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INTERACTIVE VIRTUALIZATION IN THE ENVIRONMENT OF FLASH-CC, JAVA SCRIPT OF ALGORITHMS OF MATHEMATICAL COMMUNICATIONS THE PHENOMENON OF WAVE OPTICS

Abstract. The wave optics – considers light distribution, by means of Huygens' principles which pass through the power relations. Nevertheless, the considered in optics, all wave phenomena, by means of optical instruments are based on laws of wave optics. For example, the interference and the diffraction. Many tasks of the theory of optical installations are based on laws of wave optics. In this work, algorithms of mathematical communications of wave optics, i.e. laws of interference, diffraction of light rays, are considered on the studied virtual and interactive installation on the computer when passing light through a bi prism of Frenel and the diffraction grating, etc., as in an actual pilot unit.

Optical processes of an interference and diffraction are visualized and interactively virtualized by means of the computer program Adobe Flash-CC environments. The laboratory work was made on a research of processes of wave optics is very effective at development of this course, and the technology of creation of VIL described in this article, is very relevant for creation of the similar virtual and interactive laboratories (VIL) in other objects.

This virtual interactive laboratory development is introduced in educational process of the Eurasian technological university and is successfully applied in tutoring.

Keywords: Algorithm, the virtual interaktivization, wave optics, interference, diffraction, experiment of Young, coherence, mathematical functions.

Introduction. Historically the first interference experience which received an explanation on the basis of a wave theory of light was experience of Young (1802). In experience of Young light from a source as which the narrow crack of S served fell on the screen with two close located cracks S_1 and S_2 (picture 1). Passing through each of cracks, the light bunch broadened owing to diffraction therefore on the white screen E light bunches which passed through cracks S_1 and S_2, were blocked. In the field of overlapping of light bunches was observed the interference figure in the form of the alternating ghost and dark fringes.

Young was the first who understood that it is impossible to observe interference at addition of waves from two independent sources. Therefore in its experience of a crack S_1 and S_2, which can be considered according to a Huygens ' Principle as sources of secondary waves, were lit with light of one source of S. At the symmetric arrangement of cracks the secondary waves which are let out by sources S_1 and S_2, are in a phase, but these waves pass P different distances to an observation point r_1 and r_2. Therefore, the oscillation phases created by waves from sources S_1 and S_2 in the point P, generally speaking, are various. Thus, the task about wave interference comes down to a task about a superposition of oscillations of the same frequency, but with different phases. A statement that waves from sources S_1 and S_2 extend independently of each other, and in an observation point they just develop, is the experienced fact and carries the name of a principle of superposition. The simple harmonic wave extending in the direction of a position vector $\vec{r}$, registers in a look

$$E = a \cos(\omega t - kr),$$

where a – wave's of amplitude, $k = 2\pi / \lambda$ – wave number, λ – wave length, $\omega = 2\pi\nu$ – circular frequency. In optical tasks it is necessary to understand the module of a vector of a strength of electric field of a wave as E. At addition of two waves in a point P resultant fluctuation also happens at a frequency ω and has some amplitude of A and a phase φ:

$$E = a_1 \cdot \cos(\omega t - kr_1) + a_2 \cdot \cos(\omega t - kr_2) = A \cdot \cos(\omega t - \varphi).$$

