Serbian Association for Geometry and Graphics

The 7th International Scientific Conference on Geometry and Graphics

moNGeometrija 2020

September 18th - 21st, Belgrade, Serbia

BOOK OF ABCTRACTS

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BOOK OF ABSTRACTS

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TOPIC 1: THEORETICAL GEOMETRY AND GRAPHICS

CONTENT

- INVITED LECTURE -

GEOMETRIC PROPERTIES OF THE "FLOWER" CONCAVE ANTIPRISMS OF THE SECOND SORT

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ABSTRACT

This study presents a continuation of the research on the concave polyhedra of the second sort, adding to this family a new group of related polyhedra. They are formed over a specific type of isotoxal concave polygons that allow geometric arrangement of a double row of equilateral triangles into formations which enclose a deltahedral lateral surface without overlaps and gaps. As in all other representatives of the concave polyhedra of the second sort, we expect to find here the "major" and "minor" type, depending on the way we fold the net. This research has identified both these polyhedra types, which have the same planar net, but are formed over different basic concave polygons. The origination, constructive methods and properties of these solids are elaborated in the paper.

Keywords: concave polyhedron; concave polygon; polygon elevation; antiprism; isotoxal; constructive geometry

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SETS OF PLANAR AND SPATIAL TESSELLATIONS BASED ON COMPOUND 3D MODELS OF THE 8D AND 9D CUBES AND ON RE-STRUCTURED CONVEX UNIFORM HONEYCOMBS

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ABSTRACT

A set of the convex uniform honeycombs consists of combinations of some Platonic and Archimedean solids as well as regular octagon based prisms. The edges of these solids are parallel to these ones of the Archimedean truncated cuboctahedron. It is the hull of a 3D model of the 9D cube. Special, symmetric 3D models of the 8D and 9D cubes and those of its lower-dimensional parts provide other sets of stones for further periodical space-filling mosaics. Subsets of these stones are building boxes of compound models of the elements applied in the tessellations of the above initial solids or models. The rebuilt tessellations can have fractal like structures as well.

Keywords: constructive geometry; hypercube modelling; convex uniform honeycomb; tessellation; fractal

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OBTAINING PENCILS OF CURVES OF HIGHER ORDER BY APPLYING A SUPERSYMMETRY TO PENCILS OF CONICS

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ABSTRACT

In this work, pencils of conics are mapped into pencils of curves of the higher orders, using supersymmetry. A Model of basic transformation for mapping of dots (inversion) is shown graphically and using equation as well. The conics were mapped using a chain of inversions where the order of obtained curves was being doubled. The inversion was interpreted in two ways: as quadratic transformation in the classical projective geometry and as pure symmetry in the relativistic geometry. The recognition of the equivalence between inversion and harmonic symmetry has created numerous possibilities for mapping curves and obtaining new forms. Two types of pencils of conics which have not been mapped before are mapped in this work. Research studies in the field of enlarged symmetries offer inexhaustible space for further discoveries about plain and spatial forms. Obtained results will be of use in the theory of geometry and in the practice of architecture.

The mapping model was used to create the Lisp routine, which was then used in the AutoCAD software, for the purposes of computer drawing of pencils of conics and equivalent pencils of curves of the higher order. The order and the shape of the obtained curves depend on where the center of inversion has been constructed related to the base points of the pencil of conics. It is shown that the obtained pencils of curves intersect at the same number of base points as the original pencils of conics.

Keywords: inversion; supersymmetry; pencils of conics, pencils of curves of the higher orders

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PLÜCKER'S CONOID, HYPERBOLOIDS OF REVOLUTION, AND ORTHOGONAL HYPERBOLIC PARABOLOIDS

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ABSTRACT

Plücker's conoid $\mathcal{C}$, also known under the name cylindroid, is a ruled surface of degree three with a finite double line and a director line at infinity. The following two properties of $\mathcal{C}$ play a major role in the geometric literature:

The bisector of two skew lines ℓ_1, ℓ_2 in the Euclidean 3-space, i.e., the locus of points at equal distance to ℓ_1 and ℓ_2, is an orthogonal hyperbolic paraboloid $\mathcal{P}$. All generators of $\mathcal{P}$ are axes of one-sheeted hyperboloids of revolution $\mathcal{H}$ which pass through ℓ_1 and ℓ_2. Conversely, the locus of pairs of skew lines ℓ_1, ℓ_2 for which a given orthogonal hyperbolic paraboloid $\mathcal{P}$ is the bisector, is a Plücker conoid $\mathcal{C}$.

In spatial kinematics, Plücker's conoid $\mathcal{C}$ is well-known as the locus of axes ℓ_{12} of the relative screw motion for two wheels which rotate about fixed skew axes ℓ_1 and ℓ_2 with constant velocities. The axodes of the relative screw motion are one-sheeted hyperboloids of revolution $\mathcal{H}_1$, $\mathcal{H}_2$ with mutual contact along ℓ_{12}. The common surface normals along ℓ_{12} form an orthogonal hyperboloid paraboloid $\mathcal{P}$ passing through the axes ℓ_1 and ℓ_2.

The underlying paper aims to discuss these two main properties. It seems that there is no close relation between them though both deal with Plücker's conoid, orthogonal hyperbolic paraboloids, and hyperboloids of revolution – however in different ways.

Keywords: Plücker's conoid; cylindroids; bisector; one-sheeted hyperboloid of revolution; orthogonal hyperbolic paraboloid

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THE BIJECTIVE PART OF THE MONGE CUBOID FOR THE MAPPING OF THE HELIX AND THE SPATIAL CURVE ARC

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ABSTRACT

The paper deals with the examination of Monge's theory for ensuring the reconstruction of curves. There are many ways to add an image plane system to a given curve. The aim is to provide a mathematically correct condition for these image plane systems added to a given curve for ensuring the reconstruction of the representation of the curve. In engineering practice, images of a given object have the same properties in terms of reconstructability in image plane systems that can be moved into each other by parallel displacement. Therefore, from our point of view, related to the examinations, the image plane systems that can be moved into each other with parallel shifting are classified into one class during development. A class of image plane systems is defined by a pair of projection lines, perpendicular to the corresponding image planes, fitting to the starting point O of a fixed Cartesian coordinate system. This pair of projection lines is determined by three free angle parameters. These angle parameters create a Monge cuboid. Image plane systems are determined for a given helix, in which any piece of the described helix can be reconstructed from only two images. The Monge cuboid points of these image plane systems are visualised. Mathematical determination of the positions of two CCD cameras is also presented in this paper to ensure the reconstruction of the cutting edge curve from its two images.

Keywords: Monge mapping; Monge cuboid; reconstruction; helix; Hermite arc; cutting edge

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CONCAVE PYRAMIDS OF FOURTH SORT

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ABSTRACT

The paper discusses the generation of a specific group of polyhedra, Concave Pyramids of Fourth Sort (CP IV). Correspondingly to the method of generating the Concave Cupolae of Fourth Sort (CC IV), the Concave Pyramids of fourth sort have the similar logic of origination, and their counterpart in regular faced convex pyramids. The concave polyhedral surface consists of a series of equilateral triangles, grouped into spatial pentagons and hexagons. Positioned polarly around the central axis of the regular polygon in the polyhedron's basis and linked by connected triangles, the spatial pentagons and hexagons form the deltahedron's surface area. The criterion of face regularity is respected, as well as the criterion of multiple axial symmetry. Distribution of the triangles is based on strictly determined and mathematically defined parameters, which allows the creation of such structures in a way that qualifies them as an autonomous group of polyhedra – concave pyramids. The sort of the Concave Pyramids is determined by the number of equilateral triangle rows in thus obtained polyhedron's net. The parameters of the solids were determined constructively by geometric methods.

Keywords: concave pyramids; polyhedral; equilateral triangle; regular polygon.

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SPATIAL INTERPRETATION OF ERDÖS-MORDELL INEQUALITY FOR POLYGONS OVER WEBERIAN FOCAL-DIRECTORIAL SURFACES

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ABSTRACT

In the paper we deal with a geometrical problem which originates from the Erdös-Mordell inequality (EMI) for regular polygons generalizing it by defining Weberian focal-directorial surfaces (WFDS). Furthermore, we derive such surfaces in a way suitable for their visualization and present possibilities of the application of Weber's surfaces generated by eight foci and eight directrix lines at most.

Keywords: algebraic equation; Erdös-Mordell inequality; Erdös-Mordell curve and surfaces; Weberian focal-directorial curves and surfaces

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VISUALIZATION OF SINGULAR QUADRIC SECTIONS OF FOUR-DIMENSIONAL CONES

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ABSTRACT

Recently, we have studied four-dimensional synthetic constructions of real regular quadric sections of four-dimensional cones with an ellipsoidal (for unruled quadrics) and a one-sheet hyperboloidal (for ruled quadrics) directrix in the affine classification. The four-dimensional space is visualized in the double orthogonal projection onto two mutually perpendicular 3-spaces, in which a four-dimensional object is represented by its two conjugated three-dimensional images in one modeling 3-space. This way, tools of the classical descriptive geometry are generalized and conveniently used with interactive computer graphics for synthetic constructions in the four-dimensional space. In this contribution, synthetic constructions of all the real singular quadrics in the double orthogonal projection are carried out. Each singular three-dimensional quadric is ruled, and hence for finding the most of real cases, we choose hypercones containing a one-sheet hyperboloid. Spatial sections of a one-sheet hyperboloidal hypercone through its singular point (vertex) are three dimensional real cones or two real planes intersecting in a line. Considering a hypercone with an improper singular point (i.e. four-dimensional hypercylinder) with a one-sheet hyperboloidal directrix, the following spatial sections: an elliptic, parabolic, and hyperbolic cylinder, or two parallel planes; can be derived. Furthermore, to obtain a double plane, or a proper and improper planes, as spatial sections, we choose a singular four-dimensional quadric with at least a singular line. We visualize hyperquadrics with their spatial sections in the double orthogonal projection and support the constructions with their analytic derivations in the projective extension of the real space. All visualizations are supplemented with interactive 3D models with step-by-step constructions. The purpose of the presented work is to show how a generalization of descriptive geometry methods of Monge's projection is applied for a deeper understanding and investigation of the properties of four-dimensional hyperquadrics.

