expected damage from adverse events. The ‘Investor’ checks the students’ business plan and negotiates, asking clarifying questions on agroclimatic zoning and forecasting yields depending on weather conditions.

In ‘Applied climatology’ and ‘Building climatology’ classes, hydrometeorologists can perform climatological surveys using meteorological data for the “House of My Dreams” project. The task is to calculate the depth of soil freezing, build a scale of prevailing and dominant winds, the amplitude of fluctuations in the outside air temperature, wind-loads and snow loads, ‘driving rains’. Strong students are affirmed in their abilities, they explore the educational material deeper. Weak students are given the opportunity to experience success, and consolidate their knowledge. In both cases, the motivation for educational and, as a consequence, professional activity increases.
4. Conclusions

A common use of this application is possible when studying the ‘information-retrieval instruments in hydrometeorology’ module, especially in practical training. The above catalog of hydrometeorological instruments and complexes will help one to easily determine the type and model of a measuring device in practice. In the ‘auras’ (channels), one can have full information about the principles of operation and description of any hydrometeorological device. The location and number of meteorological instruments and booths on a site in accordance with the requirements and rules of the Russian meteorological service can be checked using a model plan preloaded in Aurasma.

Naturally, such organization of the educational process motivates for learning only a certain part of the students. For some students, game techniques help to assimilate and consolidate knowledge and information received, while for others, learning the rules and explanations of the game take time and energy from the standard learning process. The first category of students is usually creative, active, and communicative people, at the same time, the second part prefers traditional educational technologies.

The technical means of teaching in the application are designed to increase interest in meteorology and in the educational process of studying the natural sciences. Having a personal digital assistant, a student can use the additional opportunities in education. So, that is how the individualization of training, internal self-development, and the intensification of the student's independent work happens. The availability of a large amount of information leads to some oversaturation of the student’s visual memory. Therefore, it is necessary to combine the traditional methods and the alternative teaching strategies, taking into account the individual characteristics of students. The ultimate goal of the educational technologies is to give the student some internal motivation for gaining of knowledge.

The use of the new educational technologies needs an activation of the process of students' cognition. This is especially challenging in the study of the natural sciences. Modern teaching techniques of learning help the tutor be more informative, direct the student to search for the necessary knowledge in the discipline, and develop the skills and abilities necessary for the practical activities of the future specialist.

Naturally, only the tutor can implement a full-fledged educational activity, and Aurasma, as a modern information retrieval tool, will help one to achieve best results in teaching future hydrometeorologists.

Thus, on the above examples of playing technologies one can see how students' research activities and cognitive interest in disciplines are stimulated. These playing and electronic educational teaching methods make it possible to develop individual creativity and thinking abilities of the student. In the future, this will help the professional and social self-determination of the student.

References

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