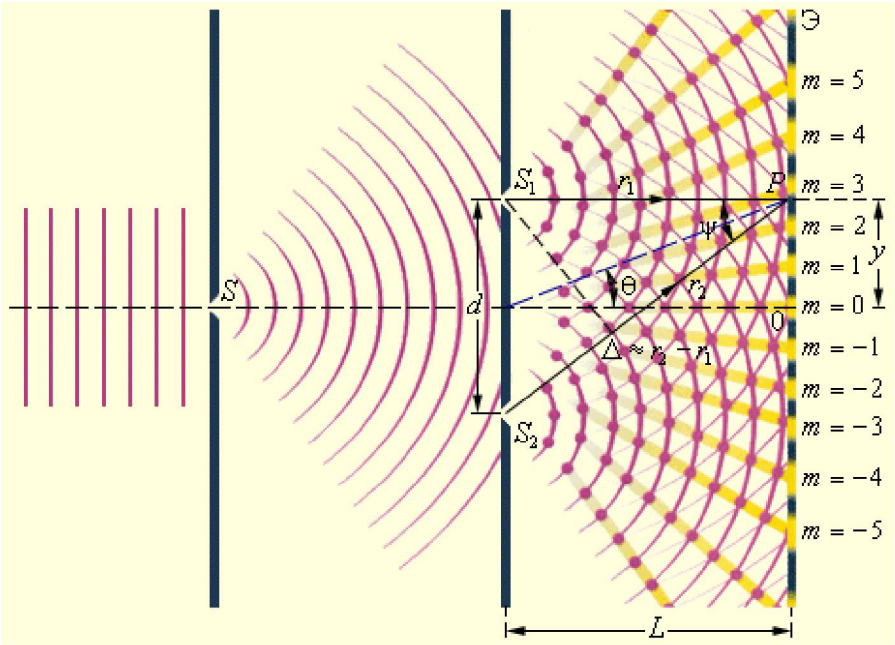


Figure 1 - Scheme of the interference experience of Young

There are no devices which would be capable to monitor fast changes of the field of a light wave in optical band; observed size is the energy stream which is directly proportional to a square of amplitude of an electric field of a wave. The physical quantity equal to a square of amplitude of an electric field of a wave, it is accepted to call intensity: $I = A^2$.

Simple angular transformations lead to the following expression for intensity of resultant fluctuation in a point P:

$$I = A^2 = a_1^2 + a_2^2 + 2a_1a_2 \cos k\Delta = I_1 + I_2 + 2\sqrt{I_1 I_2} \cos k\Delta, \qquad (1)$$

where $\Delta = r_2 - r_1$ – so-called difference of the course.

Follows from this expression that the interference maximum (bright fringe) is reached in those points of space, in which $\Delta = m\lambda$ ($m = 0, \pm1, \pm2, ...$). As the same time $I_{max} = (a_1 + a_2)^2 > I_1 + I_2$. The interference minimum (dark strip) is reached at $\Delta = m\lambda + \lambda / 2$. Minimum value of intensity $I_{min} = (a_1 - a_2)^2 < I_1 + I_2$. In the figure 2 is shown distribution of intensity of light in the interference figure depending on the difference of the course Δ.

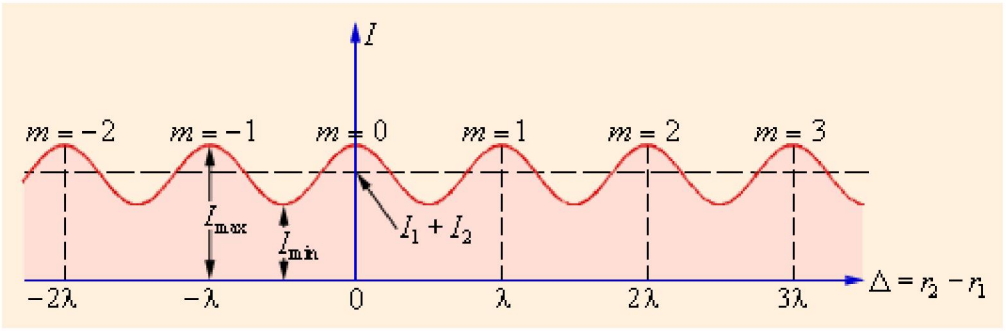


Figure 2 - Distribution of intensity in the interference figure.
An integral number of m – an order of the interference maximum

In particular, if $I_1 = I_2 = I_0$, i.e. intensity of both interfering waves are identical, expression (1) takes a form:

$$I = 2I_0(1 + \cos k\Delta). \qquad (2)$$

In this case $I_{max} = 4I_0$, $I_{min} = 0$.