Keywords: four-dimensional visualization; double orthogonal projection; descriptive geometry; quadrics; computer graphics

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TOPIC 2: APPLIED GEOMETRY AND GRAPHICS

CONTENT

ABOUT THE GEOMETRY OF SOME FITTINGS USED IN FLAT-OVAL DUCTS

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ABSTRACT

The classic solutions for the ventilation or air conditioning installations, which transport fresh, treated or polluted air, are realized by means of circular or rectangular ducts. A current solution is represented by the use of flat-oval channels, which combines the advantages of the previous types, among which, one can mention: the reduced height of the section for the same area compared to the circular sections, respectively, low pressure losses and reduced risk of depositing impurities compared to the rectangular sections. Despite these advantages, their use has not become widespread on the market in our country due to the reluctance of designers and manufacturers. The subject about the flat-oval sections was approached by the authors in a previous paper. In this paper, the attention is focused on the geometrical solving of some pieces used for changing the flow direction such as elbows, branches or bifurcations. By default, these parts introduce local load losses, which means increased energy costs. The pressure losses in fittings are described using the K-factor and the equivalent length concept. By selecting suitable geometric solutions the pressure losses can be reduced. Solving these pieces requires knowledge of descriptive geometry regarding cylindrical surfaces, namely, plane sections, developments and intersections between cylinders. Based on the graphical and/or analytical solutions of fittings developments, calculation programs are made to be implemented on numerical control machines, increasing in this way the production efficiency and also the execution precision.

Keywords: descriptive geometry; applied geometry; cylindrical surfaces; flat-oval ducts; elbows; branches.

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INTERACTIVE PRESENTATION IN ARCHITECTURE BY VIRTUAL REALITY

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ABSTRACT

The aim of this paper is the presentation of a house using interactive virtual reality, as well as to discuss general control, movements and interaction with objects in a virtual environment. The paper presents and analyzes the workflow starting from the design of the house to the process of applying interactive virtual reality in architecture by using Unreal Engine software. It describes and explains the way of making a scene for an interactive architectural visualization, the possibilities of user interaction with virtual space, the usage of VR in architectural visualization, as well as moving (teleportation) through virtual space, interactive (moveable) assets and interactive (changeable) assets via controllers. As a result, it also explains the segments that affect the quality of experiencing a virtual space and the ways to improve the segments that produce inadequate results. It shows the advantages and disadvantages of experiencing space through virtual reality, the pros and cons of interactive architectural visualization and it makes a comparison between the VR presentation and other forms of presentation. Also, it presents the problems that originate during the creation process of an interactive virtual walk and the way of solving them. The presented method of creating an interactive scene can be useful for the architects, designers and in the real estate sales, because it can place the user in the virtual space, visualizing the design before it is built.

Keywords: Virtual Reality; Interactive Visualization; Architectural Visualization

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REVERSE PERSPECTIVE – DIFFERENT APPROACHES AND APPLICATIONS

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ABSTRACT

Due to the paucity of medieval sources which could provide answers to why after ancient knowledge of perspective, was applied a new method for representing space in Byzantine painting. Nowadays exist different interpretations of the reverse perspective method. Many of these interpretations date from the first half of the twentieth century. The goal is to show the application of reverse perspective in modern visual arts.

In addition to reverse perspective, elements of artistic perspective and visual effects were used in the comparative analysis of examples of Serbian medieval painting and modern visual art. Of note are the works of contemporary Spanish, British and Serbian artists such as Perez Villalta, David Hockney, Aleksandar Tomašević.

Keywords: inverse perspective; fish-bone perspective; axonometric projection; optical-physiological perspective; representation of architecture

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POLYHEDRA IN ARCHITECTURAL DESIGN

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ABSTRACT

With the advent of the computer are dramatically influenced, both the shape and materialization of architecture, and of course the representation in architectural design. New trends, theories and styles appear in the architecture produced by digital. A new language of architectural forms, the so-called free forms, makes its presence felt in the built environment. The relationship between the shape of these free volumes and simple geometric volumes represents an evolution whose result is the change of the architectural paradigm towards a digital architecture. At the base of this new architecture is geometry, with its primary volumes. In this paper we want an inventory of buildings that use irregular and regular polyhedra as geometry. These polyhedral volumes allow modularity and repetitiveness, and this process can be extended to give rise to more complex forms such as free forms. Descriptive geometry must provide basic knowledge about the creation of space, shapes and methods by which they can be represented.

Keywords: irregular polyhedrons; regular polyhedrons; architectural design; descriptive geometry; applied geometry

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SOLVING THE 3D BIN PACKING PROBLEM TO IMPROVE TRANSPORT EFFICIENCY

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ABSTRACT

The application of geometric modelling in order to improve the efficiency of utilization of cargo space of vehicles is one of the steps forward in the practical application of the synthesis of basic geometric principles and computer programming. The paper presents the concept of solving a three-dimensional packing problem – the 3D Bin Packing Problem. The final result of the implementation of the aforementioned concept is the formation of a three-dimensional model of the packing plan, on the basis of which the compactness of cargo and the maximum utilization of cargo space is achieved. The applicability is shown in the example of packing packages within a company that deals with the transfer of postal express items. In such systems, solving the 3D Bin Packing Problem produces significant results. The reason for this is the stochastic nature of the transport requirements, which is primarily reflected in the different physical characteristics of the packages being transported. The efficient utilization of cargo space within transport systems contributes to the improvement of the realization of business activities and the reduction of costs.

Keywords: packing problems; 3D CAD model; cargo space engineering; transportation; postal items

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SIMULATION ANALYSIS OF THE SPATIAL DISTRIBUTION OF MARKET STALLS IN THE PUBLIC OPEN SPACE

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ABSTRACT

The design of public open spaces affects the movement of people, their behaviour and interaction. For temporary settings in public spaces, there are generally no defined rules that dictate their spatial distribution. In this study we intend to improve functionality of public open space during the events by proposing a multi-agent simulation-based model as a decision-making support tool.

Simulation analysis is based on a model in which agents in the pedestrian flow represent visitors of the event and passers-by. The results presented in this paper show that the distribution of market stalls affects the retention time of both groups of agents in the analysed public open space. The case study was conducted for a real space, the main square in Novi Sad, where we compared different spatial distributions of the same number of market stalls based on agents' spent time. The aim of the research is to contribute to better decision making and to point out the impact of things that are often overlooked in the design process.

Keywords: agent-based modelling; spatial simulation; urbanism; decision-making support

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GEOMETRY OF SOLAR TOWER WITH ELLIPTICAL TORUS MIRROR

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ABSTRACT

An intense increase of research in "green" technologies brings a variety of science fields in common goal to contribute sustainable development. Such an example is concentrated solar power (CSP) which combines knowledge of astronomy, thermodynamics, mechatronics and geometry in one final product. The solar power tower is a system that uses an array of flat, movable mirrors called heliostats to focus Sun's rays into one focal point which is usually a boiler located on top of central collector tower. This paper will present one possible design of solar power tower by using geometry to relocate its focal point. Most common solutions for solar power tower are shown and they are based on concept where boiler is in plain sight. Idea behind this relocation of focal point in novel construction is that boiler will be isolated from environment conditions and by doing so it can preserve more thermal energy during night. This can be achieved by installing additional mirror on solar power tower which has a shape as revolved partial ellipse. Here will be explained how this additional mirror can be used as economiser for fluid that is being heated in solar power. Paper also explains use of "fat point" at focal point and thus compensate errors that can occur if rays from heliostat are inaccurate.

Keywords: solar power tower; ellipse; concentrated solar power; focal point; fat point, accuracy; applied geometry

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IS THE EARTH ROUND?

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ABSTRACT

In this two part exposition on the importance of philosophy in science and thought in general, we will explore the mathematics of the recent philosophical issue of the Earth being round or flat, the problem answered millennia ago, but that has recently re-emerged as a question in our society.

The first part is the discussion on philosophy and affiliation towards knowledge in general. The historic solution of the problem, known in ancient Greece and probably to other much older civilizations, is founded in astronomy and is the undoubtable principle that we are living in Space, and that the Earth, as well as other visible celestial bodies, must be of round shape, rotating and revolving. This shape is the only shape suitable to the revolving motion.

In the second part we present the mathematics of the problem; sphere as a three-dimensional object and its planar projection - stereographic projection; spherical geometry; sphere as a Riemann surface, Gaussian map, cartography and its general link to geodesy.

We will reveal the true cause of this misapprehension of reality through our mathematical reasoning in the conclusion of the paper.

Keywords: philosophy; spherical geometry; Riemann surface; stereographic projection; geodesy

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INTRODUCING ADDITIVE MANUFACTURING AND AUGMENTED REALITY IN THE CONCEPTUAL PHASE OF THE DESIGN PROCESS

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ABSTRACT

The conceptual phase is often neglected and rushed by the other departments involved in the design and production process. But the conceptual phase is of great importance for the success of the product on the market. Here, the designer incorporates all the information that he/she has about the new design, generating ideas in order for the output to be a functional and aesthetic product. It is important to make the most of it in order to assure quality result. In order to ensure short conceptual phase that will not reflect on the products' quality we propose introduction of two "new" technologies in the conceptual phase. These "new" technologies that we are proposing to be included in the conceptual phase are Additive Manufacturing (AM) and Augmented Reality (AR). AM is used for creating more realistic prototypes and proof of concepts in a short period of time. While the AR is used for more detail explanation of the products' functionality and usability.

If we apply this approach in the conceptual phase to focus groups meetings, we can be certain that the message that needs to be sent as a designer's intent is received and rightfully understood. In that manner the responses will be on the point and can be used in total, in the redesign phase or the further phases of the design process.

By incorporating new technologies in the conceptual phase, the overall time can be shortened and at the same time, the outcome can be better.

