Data Formats for Electronic Multimedia Collections

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Abstract. The article analyzes data format requirements from collection support services, content owners, and external users, as determined by the presentation, storage, and access characteristics of multimedia elements of electronic collections. Possible reasons for supporting (or not supporting) certain formats utilized for storing collection items are considered, taking into account the authors' experience with the development of an electronic scientific journal publishing platform which allows multimedia materials to be published via a web interface.
The analysis of multimedia data formats enabled the selection of the "technology stack" of libraries and modules, which serves as the basis for creating electronic multimedia collections and is currently under development. The system has been brought to the stage of "out of the box" deployment – both in its version for creating universal collections and in its version oriented toward electronic multimedia magazine publishing. Further support for all formats discussed in the article is planned.

Keywords: digital collections, multimedia content, data formats.

1 Open systems to support electronic collections

Over the past few decades, both the Internet as a whole and its web segment have expanded. Digitizing a large number of cultural and scientific artefacts can potentially make them available to anyone, regardless of their physical location. Consequently, the importance of creating thematic collections of digital resources, with the support of effective ways of access to them (electronic collections), is growing. Services which – to a greater or lesser extent – make it possible, appear in open access. A common goal for this kind of services is that a visitor to a collection not require any effort – or incur any cost – to access the collection. The only pre-requisite, ideally, should be a standard browser on the user's device and access to the network. However, the downside of using such services is the delegation of the rights to use data to the service providers and, possibly, an obligation to view advertising. In some cases, such a compromise may be unacceptable. The creators of electronic collections may then try to implement their own version of the platform with specific functionality; however, the labor costs for creating and maintaining such services may turn out to be unacceptably high.

Web publications are becoming increasingly relevant in the scientific field. To ensure long-term availability of information resources, the exchange of meta-information, etc., a number of systems have been created used by the scientific and educational communities. The following are some of the examples of systems used for electronic scientific publications:

- The support system for digital repositories (institutional repositories) is widely used to build open access archives and electronic libraries to create, store, and distribute digital materials. These include open-source software platforms such as DSpace, EPrints, GreenStone, Fedora, and others. The most reputable platforms are supported by large scientific and technological organizations: for example, DSpace was developed jointly by HewlettPackard and MIT libraries (Massachusetts Institute of Technology) [1, 2].
- Some electronic scientific journals use electronic publishing systems such as Open Journal Systems (OJS). The main advantages of this approach is the implementation of a complete publishing cycle for the preparation of electronic publications. It should be noted that layout itself is done “outside” the system, and ready-made files are loaded into OJS. Also, this system does not provide for displaying multimedia content. At the same time, the format of the scientific publication itself remains very traditional; on the web, content can be presented in two formats - PDF and static HTML.
- New technological and organizational approaches to scientific publications are developing:
- Integration issues are resolved using a metadata exchange technology based on the OAI-PMH protocol.
- The concept of "live publications" is being developed. A “live publication” is a scientific work posted on the Internet, in public domain, which is continually maintained by its author in an up-to-date state [3].
- Since 2014, several Elsevier journals have begun publishing reviewers' reviews along with articles. Such an approach, called the “open review,” leads to an improvement in the quality of articles; additionally, the contribution of the reviewer to the publication process is recognized [4].

Since the early 2000s, online electronic resources, such as electronic journals, have been actively developing. Electronic journals publish articles in both PDF and HTML formats, which provides more opportunities for publication, including of multimedia materials.