Formulas (1) and (2) are the universal. They are applicable to any interference scheme in which there is an addition of two simple harmonic waves of the same frequency. Distinction is shown only in how the difference of the course Δ depends on the provision of a point of observation of P. If in a tableau of Young through to designate observation point shift from a plane of symmetry, then for a case when $d << L$ and $y << L$ (in optical experiments these conditions are usually satisfied), it is possible to receive approximately:

$$\Delta \approx d \cdot \theta \approx \frac{d \cdot y}{L}. \tag{3}$$

At shift along a coordinate axis of y on the distance equal to an interference bandwidth Δl, i.e. at shift from one interference maximum in next, the difference of the course Δ changes on one wavelength λ. Therefore,

$$\frac{d \cdot \Delta l}{L} = \lambda \quad \text{или} \quad \Delta l = \frac{L \cdot \lambda}{d} \approx \frac{\lambda}{\psi}, \tag{4}$$

where ψ – angle of convergence of "beams" in an observation point P. Let's execute the quantitative assessment. Let's say that d distance between cracks S_1 and S_2 equally to 1 mm, and the distance from cracks to the screen E makes L = 1 m, then $\psi = d / L = 0{,}001$ rad. For green light (λ = 500 nanometers) we will receive $\Delta l = \lambda / \psi = 5 \cdot 10^5$ nm = 0,5 mm. For red light (λ = 600 nanometers) $\Delta l = 0{,}6$ mm. In such path Young for the first time measured lengths of light waves though accuracy of these measurements was small.

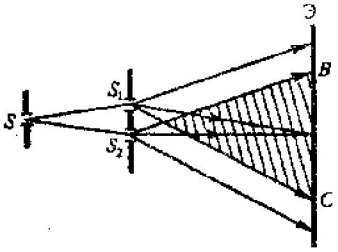
Actual light waves are not strictly monochromatic. Owing to the fundamental physical reasons radiation always has statistical property. Atoms of a light source radiate independently of each other in casual instants, and the radiation of each atom lasts very short time ($\tau \le 10^{-8}$ s). Resultant radiation of a source in each instant consists of deposits of huge number of atoms. Through order time τ all set of radiating atoms is updated. Therefore cooperative radiation will have other amplitude and that is especially important, other phase. The phase of the wave radiated by an actual light source remains approximately constant only on order time slices τ. Separate "scraps" of radiation of duration τ are called hemlocks. Hemlocks have the space length equal to cτ where with – light velocity. Fluctuations in different hemlocks are not coordinated among themselves. Thus, the actual light wave represents the sequence of wave t with randomly changing phase. It is accepted to say that fluctuations in different hemlocks are incoherent. The time slice τ during which the oscillation phase remains approximately constant is called a coherence time.

The interference can arise only at addition of coherent fluctuations, i.e. the fluctuations which are falling into to the same Zug. Though phases of each of these fluctuations are also subject to random changes in time, but these changes are identical therefore the difference in phase of coherent fluctuations remains to a constant. In this case steady is observed the interference figure also, therefore, is carried out a principle of superposition of fields. At addition of incoherent fluctuations the difference in phase appears a random function of time. Interference fringes experience random movements here and there, and in time Δt their filing which in optical experiments much more a coherence time ($\Delta t >> \tau$), there is the complete averaging. The recording device (an eye, a photographic plate, a photo cell) will record in an observation point the average value of intensity equal to the sum of intensity of $I_1 + I_2$ of both fluctuations. In this case the law of addition of intensity is carried out.

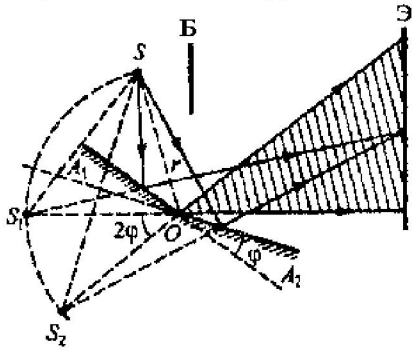
Methods of observation of an interference

To the invention of lasers in all optical instruments coherent waves received by method of division of a light beam into two beams. Passing the divided two rays of light two various geometrical paths received a difference in phase and at a slip gave the interference figure.