Keywords: conceptual design; additive manufacturing; augmented reality; design process

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KERF BENDING: A GENEOLOGY OF CUTTING PATTERNS FOR SINGLE AND DOUBLE CURVATURE

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ABSTRACT

The paper presents an ongoing research on kerf bending of sheet timber material, by removing material at strategically located areas on the surface, to weaken the material locally rendering it bendable. Through a series of experiments the aim is to understand the reciprocal relationship between the cutting pattern and characteristics such as bending curvature, material resistance under load, among others. By understanding the factors that lead to an increased degree of single or double curvature, the aim is to optimize these patterns by redesigning, combining and scaling patterns, as well as changing the direction of pattern elements. All experiments are documented, forming a genealogy of patterns that are grouped by type and geometric properties. The conclusions highlight the advantages and limitations of each cutting pattern with regards to the geometry, while they discuss the possibilities for differentiated curvature through parametrically differentiated patterns.

Keywords: kerf bending; architectural geometry; digital fabrication; curvature; cutting patterns

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BRUNO TAUT´S GLASHAUS – A MODEL FOR CONSTRUCTION TECHNIQUES OF TODAY

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ABSTRACT

The Glashaus, which Bruno Taut designed for the Werkbund exhibition in Cologne in 1914, is considered to be one of the key buildings of the 20th century. The philosophical approach, conception, and impact of the building have already been discussed in detail from an architectural point of view. No matter whether the Glashaus was inspired by nature or Gothic, the construction of the dome follows strict geometric principles and the design is strongly driven by practical building matters. The reticulated structure has only planar faces to ensure complete glazing. As such, it is a very early precursor of a non-trivial planar quad (PQ) mesh for a roof structure. We will use the Glashaus as inspiration and motive for a geometrical and structural analysis of such diagrid structures and apply the principles to modern building construction methods such as concrete printing.

At first, we propose a geometrical algorithm, which has probably been used to generate the dome. We then compare the result with an in-depth reconstruction from the plans handed down from the Historical Archive of the City of Cologne. Next, we explore the design space of the algorithm and adapt it to other surface classes like further surfaces of revolution, translational surfaces and generalized helicoids. The main focus is on the determination of the geometrical constraints, which may limit changes of the generatrix and depend on the generation method. Finally, the advantages of the proposed planar quad mesh family for large scale additive manufacturing processes will be reflected. Additional algorithms will be developed to meet the constraints of the construction process and may on the other hand push the conception for 3D-printing tools. On photographs of the erected Glashaus, unintended deformations of the dome can be detected visually. The aim of this research is, to surpass the limited accuracy of the early 20th century with contemporary manufacturing methods and trigger innovations for today's construction industry.

Keywords: dome, diagrid structure, planar quadrilateral (PQ) mesh, 3D concrete printing, Large Scale Additive Manufacturing (LSAM), parametric design

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HELICAL SURFACES AND THEIR APPLICATION IN ARCHITECTURAL PARAMETRIC DESIGN

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ABSTRACT

The use of ruled surfaces has been common practice in architecture and design ever since first coliseums appeared. Most ruled helical surfaces, due to their visual, kinetic, and economic properties, have gained popularity over time. Nevertheless, its rationalization has not been fully displayed in recent years causing it to be a problem due to complex solutions when developing engineering or design projects. The overall picture that connects mathematical context and ready to use render visualizations are accompanied by some complexity in the process. As a consequence, parametric design and its technical characteristics cannot always be fully understood by the user.

This article aims to create a comprehensible model, which will show the overall process of parametrical shape-forming taking the developable and oblique type and its parametric equations with the initial conditions. Also, three case studies will be reviewed as part of the analysis. The main goal of this study is to make the parametrical algorithmic exploitation process easier to assimilate and utilize. Starting with some ground information about ruled helicoids and finishing the ready to use surfaces. Rhinoceros 6 and grasshopper are the main programs applied due to their visual simplicity and interactive usage. And finally, conclusions are made and recommendations given for further research.

Keywords: helical surfaces, ruled surfaces, helicoid, algorithm, Grasshopper, Rhinoceros, design, revolution surfaces, architecture, parametric design.

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SIMULATION OF THE CONTACT SURFACE BETWEEN THE HOBBING CUTTER AND THE WHEEL ON AN FD320A MILLING MACHINE

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ABSTRACT

This paper is a result of numerous studies on the dynamics of the process on an FD320A milling machine. We also try to propose a method for the determination of the displacement of the contact surface using an analysis with finite elements. Before this, we outline an important problem of the achievement of a model with finite elements that must be the best approximation of the tool-machine structure first, and then the problem of making a geometric model for the contact surface. Additionally, we collected some experimental data. The findings of theoretical studies are mostly confirmed by experimental data, registered with an acquisition system set on the shaft's slides of the final elements for the milling machine. We performed a dynamic analysis with variable forces since it is, well known that the vibrations that appear may cause large displacements and severe stresses in the actual situations. The analysis proves that displacements are in admissible limits and do not exert major influence on the quality of the processing surfaces.

Keywords: finite element, displacements, milling machine, hobbing cutter.

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THE PRACTICE OF STRUCTURAL ANALYSIS AT THE "KULA" CONSTRUCTIONS

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ABSTRACT

The study presents the "Kula" constructions from Romania, Oltenia region, and structurally analyses their long-term behaviour. The input parameters on which the behaviour of massive masonry buildings depends over time are analysed and taken into account. Heritage buildings of this type have been built in the Southwest of the Roumania for three centuries. The term "kula" refers to square or rectangular structures. These buildings can endanger the lives of a large number of people, first of all, their owners, but sometimes visitors and other people in their neighbourhood. Under these circumstances, the consolidation and maintenance of masonry construction is a major interest to groups of specialists. Through the obtained results and conclusions, valuable contributions are made to the lifetime estimation of heritage buildings by defining the exact role of each input parameter and the impact of each cause on the pre-collapse and collapse state.

Keywords: Kulas, degradation, descriptive statistics, seismicity, landslide

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GEOMETRY AND KINEMATICS OF HUMAN KNEE JOINT

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ABSTRACT

At first glance, the human knee can look like a simple rotational joint but the real knee has more complex geometry and kinematics. Kinematics of the human knee depends on its geometry and applied analysis showed that it is a rolling joint, where the upper part of tibia rolling on femur lower end. Such kind of motion can be simply explained with rolling curves generation. In the simplest case, circle rotates on a flat surface and each point on circle circumference will generate one cycloid. Curves defined through this method highly depend on the shape of the rolling object and shape of the surface where the object roles.

In the literature complex, geometry and movement of the human knee can be solved with a relatively complex mechanism that can reproduce real movement or simply by replacing knee with one rotational joint. Application of the new popular technologies (3D printing, CAD) and new approaches of mechanisms design (where the mechanism is produced as one part, and its geometrical shape allows relative movement through elastics deformation), can simplify the overall geometry and kinematic of an artificial knee joint. This will further simplify manufacturing processes, lower costs of the knee and leg prosthetics, and increase its durability by reducing the number of movable parts.

Keywords: Human knee; rolling joint; simulation; 3D printing; CAD

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CONTEMPORARY ARCHITECTURAL GRAPHICS THE IMPACT OF AVANT-GARDE MOVEMENTS

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ABSTRACT

Until the 19thcentury, architecture was the determinant of stylistic changes, after which period painting took over. As a consequence, at the beginning of the 20thcentury, there was a gap between the condition in fine arts, on the one hand, and architecture and applied arts, on the other. Architecture was clearly behind, contributing to the emergence of many avant-garde movements across Europe. Such movements represented the leading force behind the development of architecture as well as new principles and techniques of architectural visualization and presentation. This paper analyzes the impact of avant-garde architectural movements on contemporary architectural graphics. Finding key visual specifics in the architectural representations of avant-garde architects of the 20thcentury, which are also applicable in contemporary visualizations, was the starting point of the analysis. After that, their systematization was carried out.

Keywords: contemporary architectural graphics; architectural visualization and representation; avant-garde movements

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MIMICRY OF GEOMETRY AND DESIGN FROM THE NATURE AND BIOLOGY TO MATERIAL SCIENCE AND ENGINEERING

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ABSTRACT

In this paper geometry and design in material science and engineering, which have been an inspiration from nature and biology is investigated. It is found out that symmetry, harmony, and perfection play crucial rule in this mimicry. In the symmetry approach not only symmetry of the crystallography group is included, but also molecular symmetry groups, Kugel and Curie symmetry groups. The criteria of harmony are based on Fibonacci sequences and Fibonacci numbers Φ,-Φ,ϕ,-ϕ. Symmetry and harmony are giving beauty to geometry and design in nature, biology, and engineering. However, in this investigation, perfection is also included (based on the perfect numbers) that gives, besides beauty, a new property of "sublime" to the objects and processes.

In this paper, a few examples of mimicry in relation to nature-biology-engineering based on symmetry, harmony, and perfection are presented. One of the examples of that kind of mimicry is a spiral galaxy- centrioles-solar plants. The second one is molecule C_{60} in space (in cosmic dust), clathrin in the human brain, and C60 in nanophotonics, nanocosmetics, and medicine. However, more examples of biomimicry (from biology to engineering) are presented. One of the more interesting examples is a container for cosmetically use with complex geometry and design based on the pentagonal-hexagonal organization of collagen in human tissue.

According to our investigation, we can conclude that optimization of mass-energy, energy-information, and information-control (regulation) in the nature, biology, and engineering are principle which determinate geometry and design of objects.

Keywords: symmetry, Fibonacci, applied geometry, mimicry, design, optimization

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ON POSSIBILITIES TO ENCODE ARTISTIC STYLE AND MANNER PRESENT IN A CONCRETE ARTWORK USING MICRO-PHOTOGRAMMETRY AND MATHEMATICAL STATISTICS/PROBABILITY TO PROCESS THEIR GEOMETRIC DETERMINANTS

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ABSTRACT

This paper defines a procedural approach intended to scientifically encode artistic style and manner exhibited in a concrete artwork - based on quantifying their descriptors of geometric nature previously professionally identified as subject-related due to their dominant presence and/or their value-wise importance. Such encoding is a specific authentication process whose purpose is to define an ID-card of a concrete artwork or an artist's overall creative epoch the analysed works belong to. Doing so, it also becomes feasible to scientifically determine the fact whether and with which level of probability ("threshold"), a particular artwork of an initially unknown artist, is possible to be classified in the opus of a presumed artist i.e. of her/his corresponding creative epoch.

