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DEVELOPMENT OF A TOOLSET IN THE SYSTEM FOR CREATING VIRTUAL STANDS

A new system has been developed to provide the ability to construct a flat slider-crank mechanism using tools provided by the system. VR models have been developed to be used later by specialists to build new laboratory stands without the need for a new software development cycle.

Keywords: virtual reality, professional toolset, immersive education.

Introduction. Virtual reality is used to improve educational and professional research by providing students and researchers with immersive experiences. It is gaining more and more popularity in educational institutions and thus, increasing the demand for educational software to include more possibilities.

This paper presents the development of a virtual toolset for the laboratory system, which provides the ability to conduct the following lab: Metric synthesis of a flat crank-slider mechanism according to the given three positions.

To create VR experiences, the Unity Engine has been used. The OpenXR standard and the OpenXR package [1] for Unity Engine developed by Khronos Group have been used to provide consistency between different VR devices. HTC Vive Cosmos Elite PC tethered device has been used for simulations throughout this paper. 3D models and programs in the C# language have been used to make assets [2].

Theoretical foundations of synthesis. The flat crank-slider mechanism is a four-link mechanism, which consists of a footing, a crank, a connecting rod and a slider [3] (see Fig. 1).

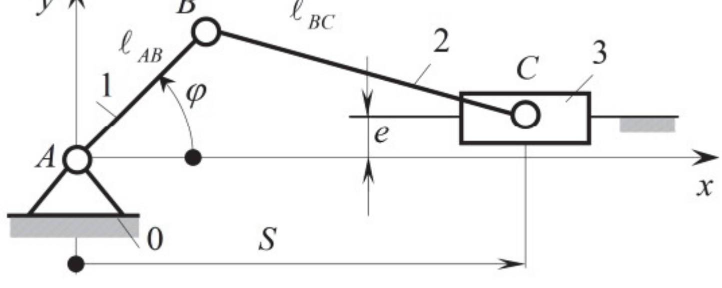

Fig. 1. Crank-slider mechanism, 0 – Footing, 1 – Crank, 2 – Connecting Rod, 3 – Slider

To synthesize the mechanism, it is necessary to have as initial data the value of the eccentricity of the slider (e), coordinates (S1, S2, S3) of the three positions of the center C of the slider, calculated along the horizontal axis x, as well as a change in the angle of rotation of the crank at the next two positions of the slider: $\partial\varphi_2$ and $\partial\varphi_3$.

$$\partial\varphi_2 = \varphi_2 - \varphi_1 \quad (1)$$

$$\partial\varphi_3 = \varphi_3 - \varphi_1 \quad (2)$$

As a result of the synthesis of the mechanism, it is necessary to determine the length of the links (l_{AB}, l_{BC}) and the angle of rotation of the crank for the first position of the slider.

Stand Components. The following components are needed to compose the stand: Mounting Plate, Drive Unit, Slider Movement Unit, Crank, Hinge, Connecting Rod.

3D Models for all the components listed above have been created using the SketchUp program. The OpenXR package components have been applied to these models to make interactive [4]. The main components used are XR Grab Interactable component, which allows to drag, move and drop the component, and the XR Socket Interactor component, which allows other components to be attached to the area defined by the socket.

Mounting Plate. Mounting plate is a component where all the other components are going to be mounted (See Fig. 2). 2 XR Socket Interactor components from the OpenXR package have been used to make sockets for the Drive Unit and Movement Unit to be attached to the mounting plate. To define borders for working space for the sockets, Sphere Collider components have been utilized. So, after dragging an object into the outlined sphere and colliding the borders, the object being dragged will be mounted on the plate.

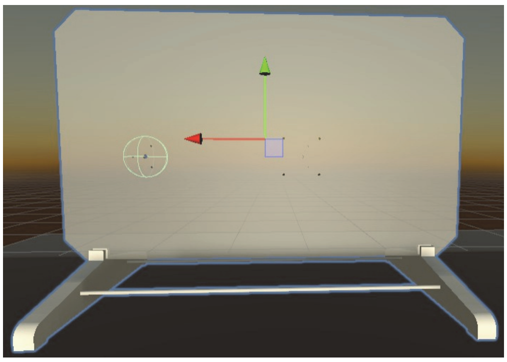

Fig. 2. Mounting Plate

Drive Unit. Drive Unit is a component mounted on the mounting plate (see Fig. 3). It includes a rotating shaft sub-component. A Box Collider component has been used to define the borders of the component. These borders aren't visible during VR experience and serve as triggers to detect collision with borders of other objects. An XR Grab Interactable component has been applied to the model to make it interactive.

Another Sphere Collider component has been utilized atop the shaft subcomponent to define the space where other components may be attached. An XR Socket Interactor component has been applied to make the objects actually attach to this space defined by the Sphere Collider component.