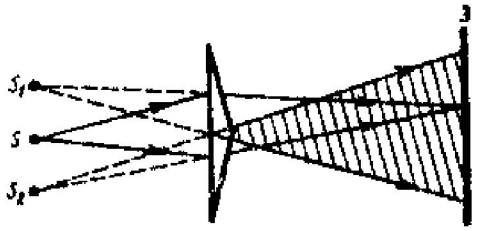
1. Method of Young. Passing light through a crack of S gets on two cracks S_1 and S_2, carrying out a role of two sources of coherent waves, through whom pass give a difference in phase, iinterferentsionny picture BC it is observed on the screen E .



2. Fresnel mirrors Свет от источника ***S*** gets on two plane mirrors of A_1O and A_2O. These mirrors have a small corner of an arrangement φ to each other and give two virtual images of S_1 and S_2, S light source which are carrying out a role of two coherent light sources. The interference figure is observed on the screen. That light did not get directly on the screen is applied the valve B .



3. Fresnel biprism. Light from a source S after passing through a biprism, refracting forms two sources of coherent waves of S_1 and S_2 and when imposing on the screen give the interference figure.



4. Lloyd's mirror. The S-point source of light is located close to a surface of a plane mirror of M. The light source of S and its virtual image of S_1 carry out a role of two coherent light sources.

Interactive tools and virtualization on the computer of laws of wave optics in the program environment Flash-CC, Java - script.

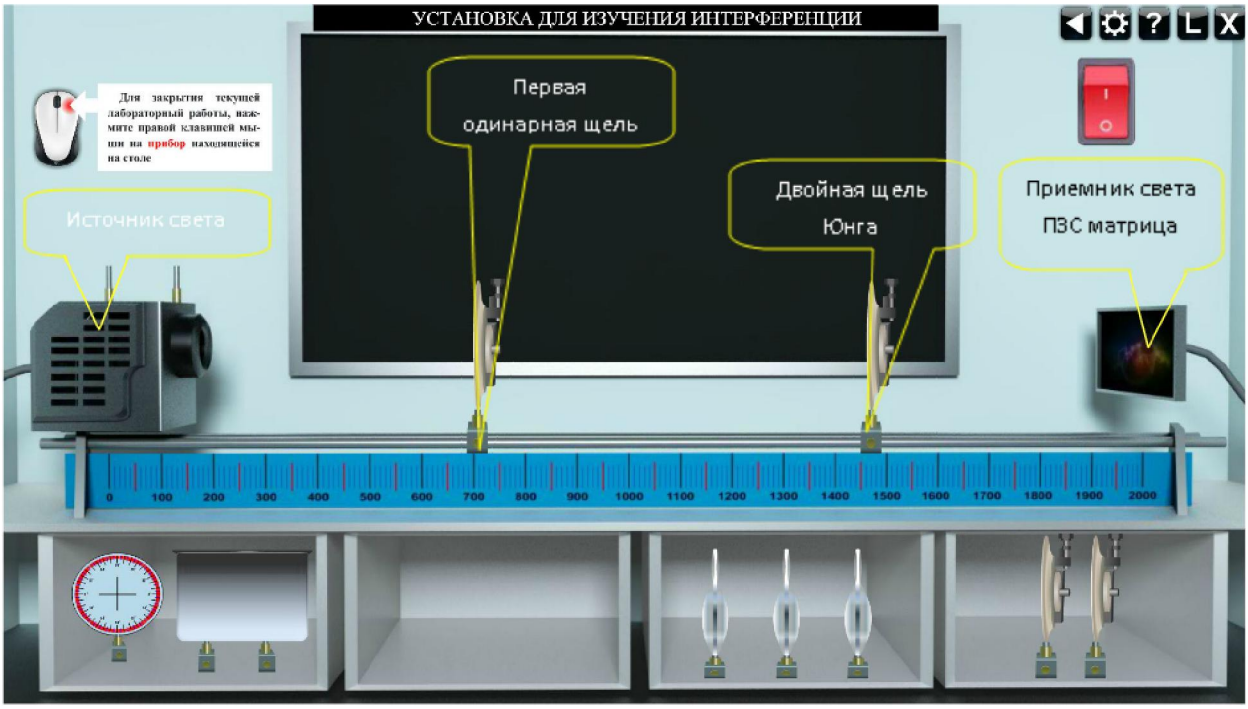
The present requirement of time for transfer larger volume information on the Internet, including animation images in driving work with them demands the large volume of memory. And for reduction of capacity of use of memory use for the virtual – interactive tools of Flash technologies is very efficient. [3,4]. From the basic vector – the graphic Flash format of technologies Shore wave Flash (SWF) – a branch was created. But, it is not the first vector format; it is the Web broadcast mechanism – pages to SWF as finding of the graphic representation, the coordinating link of an instrumental inventory and the graphic representation. Advantage of SWF-of the application it it easily an acceptability on other