To explain the procedure as comprehensively as possible, only one geometric-wise descriptor of artistic style and manner is analysed: "thickness of the painting-layer" – as their dominant indicator present on the chosen experimental painting. This quantifying is realized in a two-step activity which is carried out: (i) by using contemporary micro-photogrammetric technique and related equipment (to digitize the artwork, namely, to acquire and extract the mentioned descriptor), and (ii) by performing relevant statistical management that includes probability calculation, analysis and estimation of cross-referenced previously digitized data. Goal-directed Id-card is constituted by a set of those calculated outputs.

Keywords: Micro-photogrammetry, Geometry, Architecture, Fine & Applied Arts, Mathematical Statistics, Probability

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IMPLEMENTATION OF THE 3D MODEL COMPLEXITY IN VR ENVIRONMENT IN THE CASE OF NOVI SAD CITY CENTER

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ABSTRACT

In this research, the aim is to create a large urban fragment representation with a lot of details and simultaneously with a low polygon count. Models of real-world objects with a high level of details are usually made by assessing and stored as a point cloud to preserve details. However, this can have an impact on the processing power of the computer. For that reason, a low poly model is preffered to be used, where the details were indicated by the material textures and not through geometry. Meanwhile, the lack of details in the geometry of the buildings can be compensated with urban furniture and tiling of the street in order to introduce more details and make the immersion adequate. In this paper, different objects and materials are used in the scene and the quality of immersion success is rated. The background of this research are ready-made 3D models of buildings in the pedestrian zone of Novi Sad, modeled by students. The link between the models and virtual reality was used to show the general public the city center of Novi Sad, without having to walk through it.

Keywords: Virtual Reality; Interactive Visualization; Architectural Visualization

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AUGMENTED REALITY KITCHEN DESIGN

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ABSTRACT

Kitchen represents a space with great importance for one family. That's why the goal is to have a kitchen with the best possible design. This implies the creation of a kitchen with the best possible organization, maximal space usage and aesthetic appearance in accordance with the owner's taste. The traditional kitchen design process assumes the use of professional services, such as an interior designer or architect. The kitchen design process consists of several steps:

Space measurement and initial design discussion;

2D / 3D design;

Design evaluation;

Technical drawing creation.

Professionals in the design phase use different manual and digital tools and software. Precise kitchen space measurement is done in a family home using measurement tools. Design discussion has a goal of understanding the homeowner's taste and desire for the kitchen appearance and functionality. Based on discussion and measurements, the designer creates first kitchen visualizations in the form of sketches, 2D images, or 3D models. This design is then discussed with the homeowner and readjusted several times until the final version. This final version is then used for the creation of technical drawings that are used for kitchen assembly.

The evolution of contemporary devices and computer graphics lead to the development and adaptation of Augmented Reality in design. Augmented reality (AR) is an emerging computer technology where the perception of the user is enhanced by the seamless blending between a realistic environment and computer-generated virtual objects coexisting in the same space. The resulting mixture supplements reality, rather than replacing it.

In this paper possibilities for Augmented Reality use in the kitchen design process are investigated. Analysis and comparison of currently available, state of the art solutions for Augmented Reality kitchen design are performed. State of the art in the field of AR space measurement, AR 3D model presentation, and AR kitchen design are investigated. Analysis of currently available solutions for Augmented Reality kitchen design is performed and compared.

Keywords: Kitchen Design; Augmented Reality; Computer Graphics; Visualisation

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THE CONTEMPORARY VISUALIZATION AND MODELLING TECHNOLOGIES AND TECHNIQUES FOR THE DESIGN OF THE GREEN ROOFS

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ABSTRACT

The contemporary design solutions are merging the boundaries between real and virtual world. The Landscape architecture like the other interdisciplinary field stepped in a contemporary technologies area focused on that, beside the good execution of works, designer solutions has to be more realistic and "touchable". The opportunities provided by Virtual Reality are certainly not negligible, it is common knowledge that the designs in the world are already presented in this way so the Virtual Reality increasingly used.

Following the example of the application of virtual reality in landscape architecture, this paper deals with proposals for the use of virtual reality in landscape architecture so that designers, clients and users would have a virtual sense of scope e.g. rooftop garden, urban areas, parks, roads, etc. It is a programming language that creates a series of images creating a whole, so certain parts can be controlled or even modified in VR. Virtual reality today requires a specific gadget, such as Occulus, HTC Vive, Samsung Gear VR and similar.

The aim of this paper is to acquire new theoretical and practical knowledge in the interdisciplinary field of virtual reality, the ability to display using virtual reality methods, and to present through a brief overview the plant species used in the design and construction of an intensive roof garden in a Mediterranean climate, the basic characteristics of roofing gardens as well as the benefits they carry.

Virtual and augmented reality as technology is a very powerful tool for landscape architects, when modeling roof gardens, parks, and urban areas. One of the most popular technologies used by landscape architects is Google Tilt Brush, which enables fast modeling. The Google Tilt Brush VR

app allows modeling in three-dimensional virtual space using a palette to work with the use of a three-dimensional brush.

The terms of two "programmed" realities - virtual reality and augmented reality - are often confused. One thing they have in common, though, is VRML - Virtual Reality Modeling Language.

In this paper are shown the ways on which this issue can be solved and by the way, get closer the term of Virtual Reality (VR), also all the opportunities which the Virtual reality offered us. As well, in this paper are shown the conditions of Mediterranean climate, the conceptual solution and the plant species which will be used by execution of intensive green roof on the motel "Marković".

Keywords: Visualization, Landscape architecture, Green roof, Virtual Reality

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PARAMETRIC ANALYSIS OF URBAN BLOCK GEOMETRY BASED ON VISUAL PRIVACY CONDITIONS PARAMETRIC - REFLECTING ON COVID-19 LOCKDOWN

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ABSTRACT

This paper presents the results of the parametric analysis of visual privacy conditions in the case of three urban blocks with distinct geometry type. The influence of visual privacy on the health of the residents and the general living conditions is analyzed. The parameters are defined based on the results of research in the field of psychology, sociology, and medicine. Geometry and dimensioning of an urban block as the building element of the city environment is essential for the creation of a humane living environment. The built environment in terms of defining this aspect works on several generations of inhabitants and has long-term consequences. Computer graphics served as a framework for presenting the results of this research. Grasshopper and Rhino 3D software was used for simulation of visibility-vulnerability of the surface of the facade based on predefined conditions. The process is performed by determining critical points of the facade area of the urban block as part of the predefined grid. The grid applied in this analysis is at a macro level with a potential for resolution adjustments. The results are displayed in a form of graphs and as a graphical 3D model.

Keywords: computer graphics; simulations; computer science; urban block; privacy

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GEOMETRIC PARAMETERS OF THE CLOCK DIAL

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ABSTRACT

This paper deals with the geometric parameters required for the construction of a well-designed clock face as a part of pendulum wall clock described thoroughly in the master work. The face or dial of a clock is a circle whose circumference is divided into 60 equal parts, called minute spaces. A clock has two hands, the smaller one is called the hour hand or short hand while the larger one is called the minute hand or long hand. In order to determine the relation between the diameter of the clock and the distance from which one can clearly read position of its hands, it is necessary to adopt some of the basic geometric characteristics of minute and hour division on the clock face. Second important thing when it comes to the construction of a dial, is the height of the clock face. The criteria for dial height can be derived from the approved standards for the view field width of increased attention.

Keywords: clock; mechanisms; clock face geometry; clock hands; pendulum

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TOPIC 3: ENGINEERING COMPUTER GRAPHICS AND GEOMETRY

CONTENT

CAD STRUCTURAL OPTIMIZATION OF LARGE CANTILEVER GIRDERS ON CRANES

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ABSTRACT

The paper deals with the structural optimization of the cantilever girder. Standard CAD optimization tool is used for the model of the main girder on a large jib crane. The objective function is the minimum weight of the girder subjected to the given payload, while constraint functions are postulated according to the usual structural rules and regulations. The illustrative example shows an easy way of optimization which can be used in everyday CAD designing practice. It gives practical recommendations in the selection of variable parameters. The obtained results indicate that the algorithm is time-saving when compared to the analytical approach, especially when variability of the section needs to be included in the design.

Keywords: Structural optimization, CAD, FEA, CATIAV5, jib crane, cantilever

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SYNTHESIS OF EPICYCLIC GEAR TRAIN AS A DRIVE FOR GENEVA MECHANISM

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ABSTRACT

While the Geneva mechanism is a staple in many industries, there are two main drawbacks to its use. The first is the existence of impact loads, and the second are velocity and acceleration jumps, both of which lead to the appearance of vibrations and wear. This paper shows the synthesis of an epicyclic gear train as the driving component for a conventional Geneva mechanism. Based on a number of proposed requirements, two solutions of the modified Geneva mechanism were considered, with one and with two planet gears. Both variants completely eliminate the impact loads, and significantly decrease the velocity and acceleration jumps. Aside from this, the variant with one planet gear offers lower angular velocity and acceleration values in general, while the variant with two planet gears offers a decrease in the size of the mechanism.

Keywords: Geneva mechanism; epicyclic gear train; synthesis; kinematics;

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DESIGN OF A GAME CONTROLLER FOR PEOPLE WITH MOTOR IMPAIRMENT

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ABSTRACT

The entertainment industry is one of the largest and most profitable industries today. A great portion of that industry involves video games that are designed with the intent to be played using a game controller. The designers of games usually include options to improve the gaming experience of people with visual or hearing impairments, but the population with motor impairments are left to be dealt by the producers of the game controllers. A number of solutions exist today on the market that tackle this issue, but there is still a good possibility for improvement mainly from the possibilities offered by advanced technologies like 3D printing.