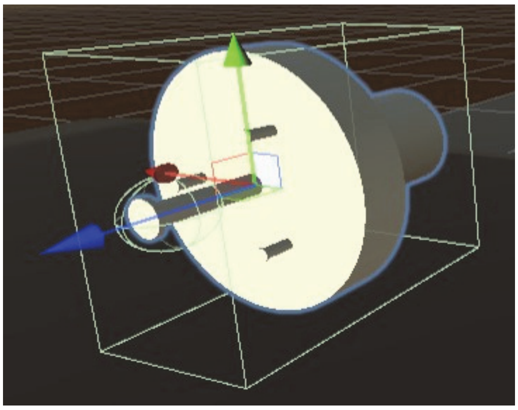

Fig. 3. Drive Unit

The following C# script [5] has been applied to the shaft sub-component to simulate the rotation.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
public class Rotate : MonoBehaviour
{
 public float speed = 50f;
 void Update()
 {
 float rot = Time.deltaTime * speed;
 transform.Rotate(new Vector3(0f, 0f, rot));
 }
}
```

Slider Movement Unit. An XR Socket Interactor component has been used for the hinge to be attached. A Box Collider component along with XR Grab Interactable has been used to define the borders of the component and make the possibility for it to be grabbed and moved. Also, a Box Collider and XR Socket Interactor components have been applied to define an attaching point for the connecting rod (see Fig. 4).

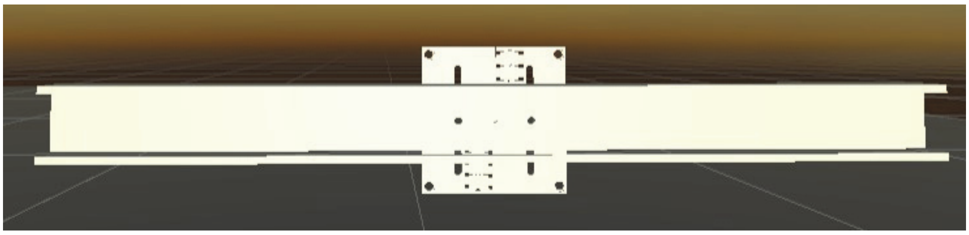

Fig. 4. Slider Movement Unit

Crank, Hinge and Connecting Rod. XR Grab Interactable components have been applied to each of these 3 objects to be interactive. XR Socket Interactor components have been applied to the Crank component for the Hinge to be attached and to the Hinge component for the Connecting Rod to be attached (see Fig. 5).

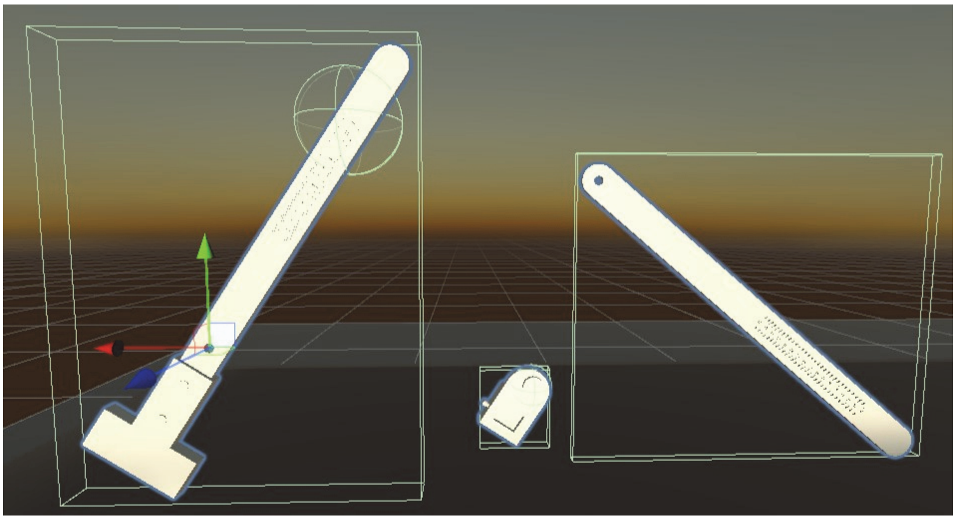

Fig. 5. Crank, Hinge and Connecting Rod

Conclusion. This paper presents the development of subject library for the crank-slider mechanism stand. The stand was decomposed to reusable components, and a 3D model for each component was implemented using SketchUp real time rendering technology. These models were imported into Unity Software, and the OpenXR package developed by Khronos Group was used to make them interactive.

A custom C# script was written to simulate the rotational movement of the Drive Unit shaft.

This library can further be improved to include new components and give the ability to compose several stands, thus decreasing the dependency on a new development cycle for new stands to be created.

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ԳՈՐԾԻՔԱԿԱԶՄԻ ՄՇԱԿՈՒՄԸ ՎԻՐՏՈՒԱԼ ՍՏԵՆԴՆԵՐԻ ՍՏԵՂԾՄԱՆ ՀԱՄԱԿԱՐԳՈՒՄ

Մշակվել է նոր համակարգ, որը հնարավորություն է տալիս համակարգի տրամադրած գործիքների միջոցով կառուցել հարթ շուռտվիկ-սողնակային մեխանիզմ: Ստեղծվել են VR մոդելներ, որոնք հետագայում կարող են մասնագետների կողմից օգտագործվել նոր լաբորատոր ստենդներ ստեղծելու համար՝ առանց ծրագրային ապահովման մշակման նոր ցիկլի անհրաժեշտության:

Առանցքային բառեր. վիրտուալ իրականություն, մասնագիտական գործիքակազմ, իմերսիվ կրթություն:

А.А. ОГАНЕСЯН

РАЗРАБОТКА ИНСТРУМЕНТАРИЯ В СИСТЕМЕ ДЛЯ СОЗДАНИЯ ВИРТУАЛЬНЫХ СТЕНДОВ

Разработана новая система, обеспечивающая возможность создания плоского кривошипно-ползунного механизма с использованием инструментов, предоставляемых системой. Разработаны модели виртуальной реальности для последующего использования специалистами при создании новых лабораторных стендов без необходимости нового цикла разработки программного обеспечения.

Ключевые слова: виртуальная реальность, профессиональный инструментарий, иммерсивное образование.