Wednesday, i.e. this format is used in different is information – the program platform (in the Mac OS Macintosh operating system, in OS - Windows OS). One more feature of SWF – the constructed main images not only accept animation but also are padding, an opportunity to create interactive elements and audio of installation. Besides, mathematical formula communications of physical processes can be turned into interactive elements, management of their changes give the chance, to carry out on the computer, interactive virtual researches. For example, as shown in the drawing that the mathematical dependences found Shelli's for reflection and light refraction and to form interactive virtual laboratory, very conveniently the formats SWF, CC of them – the program Flash environment. For transfer on distances of interactive multimedia additions are carried out on the known SWF format – in the Web application for the Internet.

Why, to emergence of this application of this format in Macromedia, for browsers of two main networks of the Plug in component, and to distribution to Internet Explorer and Netscape Communicator the worldwide computer network affected. One more reason popularity of SWF – a format this very mild and convenient application instruments for other platforms development of Macromedia. For example:-for creations of the multimedia presentations use the program device – Macromedia Director Shockwave Studio,

- and are used the program device to creation of graphic images – Macromedia Authorwave, Macromedia Course Builder. Therefore among Web – the publication the most recognizable and easily applied publication is Macromedia Flash Web – gives the chance to decorate each website with animation and to collect the complete page. Action Script Tools - allows to collect Web addition efficiently and its modern languages similarly probably on the scenario Java Script, Action Script and by means of the editor of Devigger is the solution of often applied elements. When there is a work of Flash – Mkh you can construct the collected clip or import graphics, later in process of work will be able to process and by means of an assembly ruler use effect of resuscitation (Time line) [4]. Such clip or the movie can be interactive, i.e. particular images can be changed at discretion and to influence events in the clip. You export it