The paper analysis the needed assistance for game controllers for people with motor impairment using the universal design methodology. Furthermore, using the advantages of 3D printing technology, the paper analysis the possibilities for custom design of game controllers according the needs and requirements of the users. After that, the paper presents a design solution for game controller for people with motor impairment together with the methodology for production of a prototype. With a detailed analysis of the improvement effects the game controller introduces to the focus group, the authors conclude on the key elements for design of game controller for people with motor impairment as well as possibilities for further research and development of the product.

Keywords: engineering design; rapid prototyping; 3D modelling; motor impairment;

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PARAMETRIC DESIGN AS AN APPROACH FOR DESIGN FOR ADDITIVE MANUFACTURING

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ABSTRACT

Additive Manufacturing (AM) refers to a group of processes that experienced rapid development over the last decade. This enabled their applicability in various areas. Their specific manner of functioning through adding material is the reason why they are so versatile. Still, at the same time, this specific manner of functioning demands a different approach in the design process, the so-called design for additive manufacturing (DfAM). DfAM is an approach based on the principle of the well-known DFM (Design for Manufacturing) and DFMA (Design for Manufacturing and Assembly). The aim of the DfAM is to help designers to adapt more easily to AM and fully exploit its possibilities. One of the most important AM advantages is the fabrication of complex geometries, which is particularly interesting to designers. Regardless of all the advantages, there are some restrictions to the AM processes that need to be taken into consideration in the design process.

In this paper, we propose the use of parametric design for designing unique models with complex geometries. Through designing the parameters, we can implement the AM restrictions in the early stages of the design process without affecting the complexity of the shape. Another advantage of the parametric design is the possibility of easy manipulation of the CAD model and a change of the parameters, so that a whole collection of unique products can be created.

Keywords: design for additive manufacturing (DfAM); parametric design; design process

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THE METHODS OF 3D MODELING OF SEVERAL TYPES OF HELICOIDS

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ABSTRACT

This article discusses the methods of 3D modeling of several types of helicoids with their subsequent printing on a 3D-printer. For printing traditional 3D models, it is proposed to use SolidWorks software, which allows to perform parametric modeling of mechanical objects with the help of engineering computer graphics, while for printing more complex 3D models, other software tools are required. In this article, there is a review of the software tools which allow to model complex forms for further exporting into SolidWorks and additive technologies. It is also described in detail by the construction of different types of helicoids. The process of 3D modeling of helicoids is described step-by-step and is divided into two stages: parametric modeling of the helicoid in SCAD Office Software, editing of the obtained model in AutoCAD and its export to a special format for 3D printing. Some problems in creating the models suitable for 3D printing are also discussed.

Keywords: 3D modeling; helicoids; SolidWorks; additive technology; computer graphics

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THE SYNTHESIS AND MOTION STUDY OF THE ASTRONOMICAL CLOCK MECHANISM

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ABSTRACT

This paper describes and explains the synthesis of the astronomical clock mechanism on which face the mean position of the Sun, Moon, lunar nodes, zodiac circle and Moon phases and their motion during the year are displayed as seen from the Earth. The clock face represents the stereographic projection of the celestial equator, meridian celestial tropics, Zodiac circle (Ecliptic) and horizon for the latitude of Belgrade from the north celestial pole to the Equator plane. This type of projection is particularly useful for the astronomical clock faces because it is conformal and thus preserves the angles at which celestial circles cross each other. The observed motions of the Sun, Moon, lunar nodes and Zodiac circle are realized by the set of clock gear trains with the carefully and properly calculated gear ratios. Since the gear ratios are rational numbers and the angular velocities ratios of the observed celestial objects are real numbers, each gear ratio is determined as the approximation of the corresponding real one. The method of continued fraction is applied to computation of proper and practically applicable gear ratios of the clock gear trains since this calculating technique produces the best possible rational approximation of the real number. The fully operational 3D model of the astronomical clock is created and the motion study of its operation is accomplished and documented by using SolidWorks 2016 application. The simulation results are compared with the astronomical ephemeris data and the detected differences are used to inspect, evaluate and discuss the long term accuracy of the Astronomical clock operation.

This work is important for the education in the field of theory of mechanisms, 3D modelling, simulation, as well as for teaching courses in astronomy. Moreover, the exposed methods of the synthesis of mechanisms can be useful for the design, construction and reparation of the large scale city astronomical clocks.

Keywords: astronomical clock, continued fractions, mechanisms, motion study, stereographic projection

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DESIGN OF AN ACCURACY EVALUATION SYSTEM FOR SURFACE FLATTENING METHODS

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ABSTRACT

Based on the analysis of the existing methods for estimating the surface flattening error, they can be roughly classified into two types of estimation methods: the relative area error analysis method and the relative length error analysis method. The advantages and disadvantages of these methods are summarized in the paper. Combining the general surface flattening methods and sheet metal stamping forming process, a more reasonable, scientific and comprehensive evaluation system for the accuracy of surface flattening is proposed. In line with the unfolding characteristics of the grid surface, the relative average area error of triangles is used instead of the traditional area error estimation method. The accumulated length error is replaced by the relative length error of each triangle in the estimation method, and the value of the change in the orientation (direction, position) relationship between the triangles is increased to assess the deformation error of the surface flattening method. The mass attributes of the patch are introduced. The minimum displacement energy method is used to supplement the evaluation of surface flattening accuracy. Finally, a comprehensive evaluation system is established and proposed, which takes into account the accuracy of local and global surface flattening.

Keywords: *surface flattening; triangle; area error; length error; deformation error; evaluation system*

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VIRTUAL AND EXPERIMENTAL TESTS APPLIED ON A REVISION PROSTHETIC HIP

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ABSTRACT

The hip joint is a complex structure consisting of bones covered with cartilage, muscles and their tendons, fascia and ligaments. It is a typical spherical joint with three axes of motion and has a great importance in statics and locomotion. In this joint, the femoral head and the acetabulum are joined. The role of the pelvis as an intermediate segment, belonging to both the trunk and the inferior member, should be specified. From a biomechanical point of view, it performs the role of a mobile platform curving on the ends of the femurs and implanting the spine as a supporting body.

But, this biological structure can be damaged, due to age or physical activity. The hip revision prosthesis is a viable option when the initial prosthesis is damaged. The paper presents the model of a stand that can test the hip prostheses made with a three-dimensional modeling program. Also, this stand has been tested virtually using the finite element analysis method. The bone component and the elements of the prosthesis are in fact tested, the virtual bone component being taken and reconstructed from CT images, of the Dicom type. A technique was used that is based on identifying different tissues based on shades of gray and then transforming them into "point cloud" type structures similar to those obtained by three-dimensional scanning. These structures have been transformed into surface-type geometries, consisting of triangular meshes. Using certain CAD techniques, these geometries were processed, applying different methods of filling the gaps, finishing and reducing the number of elementary triangular surfaces. These models formed from closed surfaces were loaded into a CAD program where they were transformed into virtual solids. This virtual bone component was attached to the elements of the prosthesis and to the components of the test stand. Several virtual tests were defined and simulations were performed using the finite element method. A number of results were obtained which were analyzed and several important conclusions were underlined. Also, the metal components of the device have been manufactured, as it was performed real test using EDZ 20 Universal Testing Machine. Main conclusions were underlined.

Keywords: computer graphics; virtual hip; revision prosthesis; virtual test; virtual reconstruction

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COMFORT AND ELEGANCE IN AUTO DESIGN

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ABSTRACT

Today, we are witnessing a strong combination between industry and art. It can even be argued that authentic artistic industry is being created, which consists of the manufacturing of products that combine useful qualities with aesthetic ones, all the way to the deep psychological comfort that product creates with the help of aesthetic value.

This paper presents the concept of industrial aesthetics, argumentation of the beauty problem, aspects, guidelines and personal observations. Additionally, we provide an algorithm for the aesthetic evaluation of a product (beauty, attractiveness),which reveals numerous possibilities that designers haves at their disposal to meet product aesthetic requirements (e.g. comfort, elegance). Aesthetic indicators include appreciation criteria regarding the shape of the product, the ratio of shape-structure-functionality, shape-material, shape-colour-ornament, shape-colour-fashion-details, environmental form, appearance and finish, packaging and presentation of the product, expressivity trademarks etc. The design and aesthetics of the products are assets in the competitive struggle and elements of real differentiation of the products.

Keywords: car products, design for aesthetics, comfort, elegance

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ACQUISITION OF PHOTOGRAPHS FOR PHOTOGRAMMETRIC RECONSTRUCTION OF SCULPTURE IN DIFFERENT LIGHTING CONDITIONS – INDOOR AND OUTDOOR PHOTOGRAPHY

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ABSTRACT

To obtain a set of photos suitable for photogrammetric reconstruction, in addition to determining the exact positions from which the photos will be taken, it is also necessary to adjust the camera parameters in accordance with the lighting conditions in the recording environment. The aim of this paper is to compare the results of taking photos of the same sculpture under different lighting conditions. Therefore, in the first case, the photos of the sculpture were taken in the exterior where the light source was the Sun. The sculpture was static, on a pedestal, and the camera was moved around a circle of calculated diameter with a certain increment of angle. Another case was taking photos in a laboratory where the light was diffuse, the camera was static, and the sculpture rotated on a turntable. To align the camera parameters with the lighting conditions in the recording environment, the first thing we need to do is to measure the light intensity. The measurement is done automatically or manually, but the camera parameters must be constant during the shooting. The reconstructed object is dominated by darker shades of brown and golden-yellow colour, composed of complex free-form surfaces that faithfully depict the upper part of the human figure, to be exact the head, neck and torso.