Focusing on the analysis of scientific journals, the following observations can be made:

- The receipt of texts of articles and related multimedia materials by the editors is conducted via e-mail. *That is, the process of loading collection items is not by itself technologically advanced*.
- The editorial staff is expected to indicate the place in the text of an article where it is necessary to insert the appropriate multimedia material. *That is, authors do not directly participate in the laying out of the article*.
- Not a single magazine analyzed publishes a full range of multimedia files. The principal published formats are: graphic files of various formats (e.g. JPG, GIF,

PNG), video (e.g. AVI, MPG, MOV), animation (SWF, GIF) [5], audio of various formats, and presentations. There are separate magazines that publish, in addition to the entire range of multimedia formats listed, virtual reality content in the VRML format (e.g. the journal Scientific Visualization, http://sv-journal.org/). *To date, no system supporting a wide range of multimedia formats exists.*

- To display video in articles, various video players are used or cloud video services' code is embedded. *That is, third-party applications are used to display the elements of the collection, whose support is not guaranteed in the future.*
- Magazine sites are either of original designs or else they are built on top of publishers' platforms. The widest range of displayed multimedia materials is published by the journal Scientific Visualization (http://sv-journal.org.). However, even on the pages of this magazine, viewing some of the multimedia objects (for example, 3d, http://sv-journal.org/example/index.html), requires additional software installed on the user's computer. *That is, the user must use additional applications or plug-ins in order to view elements of a collection.*

The authors faced a number of such problems while developing the tool platform of the electronic scientific journal which allows the publication of multimedia materials and provides access to them through a web-based interface [6,7]. One of these problems was the choice of data formats that could be transparently processed within the platform and, if possible, furnish authors with various opportunities to publish multimedia data.

Without claiming the above to be an exhaustive description of the data that can be stored in a wide range of diverse collections, we turn to the range of multimedia formats related to articles in scientific online journals. The above list of the main types of multimedia components can be further expanded with the development of the platform; however, even with the list of types considered, almost any content can be adequately presented.

The main prerequisites that were considered in the selection and analysis of supported data types were the following:

- materials provided by the authors should be efficiently processed on the server, and the journal staff should not be required to perform a large amount of tedious actions and or have to master modern software development environments. For the correct reproduction of a complex object, it is often necessary to preserve the structure of a project containing dozens of directories and hundreds, maybe thousands of separate files. Moreover, the project may retain absolute paths to the resources used, so that even when copying the entire project tree to another location, the correct reproduction of the object may be compromised. Embedding such an object in a document may require the use of highly specialized skills from the staff of the journal (the team of software and technical support for the collection);
- the user must have access to the article and its individual components (individual elements of the collection) without installing specialized software. Ideally, is should be enough to have access to the Internet and have a standard browser installed on the user's computer. The use of specialized, and sometimes proprietary, extensions by the article authors can lead to making the reproduction of

the object impossible on the computer of the reader (an external user trying to access the elements of the collection).
- the selected limited set of supported formats should, if possible, provide wide-ranging opportunities for the use of multimedia resources.

Currently, the types of supported multimedia components and the types that will be supported in the future include the following:
- text fragments, quantitative data;
- raster and vector images;
- audio data;
- video of various formats, including Video 360 format;
- 3D models;
- virtual and augmented reality scenes;
- map data;
- charts;
- formulas, etc.

Along with the presentation of multimedia objects, an important aspect is the storage method. It should be noted that the element of the multimedia collection can be not only a mere arbitrary fragment of data acceptable for the platform of types, but also an arbitrary aggregate including fragments of data of different types. Please note that the first paragraph of a section or subsection is not indented. The first paragraphs that follows a table, figure, equation etc. does not have an indent, either.

2 Some aspects of preparing multimedia materials for online magazines. Three formats and three contexts

Essentially, for each multimedia element of an online article, at least three formats are relevant:
- the format intended for an end user viewing an online article in a browser;
- the format of internal storage;
- the format in which the author of the article submits materials to the editor.

When considering issues related to the formats of multimedia elements of online articles, we take into account three groups of factors:
- the efficiency of users in various roles;
- aspects of technological implementation and support capabilities at different stages of the life cycle of an information system;
- the need to ensure the preservation of the source data, without any data loss associated with the formats and parameters relevant at the time of publication.

We would venture to say that the third of the factors mentioned above often remains outside the discussion scope of discussion when considering current and prospective technology solutions. Converting data to the actual formats of the final presentation in the browser can result in future data losses.

As an obvious example, let us consider the archived versions of web sites created 10-15 years ago. Small images and low-quality video (in the SWF format) were specially prepared for publication, but the originals have, in most cases, already been lost.