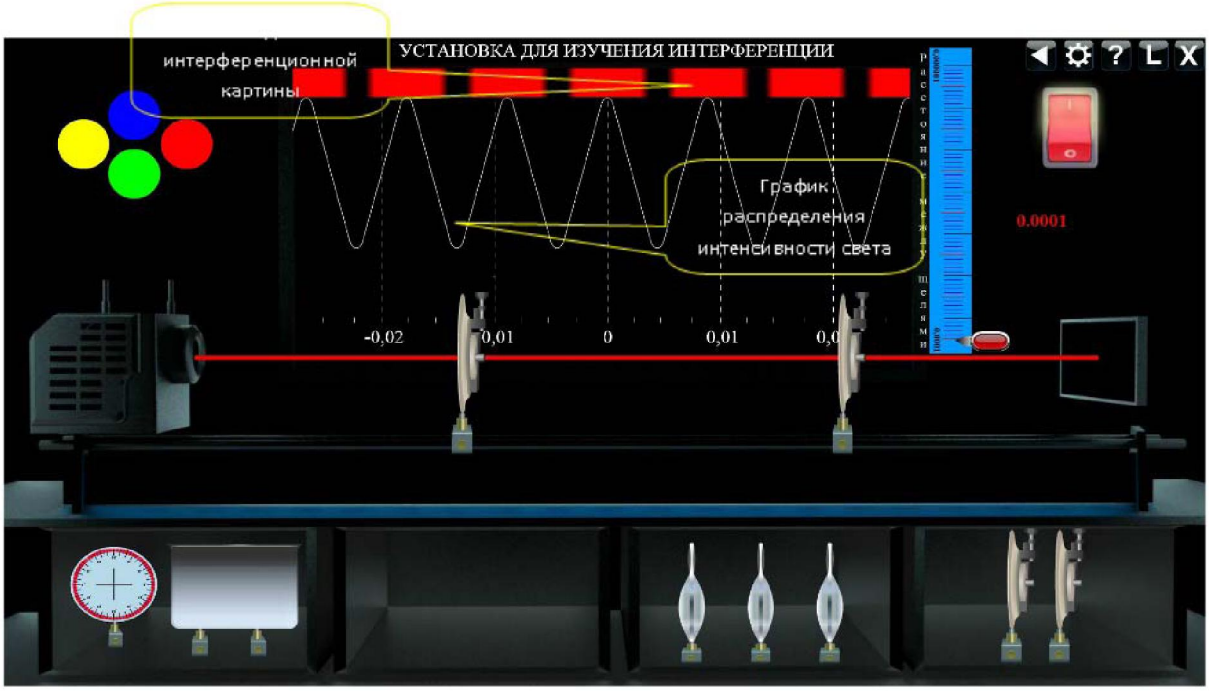
INSTALLATION FOR STUDYING OF THE INTERFERENCE



Turn of devices. The click by the right button of a mouse on the image of light filters, an individual crack and a double crack of Young deploys these devices by 90 degrees. The choice of the light filter (blue, green, red, yellow) is carried out by click of the left-hand button of a mouse on area of the light

filter. Parameters of an individual crack do not change. At a turn of a crack of Young the window of parameters in which it is possible to see and change distance between cracks and light wavelength opens. These parameters are given in meters. After the choice of parameters it is necessary to press the accept button.

Movement of a crack of Young on a bench. Guide the index of a mouse at the screw of fastening of a crack on an optical bench (the hand will appear). Press and hold the left-hand button of a mouse, moving a mouse to the right or to the left. Pressing the remove button in a window of parameters, leads to removal of installation. It must be kept in mind that installation will work only when all devices are installed in operative condition and in laboratory light is switched off.



Rescaling of the schedule of intensity of light. Establish the index of a mouse in the top left-hand corner of that area of the schedule which you want to see in an expanded scale. Press and hold the left-hand button of a mouse. Move the index from top to down and from left to right to the necessary point. Release the button. You will see the enlarged image on the screen. To return the schedule to a reference state, it is necessary to make the same, only driving of a mouse from right to left and from below up.

Conclusion.

As a part of informational technologies the new branch develops - it is the virtual interactive tools and visualization of the hardly understood subjects of physics, chemistry, biology and other objects [5]. And creation is virtual – interactive laboratories on called a subject meet the operated measuring apparatuses very seldom. Therefore the technology of creation of the virtually-interactive laboratory (VIL) for the section of physics given in this work. "The optics - ray optics" will be very relevant to creators similar to VIL – at higher step in other objects of knowledge. Such VIL – on the computer are very effective for development of a particular course of knowledge and develop self-contained research skills and awaken to creative searching of research techniques. Given VIL on ray optics, due to rituality and interactive intervention in change process an experiment condition, it is very useful to fast development of a subject of physics by students and to development of skills researching it. Brought VIL – on ray optics are introduced in educational process of the Eurasian Technological University and are successfully applied there.