Photographing in the exterior

When shooting is done in daylight, light conditions cannot be affected. The best light source is sunlight because it has the widest spectrum, but an object should not be exposed to such light directly. The reason is the sharp shadows on the parts of the reconstructed object and the reflection on flat and shiny surfaces. The most preferred type of light for photogrammetric reconstruction is diffuse light. The shooting was done on a sunny day in the courtyard of the Gallery of Matica srpska in Novi Sad between 10 am and 12 pm (August 2019). The movement path during the photographing of the sculpture was a circle at the centre of which was a sculpture. During the shooting, a reflection occurred so that some parts of the sculpture were more in shade because of the position of the Sun which did not change significantly. A white canvas was used to mask the background but also to block the reflection. Such uneven lighting had an impact on the results obtained.

Photographing under laboratory conditions

Photographing in the laboratory was performed under diffuse illumination. In this case, the camera was static while shooting and the recorded subject was on a turntable. To provide the required level of coverage for all surfaces, the photos were taken at five different height levels, with a 20° turntable rotation increment. Also, additional photos were taken in the face region.

For both shooting cases, the light parameters were measured in aperture priority mode so they are further manually customized and adjusted. Manual mode was used during capturing photos to ensure that the set parameters remain securely fixed.

Based on the results we have come to the conclusion that shooting outside produces worse results regardless of the ideal weather conditions. The point is that the position of the Sun does not change in such a short period of time but that the surrounding objects make shadows or reflections. Because of this, parts of the sculpture were in marked shade resulting in fewer points in the point cloud in these areas due to lack of data. Also, the texture in these areas is darker and in some places completely black. The laboratory photographing showed that a 3D model of uniform quality was obtained over the entire scope of the shooting, i.e. per unit area, there was a similar number of points in the cloud. Also, the texture is uniform in quality and brightness.

Keywords: photogrammetry, sculpture, 3D model, texture

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SHAPING THE PERCEPTION OF ENGINEERING OBJECTS BASED ON GEOMETRICAL MODELING

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ABSTRACT

In the process of engineering designing, a well-developed spatial imagination is a necessary pre-requisite for correct perception of three-dimensional space. Moving objects or changing the perspective of looking at them in our mind is easier for people whose sense of spatial vision is well developed. The correlation between understanding space or moving in it and the ability to reproduce it in projection methods and graphic notation is inseparable.

The main objective of research studies carried out in the work is the issue of developing and shaping spatial imagination and its impact on the ability to think creatively. The search for new ideas together with the simultaneous ability to combine existing facts often leads to the development of innovative solutions for engineering objects. Currently, rapid technological development imposes on the designers the capacity of being able to move freely in three-dimensional space. They work using advanced computer programs for spatial modeling, in which they often realize complex visions of engineering structures. The requirements demanded from Engineers involve the ability to construct flat images and transform their location with respect to one another. Therefore, they must be practical and creative, and their decisions must be quick and error-free.

The considerations undertaken in the work are intended to prepare the student for proper perception of engineering objects and to practice the ability to read them based on the drawings presented in the technical documentation. The work makes use of a model, a cubic block presented in an axonometric projection and its mapping in the expanded form. Models of various difficulty level were used. Then we related the skills developed by the student to the mapping of other objects such as roofs or buildings. The final stage of the considerations comprised a summary of the work with students in the form of carried out tests. On their basis, it was assessed whether the work with models improved their perception of engineering objects.

Keywords: geometry and engineering graphics; spatial perception; 3D geometric model; spatial ability

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ONE METHOD FOR REAL TIME VISUALISATION OF EEG DATA

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ABSTRACT

Human brain wave reading instruments have been around for quite some time, although many of the imaging tools currently used are limited in their scope and often produce data that is hard to read. In this paper, we aim at creating a real time platform for brain wave visualization. Electroencephalograms come in many different forms, the main differentiator being number of electrodes featured. This platform is mainly targeted at the researchers in this field and people who work with electroencephalographic devices on a regular basis, but struggle with currently available visualizing software. It is developed using open source solutions. Visualization is done in 3D, with five different types of brain waves – alpha, beta, gamma, delta and theta, visualized in a distinct manner.

Keywords: computer graphics; electroencephalography; brain waves; 3D imaging;

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TOPIC 4: GEOMETRY, GRAPHICS EDUCATION AND TEACHING METHODOLOGY

CONTENT

DIAD-TOOLS PLATFORM AS A REALIZATION OF THE IDEA OF EDUCATIONAL COOPERATION

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ABSTRACT

Education is all activities and processes that enable people to get to know nature, society, and culture, and at the same time participate in their transformation, as well as the most comprehensive development of their physical and mental fitness, interests and abilities. The education process is based on teaching and learning and involves the participation of teachers and learners. General education enables the acquisition of general qualifications (knowledge, skills and values) necessary for everyone, regardless of their social and professional role. Vocational education ensures qualifications in the chosen specialty. The content and forms of education processes are determined by the general learning objectives formulated as part of individual concepts of general and vocational education. Traditionally, three levels of education are distinguished: basic, also called elementary, secondary, i.e. enabling preparation for higher and higher studies. The idea of the concept of vocational education implemented at two complementary levels of education, secondary and higher, is one of the main objectives of the project No2017-1-LT01-KA202-035177 "Development of Interactive Animated Teaching Tools - DIAD-tools, implemented from October 1, 2017 to 31 March 2020, as part of the Erasmus + Strategic Partnership program, by partners from

Estonia, Latvia, Lithuania, Slovakia and Poland. Representatives of technical secondary vocational schools and technical universities participate in the design work. The cooperation of teachers conducting vocational education at two levels of education has enabled the identification of basic thematic issues, which as the content of education appears in the curricula of subjects such as drawing, technical drawing or engineering graphics, at the secondary and higher level of vocational education. The authors will present the implementation of the concept of the internet platform developed as part of the DIAD-tools project containing interactive and animated teaching materials supporting the independent learning of secondary technical school pupils and technical university students in the field of geometry and technical drawing. The article will present: the idea of compiling and complementing the process of vocational education implemented at secondary and higher levels in the field of geometry and technical drawing, four main thematic blocks within which didactic materials were developed, and the scope of detailed issues developed in individual blocks.

Keywords: geometry, technical drawing, architectural drawing, constructional drawing, CAD, teaching tools

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PERFORMANCE-BASED DESIGN IN ARCHITECTURAL AND URBAN PLANNING EDUCATION

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ABSTRACT

In the previous several years, performance-based design becomes very important area of research in the field of architectural and urban planning education. In contemporary practice, this approach is used as a method for modelling sustainable and intelligent urban design. Taking into account rapid development of various software applications for solar and computational fluid dynamic (CFD) simulations, students are able to create different urban designs with different geometry, and select the final design with optimal performances. In order to obtain the best solution, user has to consider climate and weather data, location, position, orientation and geometry of an urban fabric. The aim of this paper is to emphasize the importance of introducing performance-based design and software applications into student's education. Contrary to traditional procedure of urban modelling, computational parametric modelling in combination with solar and CFD simulations allows a lot of opportunities as well as fewer mistakes in the beginning of urban planning process. In this paper will be shown how urban area can be redesigned in order to minimise or maximise solar or CFD influence on selected urban area. Students used the geometrical parameters of width and height of buildings, streets, change position and geometry of urban furniture and find the best solution.

Keywords: performance-based design; urban design; solar simulations; CFD simulations; architectural education

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TEACHING RIGGING FOR ANIMATION AT THE COMPUTER GRAPHICS - ENGINEERING ANIMATION STUDIES

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ABSTRACT

Rigging is a well-known process in the computer graphics field and represent an essential step in creating 3D animation. The technique is most common in games and movies, as well as in educative animations. Rigging is the process of the creating a virtual skeleton, composed of interconnected bones, for a character 3D model. The primary goal of rigging is to make it as easy as possible for the animator to do the animation (Maestri, 2002). Basic rigging involves building a skeleton and skinning the character. Both processes can be performed inside a software for 3D modeling which provides required modifiers and controllers. This paper present a teaching process of rigging for different types of the 3D models through the contents of undergraduate subjects of the Computer Graphics study program at the Faculty of Technical Sciences, at the University of Novi Sad. The paper presents examples of rigged models created by the second and third year students, as the supervised projects, done through three subjects of the Computer Graphics study program: Character Animation, Fundamentals of Engineering Animation and Aesthetics of Visual Communications. After completing these three courses, students acquire enough skills and knowledge for studying the basics of animation of rigid bodies and 3D characters.

Keywords: computer graphics; rigging; 3D animation; teaching

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APPLICATION OF ADVANCED TEACHING METHODS IN DESCRIPTIVE GEOMETRY II ACADEMIC COURSE AT THE FACULTY OF CIVIL ENGINEERING AND ARCHITECTURE IN NIŠ

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ABSTRACT

Theoretical and practical teaching in Descriptive Geometry II academic course, at the study program Architecture, at the Faculty of Civil Engineering and Architecture, University of Niš, is performed using advanced teaching methods. These methods imply the use of digital drawings, which are projected onto the screen via video bim. The didactic principle of step-by-step problem solving was applied for creation of digital presentations in teaching, as in the classical teaching method. The application of step-by-step presentations has advantages compared the classical method, drawing on a board, because the drawings are larger, more precise and there is ability to move back and forth on the slides. The step-by-step presentations have been applied in the last 10 academic years in theoretical teaching, and in the last 2 academic years also in practical teaching.

The goal of the paper is to show what are the benefits of applying advanced teaching methods, which are individual work with students and better acquired knowledge in the subject. An indicator of the quality of student's' knowledge is a better average grade which students achieved in the exam, during the last two academic years, when advanced teaching methods have been applied in practical teaching too.

Keywords: Teaching, Advanced Methods, "Step-by-step" Presentations, Exam Average Grade

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TEACHING PERCEPTION AS MOTIVATION FOR STUDENTS TO APPLY DESCRIPTIVE GEOMETRY AND PERSPECTIVE

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ABSTRACT

For Descriptive Geometry and Perspective, traditionally regarded as difficult subjects, the introduction of perception related topics may lead to better motivation of students in mastering the topics and in further applying the gained knowledge. In this paper some general perception theories together with the accompanying principles and examples are presented, as well as the selection of the topics which appear to be the most attractive to the students. Such topics, being most visually intriguing, seem to maximize the extrinsic motivation by the social context and therefore they are selected as the most important driver for self-determined learning.