Requirements for the formats of multimedia elements are largely determined by the tasks and by the specifics of the work of users playing different roles within the information system.

The end user (or "Reader") should be able to adequately view multimedia articles on a wide range of devices. The playback of multimedia elements must be accurate on all current operating systems and in all modern browsers. Moreover, a significant trend of the last decade has been the desire to implement the required functionality exclusively within the browser, and without third-party plug-ins. We would dare say, for example, that at present, any suggestion to install a plug-in for viewing video will be perceived negatively by the user.

The "Author" user, on the other hand, uses familiar applications or online services to prepare multimedia elements. As a result, he or she receives the multimedia elements of a future article in one of the formats that are "exported" by the application. What should be the online magazine's policy? Several approaches can be considered, of which we will mention only two. The first approach involves a severe restriction: the author is required to prepare a multimedia element in one of the formats that can be directly displayed in the browser. The second approach would allow the author to submit materials in a range of formats that are to be further converted before publication. Ths conversion can be carried out either manually by the content manager, or by the corresponding software module of the information system.

The content manager loads the material prepared by the author into the system. The stricter the requirements for the formats of the multimedia elements prepared by the author, the less effort the technical aspects associated with the publication will require. The scenario in which the content manager only needs to copy the text of the article into the appropriate fields and download the multimedia files, without performing any preliminary processing, requires only minimal qualifications on the content manager's part. However, in any non-trivial case, the author's work would be more complicated due to the need for the conversion of the source data into the required formats.

Note that today's ideas about the "current OS" and the "modern browsers" may take on a completely different meaning in the near future, as devices, communication channels, stylistic trends and technological capabilities will change. That is why the main format of internal storage, as a rule, involves a certain redundancy.

3 Types of components for multimedia collections

3.1 Text data

It may seem obvious, but it's worth pointing out that any article will contain fragments of text. These text fragments can be very small, e.g. the contents of fields in a questionnaire, or they can be of considerable size.

The use of text implies the use of language. A written language is associated with a possible set of symbols used - the alphabet. It is easy to imagine a situation in which several languages can be used in one text fragment, and accordingly, several character sets. This situation may have some consequences. For example, when forming lists, the owners of a collection may need appropriate lexicographic ordering rules. There are

other nuances in the use of text fragments. In our developed platform, two main languages – Russian and English – are supposed to be used. It is not intended to be used with texts which utilize the "from right to left" writing direction, as Arabic does, or the "top to bottom" direct, as does Japanese. On the other hand, a number of characters in the text, which are used in some subject areas, can be found in the texts presented, but not in the character set of Russian or Latin (or Greek, often used in mathematical formulas) character sets. In addition, the use of advanced text formatting (italics, boldness, underline, size and color of text and background, the use of various fonts, structural elements such as headings, paragraphs, etc.) are understood as standard text properties.

Thus, to represent text fragments, UNICODE can be used to adequately display a wide range of characters – the TXT format for simple text fragments and the RTF (RichTextFormat) for complex ones, both public and open. Their possibilities for presenting text fragments in journal articles seem to be sufficient.

Text tagged with HTML tags associated with stylesheets may have similar capabilities to RTF; however, using the names entered by the markup author may conflict with the markup created when the collection item is displayed in the browser, which can lead to conversion difficulties.

Storing text fragments as separate files or as text fields on database servers does not pose a problem.

3.2 Quantitative data

Many characteristics of collection elements can be expressed quantitatively. Moreover, a number of characteristics, even not of an explicit quantitative nature, can be expressed in quantitative values when digitized. For example, a color, along with its description (e.g., "red"), can be described by the numerical RGB-palette value (e.g., #FF0000).

There currently exist enough standard options for storing and presenting quantitative data. However, for text fragments as for quantitative data, various forms can be used – e.g. "Arabic" or "Roman" spelling; binary, decimal or hexadecimal representation, rational fraction form. Therefore, for the purposes of platform support, appropriate storage and display capabilities must be provided.