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ТОЛҚЫНДЫҚ ОПТИКА ҚҰБЫЛЫСТАРЫНЫҢ МАТЕМАТИКАЛЫҚ БАЙЛАНЫСТАР АЛГОРИТМІН FLASH-CC, JAVA SCRIPT-,БАҒДАРЛАУ ОРТАЛАРЫНДА ИНТЕРБЕЛСЕНДІ ВИРТУАЛДАУ

Аннотация.Толқындық оптика-Гюйгенс принципіне сүйене отырып, энергетикалық қатынастар арқылы өтетін, жарықтың кеңістікте таралуын қарастырады. Оптикалық құралдар көмегімен, оптикада қарастырылатын барлық толқындық құбылыстар, толқындық оптика заңдарына негізделген. Мысалы, интерференция және дифракция құбылыстары. Оптикалық қондырғылардың көптеген теориялық есептеулері толқындық оптика заңдарына сүйенген. Осы жұмыста,толқындық оптиканың математикалық байланыстарының алгоритмі, яғни,жарықтың интерференция, дифракция заңдары компьютерде, виртуалды-интерактивті зерттеу қондырғысында жарық сәулесі Френельдің бипризмасы арқылы және дифракциялық решетка арқылы өткенде зерттеліп қарастырылады, тура, реалды эксперименттік қондырғыдағы сияқты. Интерференция және дифракциядағы оптикалық процесстер, Adobe Flash-CC-компьютерлік бағдарлама ортасында көрнекіленіп, интерактивті түрде виртуалданған. Толқындық оптика процесстерін зерттейтін, жасалынған осы лабораториялық жұмыс, осы курсты меңгеруде өте құнды болып есептеледі, ал компьютерде виртуалды-интерактивті зертхана (ВИЗ) жасау технологиясы басқа пәндерден ВИЗ жасауға өте қолайлы және актуалды. Мақалада келтірілген-виртуалды-интерактивті зертханалық жұмыс Евразия технологиялық университетінің оқыту процессіне енгізіліп, студенттердің білім саласында қолданылуда

Түйін сөздер: Алгоритм, виртуалды интербелсенді, толқындық оптика, интерференция, дифракция, дифракциялық решетка, монохромат,когерентті толқын, математикалық функционалды байланыстар.

УДК:535.4+004.9

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ИНТЕРАКТИВНАЯ ВИРТУАЛИЗАЦИЯ В СРЕДЕ FLASH-CC, JAVA SCRIPT АЛГОРИТМОВ МАТЕМАТИЧЕСКИХ СВЯЗЕЙ ЯВЛЕНИИ ВОЛНОВОЙ ОПТИКИ

Аннотация. Волновая оптика – рассматривает распространение света, с помощью принципов Гюйгенса., которые проходят через энергетические отношения. Тем не менее, рассматриваются в оптике, все волновые явления с помощью оптических приборов, а также величина дифракционного явления.Многие задачи теории оптических установок основаны на законах волновой оптики. В данной работе, алгоритмы математических связей волновой оптики, т.е. законов интерференции, дифракции световых лучей, рассматриваются на исследуемой установке при прохождении света через бипризму Френеля и дифракционную решетку.

Оптические процессы интерференции и дифракции визуализированы и интерактивно виртуализированы с помощью компьютерных программных сред Adobe Flash-CC. Сделанная, лабораторная работа по исследованию процессов волновой оптики очень эффективна при освоении данного курса, а технология создания ВИЛ описанной в данной статье, очень актуальна для создания аналогичных виртуально-интерактивных лаборатории(ВИЛ) по другим предметам.

Данная виртуально- интерактивная лабораторная разработка внедрена в учебный процесс Евразийского технологического университета и успешно применяется в обучении.

Ключевые слова: Алгоритм, виртуальная интерактивизация , волновая оптика, интерференция, дифракция, эксперимент Юнга, когерентность, математические функции.

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