Keywords: education; perspective; descriptive geometry; perception

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THE BENEFITS OFAN ADDITIONAL PRACTICE IN DESCRIPTIVE GEOMETRY COURSE: NON OBLIGATORY WORKSHOP AT THE FACULTY OF CIVIL ENGINEERING IN BELGRADE

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ABSTRACT

At the Faculty of Civil Engineering in Belgrade, in the Descriptive geometry (DG) course, non-obligatory workshops named "facultative task" are held for the three generations of freshman students with the aim to give students the opportunity to get higher final grade on the exam. The content of this workshop was a creative task, performed by a group of three students, offering free choice of a topic, i.e. the geometric structure associated with some real or imagery architectural/art-work object.

After the workshops a questionnaire (composed by the professors at the course) is given to the students, in order to get their response on teaching/learning materials for the DG course and the workshop. During the workshop students performed one of the common tests for testing spatial abilities, named "paper folding".

Based on the results of the questionnairethe investigation of the linkages between:students' final achievements and spatial abilities, as well as students' expectations of their performance on the exam, and how the students' capacity to correctly estimate their grades were associated with expected and final grades, is provided. The goal was to give an evidence that a creative work, performed by a small group of students and self-assessment of their performances are a good way of helping students to maintain motivation and to accomplish their achievement.

The final conclusion is addressed to the benefits of additional workshops employment in the course, which confirmhigherfinal scores-grades, achievement of creative results (facultative tasks) and confirmation of DG knowledge adaption.

Keywords: Descriptive geometry course; workshop; spatial ability test; questionnaire; self-assessment.

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DIDACTIC VIDEO-MATERIALS FOR TEACHING CONSTRUCTIVE GEOMETRY COURSES

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ABSTRACT

These paper is aimed to present information about on-line educational materials developed in the Erazmus+ project DIAD-Tools to support teaching of subjects such as Technical Drawing, Descriptive Geometry, or Constructive Geometry at secondary and tertiary level in engineering educational programmes. DIAD-tools project is an international project joining powers of secondary and tertiary school teachers to improve the situation in geometric knowledge and technical skills of graduates at both types of schools, technical secondary schools and technical universities. In addition to videos, interactive materials developed in GeoGebra environment are available for on-line use, providing opportunity to investigate presented information in step-by-step mode and with individual speed. Another benefit might be seen in possibility of augmented reality usage. Investigation of all geometric constructions is possible observing 3D-scenes, as GeoGebra application provides stereoscopic view representation for red-green glasses on one click, which might improve spatial understanding, imagination and abilities of respondents.

Keywords: descriptive geometry; constructive geometry; video materials; augmented reality; 3D stereoscopic view; interactive applets

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DEVELOPMENT OF A VACUUM DRYING MODEL WITH A FOCUS ON 3D MODELING

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ABSTRACT

With the development of technology, we are forced to develop teaching in the same direction, introducing modern 3D tools and examples that are close to those in practice. For this reason, this paper will explain the development and design of a model of a vacuum food dryer, with an emphasis on 3D modeling. The model of the vacuum dryer consists of a glass base which has the function of a drying chamber, and the vacuuming is achieved by means of a compressor. The base is positioned on a wooden structure to which an electric heater is attached, on the upper side of which slices of raw fruit are placed to be dried. Humidity, temperature and pressure sensors are installed in the chamber, which are connected to the control panel of the microcontroller via a hermetically sealed cover. The task of the microcontroller is to compare the previously defined parameters with the measured values in a given time cycle. The whole process and design development was done by the students in the 3D package Solid Works, as well as the accompanying documentation necessary for making the model. After the design is completed, it is planned to test the operation of the model of the vacuum dryer. The importance of this approach in working with students is reflected in increasing student interest and encouraging ideas for independent development and design using modern tools and methods acquired in teaching.

Keywords: education; 3D modelling; new approach;

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STUDENT`S PAPERS

CONTENT

PERFORATED PANEL DESIGN FOR DAYLIGHTING CONTROL

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ABSTRACT

Contemporary architecture exhibits structures with glass facades due to aesthetic reasons and the need to provide adequate interior daylighting. However, glass facades can also bring discomfort in everyday life - excessive room heating or cooling, reflection, glare, and loss of privacy. In order to solve these listed issues, architects created passive and active shading systems. Most of the existing active shading systems are powered by electrical and operated via mechanical drive, which requires a lot of energy and money. In order to achieve more energy-efficient and cost-effective solution, in this research a passive facade system, i.e. perforated screen is suggested. This research is concentrated on designing and calculating the efficiency of an optimal perforated screen that minimizes direct sunlight. The perforations are inclined, due to the hypothesis that more direct sun rays are blocked in that manner. By changing the values of the perforation inclination angle, perforation size, and screen thickness, different exposure to direct sun rays is observed and compared. Getting countless combinations is made possible by using a parametric design approach.

Keywords: perforated panel, passive facade system, sun rays, direct light

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AUTOMATION AND PARAMETRIC DESIGN IN ARCHITECTURAL EDUCATION

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ABSTRACT

Many forms in architecture, and therefore constructions, are so complex today that they cannot be construct without some kind of automation, and this is an opportunity for architects to engage more in this area. In this sense, the subject of this research is the importance of programming use in architecture, ie in parametric design of biomimicry forms. Emphasis in this paper is placed on the efficiency of automation, because it refers not only to generated geometries but also to production. The aim of this paper is to highlight own interpretations related to the problem, ie the importance of automation in biomimicry design. The main contribution of this paper should be the proposal of programming introduction at faculties of architecture in order to effectively understand parametric design and automation.

Keywords: automation; parametric design; biomimicry; programming; education

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PARAMETRIC MODEL OF A RECTANGULAR FLAT VAULT

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ABSTRACT

Unlike the usual shape of vaulted structures, so called flat vaults are planar and are formed out of voussoirs cut in a specific way, which combines the material's properties and the needed geometrical, i.e. structural logic. Thus, the shape of the stone blocks enables their interlocking without the use of any kind of bonding agents. In this paper, the analysis of the flat vault's shape and its fundamental elements is conducted. The analytical model regarding geometric constrains of the vault over rectangular floor plan is derived and the corresponding parametric model is developed. Contrary to the common use of uniformly shaped voussoirs, which produce a strictly repetitive pattern in the ceiling appearance, the model includes the application of two systems of voussoirs. Such an approach enables various ceiling appearances suitable for diverse use in contemporary architectural design. In addition, through the parametric model, the variety of vault's form is inspected, and the physical model is digitally fabricated.

Keywords: flat vault; geometric analysis; masonry structures; parametric design

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APPLICATION OF GEOMETRIC SURFACES IN THE MUSEUM BUILDINGS OF DANIEL LIBESKIND

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ABSTRACT

The form of contemporary architecture structures has changed over time, from simple to complex shapes that were used in the design. It is noted in the works of numerous world architects that the form of structures does not have to strictly follow the function, but can be considered at the same time. When designing, it is started with a volume that can be of regular or irregular geometry. Complex geometric shapes and deviation from the conventional way of thinking about the facade of a structure are the basic features of deconstructivism. One of the most famous deconstructivists of today is Daniel Libeskind, who designed a large number of museum buildings of attractive design. He applies simple geometric surfaces, their basic shapes and parts, obtained by intersections or breakthroughs with other surfaces.

Museums are the topic of research in this paper, where the analysis of the form and geometry of completed structures will find concrete types of geometric surfaces and the methods of their merging, cutting and combining applied by Daniel Libeskind in his work. Therefore, this will point out his methodology for designing these types of structures. His museum buildings can serve as inspiration for future architecture engineers to design numerous types of public buildings.

Keywords: form in architecture; geometric surfaces; Daniel Libeskind; museums;

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SHAPE AND ACOUSTIC INTERACTION IN LARGE CONCERT HALLS

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ABSTRACT

In this work there is an effort to fully analyse the entire evolution of a concert hall formation and to identify the main typological shapes, which permitted exploring the revolution in the architecture of the concert halls in the 20th century taking as an example the Berlin Philharmonic hall by Hans Scharoun. Similarly, the configurative development in the auditorium of the concert hall and its gradual complication are evaluated. Additionally, special attention is paid to the acoustics properties of the halls and different methods of acoustic improvement are identified. The main purpose of this study is to develop a comparative analysis of both architectural and acoustic aspects through a review of historical forms and to determine the most appropriate shapes for concert halls.

Furthermore, architectural and construction systems of the "shells" type are taken into account. The use of shells in the halls contributes not only to the beautiful image of the interior, but also to the creation the effective and comfortable acoustic mode of the halls. This article discusses the issues of effective compositional and constructive application of the shape of the hall space in which the shells of the simple and complex geometry are used. Examples of successful combination of architectural expressiveness and acoustic properties are given, such as National Kaohsiung Center for the Arts (Mecanoo, Taiwan), Elbe Philharmonic (Hamburg, Germany), House of Music and Zaryadye (Moscow, Russia) and so on. The project of a concert hall for 1500 seats (diploma project of Evgenia Ermakova) in the city of Petrozavodsk, Republic of Karelia is also given as an example.

Keywords: concert hall; shape; acoustic; shells of the simple and complex geometry

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DISCRETIZATION AND OPTIMIZATION OF FREEFORM SURFACES WITH CIRCULAR MESHES FOR ADAPTING TO GRID SHELL STRUCTURES

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ABSTRACT

Freeform surfaces play a significant role in contemporary architecture. Organic shapes, often inspired by nature, seem to have an appealing effect, especially to attract audience to the buildings of cultural institutions. In this context, shell structures have an additional advantage of being constructively effective, especially for widespan roof structures. To adapt freeform surfaces to shell-properties, it is necessary to modify both shape and structure.

The approach given here makes use of mesh representations with circular meshes. Circular meshes are planar quad (PQ) meshes, which have the additional property that each face has a circumcircle. Consequently, discrete differential geometry is the basis for the actual construction and the discretization of the given surfaces. The aim is to approximate the surfaces with freeform grid shells. Starting from principal curvature lines, we optimize the structural properties, as well as the supporting beam layout, with respect to optimal node properties. The circular mesh approach enables the generation of a PQ mesh with (nearly) planar faces.