In those special cases when the standard means of storage or representation do not suffice (for example, for representing the value of Pi to the hundredth decimal place), one can use textual string representation. In any case, quantitative data can be stored either as standard numeric fields or as text. To represent related groups of numbers, special objects, such as tables, graphs, charts, and formulas, can be used.

3.3 Bitmap images

With the advent of a wide range of digital cameras and digital image editing software, storing, transmitting and displaying images has become as common and widespread as handling text data. Along with the proliferation of images, the number of different image storage formats has expanded. These formats provide specialized capabilities for presentation and use.

Raster images are characterized by the size of their pixel matrix –raster (width x height), their pixel color depth, and their storage format. The first two characteristics

determine what the image looks like when displayed without conversion, while the storage format determines the actions that must be performed before the pixel matrix is formed, which will be displayed. The size of the displayed pixel matrix may differ from a non-converted one, and modern software tools allow you to perform such conversions so quickly that users who do not think about the technical aspects of storing and displaying images may receive a false impression of the trivial nature of such actions. However, automatic conversion of the original image size to the size specified by the characteristics of the document where the image is to be placed can have negative repercussions: for example, when zooming in on the image, the image may not be clear, and when reducing its size, fine details can be lost. In addition, transferring an image that is higher in resolution than that one displayed to the user's computer consumes additional network traffic. While such a state of affairs can be considered satisfactory for everyday use, and distortions thus introduced ignored as insignificant, in some professional areas – for example, in medicine – it may be unacceptable.

Special formats are developed to solve specific problems. Thus, many camera manufacturers can provide images in RAW format - i.e. in the form of raw measurements taken directly from the sensor, which representation allows for advanced photo editing. However, one can only process such files using special programs, and for different manufacturers the programs are often not compatible. Developers of new graphic raster formats, such as JPEG200, WebP, BPG, WBMP, FLIF demonstrated the advantages that their formats afford, but so far, there has been no support for them in modern browsers, and in some cases, a special license may even be required. In view of the current situation, it was decided to use only graphic raster formats in collections that are supported directly by browsers for now, since article images are illustrative rather than documentary.

For browsers, the standard bitmap formats are JPG (Joint Photograph Expert Group), other extension suffixes in the file name are .jpeg, .jpe), PNG (Portable Network Graphics) and GIF (Graphic Interchange Format). All of the above formats are automatically recognized and processed by browsers and are based on open standards.

Thus, we can formulate the following recommendations for presenting bitmap images:

- image format is .JPG, .PNG or .GIF;
- image size - corresponds to the size of the image displayed on the user's computer.

Particularly important is the sizing of images used as a group and uploaded to a "slider" or "gallery".

3.4 Vector graphics

In some situations, vector images may be used instead of bitmaps. In this case, the image is stored not as matrix of pixels but as a description of an algorithm that can construct it. For such images, scaling without the loss of quality can be performed at much larger scale than for raster ones. The best-known vector graphic formats are WMF (Windows Meta File), CDR (CorelDRaw Document), AI (Adobe Illustrator), EPS (Encapsulated PostScript), but as for direct support of these formats in the browsers, it

leaves much to be desired. We recommend using the SVG (Scalable Vector Graphics) format, promoted by the W3C consortium and having support in all common web browsers as the default vector format for all image files.

3.5 Audio

Audio fragments are also represented by a component that should be supported in a multimedia article. Audio files are characterized by the following characteristics: container file format, codec (an algorithm for compressing audio data), sampling frequency (in terms of time and amplitude), and the number of playback channels. Currently, there are several container file formats: .WAV, .AAC, .OGG, .MP3, .M4A, .AIFF, .FLAC and others. Typically, the format of the container file determines the codec that compresses the stored data. Based on the requirement of wide availability, the data formats are played without additional user actions should be prioritized. Thus, on the WINDOWS platform in the standard distribution, codecs are installed that correspond to the containers .WAV, .MP3, .WMA; on iOS this would be .MP3, .M4A, .AIFF, .WAV; on LINUX (including the ANDROID OS) - .WAV,. .OGG, .MP3. In addition, the vast majority of computers are equipped only with dual-channel speakers, so, sound in DOLBY SURROUND 7.1 format, for example, will not be played on them.

