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Cloud infrastructure for calculations in the field of engineering and medicine

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The basic principles of cloud services building are considered. The service of processing of tomographic medical images is described. The service detects the parameters of image symmetry in different planes to highlight symmetric areas of interest for further diagnosis.

Keywords: information technologies, cloud computing, cluster.

Хмарна інфраструктура для розрахунків в інженерії та медицини. *С.В.Бараннік, О.В.Дьомін, П.О.Стаднік*

Розглянуто основні принципи побудови хмарних сервісів. Описано сервіс обробки томографічних медичних зображень з метою виявлення параметрів симетризації зображення у різних площинах для виділення симетричних зон інтересу для подальшої діагностики.

Рассмотрены основные принципы построения облачных сервисов. Описан сервис обработки томографических медицинских изображений. Сервис определяет параметры симметрии изображения в разных плоскостях, чтобы выделить симметричные зоны интереса для дальнейшей диагностики.

1. Introduction

The concept of digital economy development envisages the creation of the National Cloud of Open Science as a basis for the evolution of the digital services in Ukraine. This market of the digital services has to be integrated into the European Cloud of Open Science [1].

Cloud computing, or cloud for short, is a model for providing omnipresent and convenient on-demand access over a network to a shared pool of configurable computing resources (such as communications networks, servers, storage media, applications, and services). These resources can be provided quickly and released with minimal management costs and requests to the provider.

When using cloud computing, the software is provided to the user as an Internet service. The user has access to his own data, but cannot manage and do not have to take care of the infrastructure, operating system and software he works with. The "cloud" is metaphorical title for the Internet, which hides all the technical details. According to an IEEE document published in 2008, "Cloud computing is a paradigm in which information is constantly stored on servers on the Internet and temporarily cached on the client side, such as personal computers, game consoles, laptops, smartphones, etc."

Lots of organizations develop various cloud standards. The Open Cloud Consortium is responsible for the development of cloud computing standards and compatibility of them.

At the moment, there are three main models of cloud services:

1. IaaS - Infrastructure as a Service.
2. PaaS - Platform as a Service.
3. SaaS - Software as a Service.

IaaS is based on virtualization technology. It allows the user to divide equipment into pieces that satisfy current needs. Thus, the efficiency of using the available computing power is increased. In addition, IaaS provides the customer with a complete set of management functions in one integrated platform.

In case of Platform as a Service (PaaS) the consumer has access to the using of information technology platforms: operating systems, database management systems, software, development and testing tools hosted by the service provider. In this model, the entire information technology infrastructure, including computer networks, servers, storage systems, is fully managed by the provider. The provider determines the set of platform types, which are available to consumers and a set of managed platform parameters, and the consumer is able to use platforms, create its virtual copies, develop, test, operate application software on them. And it assumes dynamically changing the amount of computing resources consumed.

If the configuration of the operating system and environment variables is successful, then this data can be made publicly available at the system level. The following users will run the ready-made solutions. PaaS is unique in that it allows developers to build and deploy applications on the offered infrastructure. PaaS offers not a set of simple virtual machines, but a whole platform. This allows user to develop and deploy his application in the cloud.

Software as a Service (SaaS). This is the highest level of all types of cloud services. It is an advanced product that is operated and managed by a provider. Simply in all cases, the SaaS service provides software or programs that run on the Internet and can be used by end users.

2. Cloud Medical Imaging

Cloud computing technologies are actively used in various fields, including healthcare. They improve the quality of services provided and care for the sick. This is due to a more efficient system of information exchange between physicians. Cloud computing will allow to spend less attention on the management of information technology. By placing basic data in the cloud, hospitals can set up a real-time information exchange system between facilities, making it possible to view data using a variety of devices. This is especially true for small hospitals and private offices - here cloud computing will make the use of IT more profitable. Such offices often do not have IT staff - specialists who will be ready to maintain the technological infrastructure. Using "clouds" will allow them to get a modern set of IT services for a minimum cost and not pay big money for expansion. It also helps to collect and accumulate data that can then be used to process and create expert systems.

Medical imaging technologies do not stand still, and software that is in physicians' workplaces often prevents third-party software from being used to process or further analyze medical imaging. The use of PaaS and SaaS technology is a good solution to this problem.

This is especially true when you need to use advanced mathematical methods in image processing. Such calculations require significant resources, but are used for a short time. CPU or GPU speed is very important. Transferring data for processing to external resources reduces the waiting time for processing results.

Another important factor is that updating the software does not require the end user to know the features of different versions of the software. Software can be very hardware dependent. For example, CUDA implementations for different GPU models may differ significantly and may not be backward compatible with younger models. If software of this kind were installed on workstations (doctors' workplaces), the code would have to be changed for each graphics card model, which would involve significant costs in keeping the software up to date.

3. Cloud Solution for Image Symmetrization

A cloud service for processing tomographic medical images in order to identify the parameters of image symmetry in different planes to identify symmetric areas of interest for further diagnosis was developed and installed on the UA-ISMA cluster.

The crux of the problem is that during the initial acquisition of examination data, the patient never lies exactly flat. As a result, the tomographic image turns out to be rotated along several axes at once. To make a diagnosis, the doctor must first rotate image in manual mode. This is a very lengthy process that requires significant computational resources and practical skills of the doctor. The use of powerful external resources significantly reduces the processing time.

By using the interface, doctor can download a tomographic image from a local computer or use an external resource to save to-

mographic images. After that, data are processes automatically under the algorithm:

– creating isocontour three-dimensional shapes;

– approximation of figures by ellipsoids;

– bringing ellipsoids to the canonical form (turning to the main axes);

– getting the angles of rotation;

– plotting the rotation angles v.s. isocontour percentage;

– graph analysis;

– output of rotation angles values;

– construction of image slices taking into account image symmetry;

– rotating the tomographic data to the calculated angles, bringing them to a symmetrical appearance;

– graph analysis is performed either by a physician or by a neural network that can be trained on reference images.

The new tomographic image can be saved and uploaded to the physician's workplace for processing on standard software.

4. Conclusion

Popularization of cloud and grid technologies, training of different categories of users allows the use of new methods of calculation and data processing in various fields of science, medicine and education.

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