The goal of the paper is to show how the combination of the applied methods can help to optimize freeform grid shell structures with respect to geometric properties (high level of mesh planarization, small deviation from the initial design), as well as structural properties (low deformation, low stresses). In this respect, the application of circular mesh optimization has a positive aesthetic impact and is also essential for building these shapes.

Keywords: grid shell structures; shape optimization; structural optimization; circular mesh systems; free-form geometry.

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ISOPHOTES OF ROTATIONAL CONE FOR CENTRAL LIGHTING

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ABSTRACT

Isophotes represent the locus of surface's points of equal brightness, and are originally considered in descriptive geometry problems regarding shadow determination. They are applied in computer graphics for producing more realistic presentation of illuminated objects and their spatial relation.

In the present paper, the determination of the isophotes of rotational cone is considered. It is shown that the descriptive geometry method of auxiliary spheres' isophotes, commonly applied to parallel lighting, can also be used when central lighting is present. Namely, contrary to parallel lighting, in which the spatial relation between the spheres and the light source is constant, in the case of central lighting, this relation becomes variable. Accordingly, the corresponding parameters are noted and the suitable method for the determination of the sphere's isophotes is derived. Since it enables the direct construction of the desired angle between the light ray and the auxiliary spheres' tangent plane, the developed procedure is applied to rotational cone. Furthermore, admissible shapes of cone's isophotes as well as the corresponding characteristic elements are inspected.

Keywords: isophote; descriptive geometry; shadows; central lighting

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DESIGN STYLES IN LANDSCAPE ARCHITECTURE

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ABSTRACT

Since ancient times, landscape design has developed along the lines of two basic styles: geometric and landscape design style. The geometric style encompasses elements of order, proportion, rational planning and often symmetry; and has reached its peak in the period of French baroque. The landscape style is usually irregular, "informal" and simple, and is commonly related with the English romantic gardens. Since the modern art period, these two styles merge into what we recognize as the combined (mixed) design style and nowadays, the combined style is commonly seen in urban landscapes. This paper analyses the basic principles of designing a space in: geometric, landscape and combined style, with main references from history of landscape architecture. As a case study, we have selected an atrium space in Novi Sad, Serbia. On one hand, this paper describes basic principles for designing a space in a particular style, and on the other hand paper analysis main differences in between above mentioned landscape styles. The main goal of the paper is to provide guidelines for designing a space in different styles, and to emphasize its importance in terms of biodiversity preservation, social interaction, and improving visual qualities of urban landscapes.

Keywords: landscape architecture; geometric style; landscape style; combined style; visual impact

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USE OF MACLAURIN GEOMETRIC TRANSFORMATIONS IN 3D SYNTHESIS OF MECHANISMS

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ABSTRACT

This paper describes and explains MacLaurin's transformations and their use in a 3D synthesis of mechanisms. An overview of the high order curves is provided, along with their degradation to the curves of the lower order. MacLaurin's transcriptions are used to degrade the curves of the higher order to the desired curves of the lower order. This will allow us to generate different kinds of trajectories and, therefore, different kind of mechanisms. Furthermore, the implementation of the obtained curves into the CAD pragmas and 3D environment is presented. This allows a quick synthesis of a mechanism, its adaptation and simulation in order to get the desired final trajectories. Different kinds of trajectories implemented in a 3D environment are shown in this paper. Fully operational 3D models of mechanism trajectories and simulation are created and documented in the SolidWorks application.

This research could be used further in the theory of mechanisms, 3D modelling, simulations and the synthesis of mechanisms. The exposed methods of the synthesis of mechanisms may be used in the design and construction of new mechanisms or the redesign of the existing mechanisms.

Keywords: computer graphics; 3D modelling, mechanism synthesis, MacLaurins's transformations.

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THE INTEGRATED DESIGN AND FABRICATION PROCESS FOR PLANAR MORPHING TESSELLATION

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ABSTRACT

In contemporary architectural practice, the tessellation of planar surfaces, such as walls or floors is usually done by using a uniform triangular, rectangular or hexagonal tile as a template. This approach, albeit the most efficient, relies mostly on colours to induce the experience of a pattern and as such is limiting. By using differently shaped tiles, the possibilities are increased, but at the cost of time and mould fabrication. In this paper, the focus is placed on integrating the design and fabrication process in order to create a morphing tessellation from differently shaped triangular tiles, by fabricating them from a single mould with adjustable edges. The design concept was based on triangular shaped tiles where the edges morph into a curved shape created by rotating the curves around the centre-point of each side of the triangle. By generating a parametric model, the possibility for creating quick design variations is introduced by adjusting the shape of the edges through predetermined parameters. The final design consisted of ten different tile shapes, each of which would require a separate mould. However, by developing a mould with walls that can be adjusted i.e. bent according to a predetermined template, it was possible to fabricate all of the different shapes in plaster. The final result of the project took the form of a physical model of the chosen tessellation design with 336 plaster tiles produced with the adjustable mould. This demonstrates the possibility of incorporating interesting and more dynamic, but seemingly complicated designs in interior and exterior tiling along with an efficient fabrication process.

Keywords: tessellation; digital design; mould; plaster; cast

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COMPARATIVE ANALYSIS OF METHODS FOR BLOOD VESSEL DETECTION IN RETINAL IMAGES

COMPARATIVE ANALYSIS OF METHODS FOR BLOOD VESSEL DETECTION IN RETINAL IMAGES

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ABSTRACT

Images of the back part of the eye, also known as retinal images, are the basis for the diagnosis of many systemic and eye diseases such as glaucoma, diabetic retinopathy, and retinopathy of prematurity. Disease indicators may be found by observing the blood vessel network in the retinal image. A failure of an ophthalmologist to correctly identify a disease, due to fatigue or a low-quality image, may lead to severe health damage. To address this problem, many methods for automatic vessel detection in retinal images have been proposed. Among those, machine learning approaches based on convolutional neural networks have proven to yield the best results. Often, these methods require some sort of input retinal image preprocessing, such as transformation to grayscale, to emphasize blood vessels on images and reach their full potential. In this paper, we employ a subset of general-purpose algorithms for edge detection to produce retinal images with an emphasized retinal blood vessel network, which can be used for convolutional neural network blood vessel detection training. We test Canny, Sobel, Scharr, and Hollisticaly-Nested Edge Detection algorithms on the DRIVE dataset. Resulting images produced by these four algorithms are evaluated by an experienced ophthalmologist. Each image was graded and the time required to make the decision was measured. The ophthalmologist (who operated under double-blind test conditions) was later interviewed and qualitative data was collected. The data was then analyzed showing a clear win for the Sobel algorithm which, according to the post-test interview, preserves more fine detail.

Keywords: computer vision; retinal images; blood vessel; edge detection

COMPARATIVE ANALYSIS OF METHODS FOR BLOOD VESSEL DETECTION IN RETINAL IMAGES

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GEOMETRY USAGE FOR THE DESIGN OF STREAMLINED BODY

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ABSTRACT

Almost all modern industries, from manufacturing industries to movie making companies, use some kind of graphic design software. Designing a new product via graphic software can reduce a lot of time in the manufacturing processes. Further, new shapes and more complex geometries can be created to improve the overall aesthetics. Complex geometry created in the designing process does not need to be a simple combination of standard geometric shapes (a cube, cylinder, sphere), much more complex curves can be used as well. Complex curves can be created using splines, which are defined piecewise by higher-order polynomials. The surfaces constructed by splines will have a smooth curvature transition without sharp edges, which plays a significant role in its light reflection. The mathematical definition of splines allows easy implementation in computer graphics, especially in the cases when it is necessary to trace the predefined curves or contours of objects. Using this method, it is possible to convert any object from its picture into a 3D model. This paper will present the modelling processes of a sports car from its pictures, where surfaces are created with splines in SolidWorks 2018.

Keywords: 3D modelling, geometric elements in costume design, applied geometry

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PRINCIPLES OF TRANSFORMATION USED IN ARCHITECTURAL DESIGN AND THEIR IMPACT ON THE FORMS OF BUILDINGS

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ABSTRACT

The development of modern technologies, industry, but also greater possibility of application of technical mechanisms had considerable influence on the deviation from the traditional architectural structures. The ability to move, rotate, modify parts of buildings until recently represented only a futuristic approach to design on paper, without clear and workable solutions in practice. Transformation as a method which is applied in architectural design, push the boundaries when it comes to the form of the object. The possibilities of applying this method are significant, they are used in the visual improvement of the project, in order to increase the functional parameters of the buildings, but also to achieve energy efficient buildings. The purpose of analyzing these principles, as well as their effects on the shape of an individual object, the paper presents some of the examples that are built around the world. This work highlights the possibilities offered by transformability as a method used in architecture, as well as the impact of these on the design process and the visual identity of built objects.

Keywords: transformation, architectural design, buildings, geometry forms

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APPLYING OF GRASSHOPPER IN GEOMETRIC OPTIMIZATION OF TORUS SHELL

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ABSTRACT

In contemporary architecture, where function often follows the form of an object, the use of curved structures is increasingly present. The development of new technologies and software enables faster and easier creation of planned forms of objects. In some cases, modeling limits us to reduced forms with planarization of curved surfaces.

Planarization can be obtained with combination of some software and their extensions. In this paper, the authors used a canopy obtained from a torus shell. Segments of torus are determined by intersecting with vertical planes. Since the torus is a double curved surface, Grasshopper was used to obtain the planar elements of which the torus shell would be made.

As a graphical algorithm editor, Grasshopper is tightly integrated with Rhinoceros's 3D modeling tools. Because of that, Rhinoceros was used in design and Grasshopper was used in optimization and planarization of curved shape. The goal of the paper is to show how planar elements can obtain a stable, curved surface.

Keywords: torus shell; curved surfaces; geometric optimization; Rhinoceros; Grasshopper

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