Another aspect to consider is the length of audio fragments. For a fragment whose duration is limited to a few seconds, the file containing it can be stored directly on the server and transmitted to the user via a direct link. If the fragment's duration is reaches a minute or more, streaming should be used, which may require a separate streaming server. In this situation, it is possible to use external file storage on media servers: the file is placed on a special media server (for example, YouTube.com), and a link to the resource is received from the server's support service and, if necessary, a piece of program code that can be embedded in a web document that allows access from a web document to the resource and ensure the fulfillment of a number of conditions. In such a storage architecture, the media server, interacting with the user, analyzes the composition of the software and hardware and transmits the data in a suitable format, even if they were placed in a different format on the server.

To summarize, we can formulate the following recommendations for the presentation of audio files:

- container file formats: .MP3, .WAV, or .OGG (browsers that support the HTML5 standard can play them independently), MIDI files can be stored separately: support for MIDI was introduced in browsers from HTML 3.2;
- number of channels: 1 or 2;
- sampling frequencies in amplitude and time: it makes sense to choose from the most standard: 22 050 Hz, 32 000 Hz, 44 100 Hz, 48 000 Hz, with the sampling depth of up to 16 bits, but at the discretion of the author (since it may make sense to use higher resolution parameters for certain collections).

3.6 Video

Video files are also represented by a component that should be supported in a multimedia article. Video files are characterized by the following characteristics: container file

format, codec (an algorithm for compressing audio and video data), frame rate, and size. Currently, there are several container file formats, including .AVI, .WMV, .FLV, .MP4, .MPEG, .MOV, .MKV and others. Typically, the format of the container file determines the audio and video codecs that compress the stored data. For progressive streaming formats, a characteristic such as bit rate can also be considered, which represents the amount of data that must be transmitted to play one second of video.

Problems with the amount of data transfer for video playback are somewhat similar to those already mentioned for audio files. For a fragment whose duration is limited to a few seconds, the file containing it can be stored directly on the server and transmitted to the user via a direct link.

If the fragment duration is around a minute or more, then streaming should be utilized, which may require the use of a separate streaming server. In this case, it is possible to use external file storage on media servers, where the file is placed on a special media server (for example, YouTube.com), a link to the resource is received from the server support service, and, if necessary, a piece of program code that is embedded in a web document that allows access from a web document to the resource and ensures the fulfillment of certain conditions. When using such a storage architecture, the media server, in interaction with the user, analyzes the composition of the software and hardware on the user's computer, the required playback parameters, and transfers the data in a suitable format, even if it was stored in a different format on the server. Furthermore, if during the playback process, the conditions of file transfer and playback are changed, the media server, using special adaptive algorithms, changes the parameters of the transmitted media stream so that the file is played back at the user side with the best possible quality.

Thus, we can formulate the following recommendations for the presentation of video files:

- container file format: MP4, OGG (browsers that support the HTML5 standard can play them independently);
- The frame size (width x height) should correspond one of the common ratios of 4x3, 16x9, etc.

3.7 360 degree video

Recently, various specialized forms of video playback have appeared. A noticeable phenomenon was the appearance of 360º video, in which the image is captured in the video file from all directions. Playback can be carried out on a spherical screen, and the user, from the ‘inside’, chooses the direction of view independently.

Thus, it is possible to increase the level of immersion. Taking advantage of the fact that the real user’s actual angle of view is substantially less than 360 degrees, playback devices (virtual helmets) were developed that provide almost the same sense of presence without creating real spherical screens, and it is possible to create individual video streams for each user’s eye. The file containers and codecs used for encoding of 360 video are no different from those used for traditional video. The emergence of this new type of multimedia resource (360 degree video) at first involved the creation of specialized players that allow users to view the immersive content in a specialized application

(browser), using special virtual reality headsets, on mobile devices. Later, it became possible to view it in universal players, by specifying the type of resource as a parameter. Embedding metadata in the resource file, which allows players to automatically recognize the type of resource and form viewing controls suitable for the situation, now allows one to play 360º video.

One characteristic of the use of this type of media resource is the high demand it places on the throughput of the communication medium. At the current stage of software development, the media server sends the user a full spherical image, and the player selects for demonstration a fragment (approximately 10% of the area of the sphere), determined by the angle of view and the direction of the user's "gaze". This results in a situation where for an acceptable video display quality of 360 video, the minimum frame size requirements are 4K (whereas the common Full HD television format corresponds to the 2K format). The support of such media streams places high demands on the media server (particularly if the resource in question is popular). Therefore, it is more preferable to store resources in the 360 video format on third-party streaming servers, such as YouTube, and use embedded code to access the server.

In summary, the following recommendations can be formulated for the presentation of video files in 360 video format:

- container file format: .MP4, .OGG;
- the frame size (width x height): at least 2x1, with at least 4K resolution;
- when placing resources on external streaming servers, meta-information is introduced into the video file indicating that the file should be played in 360 video format.

3.8 3D models, scenes of virtual and augmented reality

The use of 3D models and interactive 3D scenes for meaningful illustrations in documents has led to the emergence of autonomous means of displaying such objects, including via the Internet. However, the complexity and variety of tools for creating such resources make it their use as elements of multimedia collections difficult. The need to install specialized software on the user's computer, in general, does not solve the problem of displaying a resource. Thus, a scene created in 3DS-max can be exported to various formats (including those designed for exchanging 3D models); however, when exporting, many features of the model will be lost, since specific modifiers of the development environment are not supported by all formats. Moreover, when using special plugins – especially commercial ones – it may not be possible to play the scene back on the user's computer. In addition, for correct scene reproduction, it is necessary to preserve the project’s structure, which, for the more complex scenes, may contains tens of directories and hundreds–maybe even thousands–separate files. In such cases, the project may retain absolute paths for the resources used, and upon copying the project tree to another location, correct scene reproduction may be impossible.

The authors are of the opinion that the solution to the problem of the full use of multimedia resources such as 3D models and interactive 3D scenes as elements of a multimedia collection can be found, in one of the following ways:

- Using specialized web services that allow the author to upload his or her project to the server; if necessary, edit and check the adequacy of its playback, and submit code for its implementation in a web page (as done, for example, on youtube.com). SketchFab can play be used as such a service. The disadvantage of this solution is that the resource is stored on an external service. Any problem with the owner's account may render the resource itself inaccessible.
- Exporting the project in WebGL format. Recently, browser support for this format has been improving. In addition, there are now development environments that allow one to implement or edit a 3D project directly in WebGL. A 3D project prepared with this technology can be presented directly on web pages using only a web browser. As a development environment, for example, one can use an environment supported by the ThreeJS community.

3.9 Use of cartographic information

In a number of electronic collections, information is tied to an existing or existing landscape. The development of modern cartographic systems on the Internet allows each user to embed a small code into a web document, ensurig the embedding of the desired map fragment with a set of functional elements. They can be provided either by the owners of the map service, or added by the user himself using the open API. Such services are provided both by Russian platforms, such as Yandex, or Mail.Ru, and global services, such as Google, Microsoft, Apple, etc. Moreover, to insert a map fragment into a document, the geographical coordinates are required and, if the map is to have additional functionality, a JavaScript library, developed on the basis of the open API of the chosen map service, has be to be included by the author. A JavaScript library is a text file that can be stored as a text fragment in the database of the log server (the collection's support server).

In summary, the following recommendations can be formulated for the presentation of cartographic data:

A snippet of code that displays the desired fragment of the map (usually generated on the web page of the corresponding map service), embedded in the web document.

JavaScript library implementing the necessary functionality, developed on the basis of an open API of the selected map service (if the map is to have additional functionality).

3.10 Formulas and Charts

Along with individual pieces of quantitative data used, arrays of such data are often used. This may require authors to demonstrate the nature of relationships between different elements of the array. One common way to achieve this is through data visualization. The functionality of pre-formed raster images of graphs and diagrams currently used in printing seems to be insufficient for online display. To solve this problem, a component is being developed that allows the user to enter a tabular array of data and their descriptions and select a display style from the palette. The prototype of the quantitative data visualization component is currently being tested.

An important and popular component of scientific articles is the availability of mathematical content. When including mathematical notation in the text, two aspects must be taken into account - the writing of the formula and its further display.

The de facto standard for entering mathematical equations is TeX, which is most often used as its LaTeX extension.

The second challenge of using formulas in articles published in a scientific online journals is their correct display in the browser. There are several approaches to solving this problem:

- displaying formulas as bitmap (GIF or PNG). While this is the simplest approach, it completely erases the meaning of formulas and precludes their further analysis. A slight improvement on this is the publication of LaTeX formulas as alternative text, along with the image;
- converting LaTeX formulas to SVG vector format;
- using the specialized mathematical markup language, MathML. MathML was designed to facilitate the use and exchange of mathematical notation data over the Internet (for more information on MathML see, for example, Wikipedia). MathML is an XML application and can be processed and displayed within the browser. However, not all browsers today offer MathML support, a fact that necessitates the use of additional libraries. MathJAX, a cross-browser JavaScript library, deserves special mention.

Automatic conversion from LaTeX to MathML is a relevant topic for discussion.

One of the options for solving the problem of the full use of formulas in an online magazine with multimedia content, in the author's opinion, may be the following combined approach:

- use the TeX / LaTeX format for formulas;
- encourage article authors to prepare formulas for publication using powerful third-party tools such as Overleaf, Authorea, Papeeria, or Lyx;
- display formulas in a browser using MathML; as a tool for cross-browser display and an automatic conversion tool from LaTeX to MathML, using MathJAX is recommended.

Currently, a platform component responsible for loading and visualizing formulas is under development.

4 Conclusion

This present analysis has shown that at the current stage of software (both serve and client), developing a platform for creating and supporting digital multimedia collections is feasible. Such a platform will provide the formation, editing, and storage of digital collections, with acceptable requirements for the operational support service. It will also provide access to the collection via the Internet using a browser to a wide range of users, without the need to install additional software on the client.

The system developed by the authors thus far has support mechanisms for publishing a limited set of components, such as single images, collections of images with visualization in the slider version and a set of thumbnails, and videos and 360º videos published on the YouTube service.

The introduction of more complex multimedia data required an analysis and evaluation of the technologies for their creation, storage, and visualization. The analysis of the data format has enabled the selection of the technology stack – i.e. libraries and modules on the basis of which the platform for electronic multimedia collections continues to be developed. The development of additional functionality continues along several paths:

- Development of modules for publishing 3D models and interactive 3D sketches based on the ScetchFab service using WebGL. The choice of publication option will depend on the format of the data submitted by the author.
- Implementation of a solution allowing full use of formulas in a magazine with multimedia content has begun. Authors are encouraged to submit formulas in TeX / LaTeX format and prepare them on one of the external resources, such as Overleaf, Authorea, Papeeria, or Lyx. A module allowing to display formulas in a browser and automatically convert from (La)TeX to MathML will use the MathJAX JavaScript library.
- The range of multimedia formats that do not require additional processing and can be directly displayed by browsers is constantly expanding. Examples include audio in the MP3 format and vector graphics in the SVG format.
- The information system is being developed in two directions:
- the creation and support of multimedia collections;
- online multimedia science journal.

Moreover, it is implemented on the basis of a single core, with slightly different functionality for the types of resources mentioned above.

The integrated development approach along both directions is accompanied by the creation of installers allowing to deploy the system “out of the box,” using any standard modern shared hosting service. The development still planned is aimed at increasing of the supported multimedia formats and also at developing metadata export modules in the electronic journal branch. At the same time, authors of individual elements of the collection may be provided with tools for downloading and online editing. The set of data formats supported by the system can provide storage for a wide range of multimedia resources used.

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