SIMULATION TOOLS FOR THE DELTA ROBOT USING AUGMENTED REALITY

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The paper focuses on simulation tools for parallel kinematics using Augmented Reality. AR is used in the design of new equipment for reasons of clarity in testing the physical model of parallel kinematics (linking real and virtual scene model). The article describes the process of the model creation and its further processing. The article focuses on other possible solutions which could be beneficial as Augmented reality simulations on multiple objects in parallel kinematics.

Keywords
Augmented Reality, Delta robotics, parallel kinematics

1. Introduction

Robots replaced a wide variety of tasks which are time consuming and dangerous. Industrial robots are used for many years and increase productivity through efficiency of automatics especially for handling and welding. Today, robots are increasingly penetrating our everyday lives. Examples of existing systems may be as follows: for home use vacuum robots, robot or pumping power of matter.

With advancing time and situations, competition forces manufacturing companies to shorten production cycles and rapid product changes. It required more dynamic innovation, shortening product life cycle. Therefore, to design new products have been selected CAD systems as a tool for increasing productivity in the design of new products. With intense global competition, industrial companies increasingly rely on collaboration solutions for CAD support the design process. Collaborative design was defined as a technical activity, where at least two designers who work on the proposed process. Designers should have good knowledge about each other, while influencing the proposed process. It follows that, in comparison with the actual CAD systems is becoming increasingly important affect each other for the whole system design. Another important aspect in the design process the designer's imagination itself. As a possible aid to virtual reality can get. Using Virtual Reality (VR) and Augmented Reality (AR) technologies have led to the development of more intuitive interfaces for product design and modelling. Many VR systems have been developed for CAD applications, where users are fully immersed in the virtual environment and interact with 3D virtual models. AR technology is relatively new technology, including computer graphics superposition over real objects / scenes, viewed through head-mounted displays (HMD), or small displays. Compared to VR, AR would have benefits in the following key aspects of product design. Firstly, the AR-based design environment is Semi-Absorbent design environment in which users can see the real world while performing the virtual product model. The advantage of AR provides a more realistic and allows a user more convenience when working on product design. Second, setting the AR-based environment is easy and cheap, no need to model the environment entities, which is the main disadvantage of VR. These features make the AR-based systems can overcome the limits of the VR-based systems and take advantage of VR-based systems, such as product design in 3D space, intuitive interface, so the AR-based CAD systems would allow users to move around in real 3D environment visualize the virtual products through HMDs and work with them and modify the virtual products, which modify the virtual interface. In addition to these advantages, users can watch the scene in the real scene and the use of real scenes and objects as interaction tools. Another important area of research interest is the development of AR applications for collaboration where multiple users can simultaneously view and interact with virtual / real objects. With these applications would be better to engage and support the collective design process. In this case, the article shows the direction issued by the Institute of Production Machines, Systems and Robotics, BUT the final proposal for a potential tool for robot-based parallel kinematics e.g. delta-robotics.

2. Augmented reality

Augmented reality is a relatively new technology that is based on connecting a computer generated objects and real terms (ie. real connection with the virtual scene.) preserve the spatial relationships between synthetic and physical data and allowing Interac, in real time. In recent years, this technology has been applied in many areas, particularly in the visualization of data in real scene. Among the developed areas include education, entertainment, media, psychology, surgery, robotics, urban design, planning, manufacturing companies.

2.1. Augmented Reality technology provides

- The direct interaction between real and virtual environments. This interface can be described as spatial, temporal or functional connections, which force users to switch from classical reflection on working with virtual models. The user uses the traditional work environment only with the benefit of the AR display.

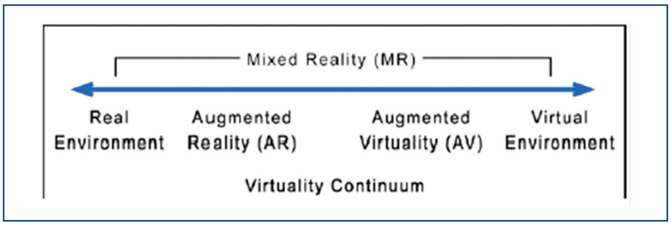

Figure 1. *Distribution of a virtual reality.*

- Real scene is not only complement the virtual objects, but also alter the reality of different filters.
- Computer-generated objects can be spatially displayed in real time according to the real environment.
- Manipulation of real objects. The AR scene is a close relationship between the virtual and real objects. Physical objects can be supplemented by
- computer-generated data, which enables dynamic overlap these elements. Therefore, physical objects can be used for direct manipulation of the scene.
- The ability to shift smoothly between the virtual and real scene scene.

2.2. Conditions at work with Augmented Reality

Compatibility between real and virtual data is an important aspect when working with AR scene. If you want to combine virtual and real objects, the scene seemed credible the perspective of virtual and real cameras to be in compliance.

3. Design a model for Parallel kinematics

For the proposal design was chosen 3D modelling software Autodesk Inventor 2008. There was made a 3D spatial object, which was subsequently imported by transport format (*. STEP) into a environment Autodesk 3ds Max 2010. In the environment 3DS MAX body was accompanied by the textures and animations loaded and transported to the COLLADA format. COLLADA format (abbreviation means COLLADA Collaborative Design Activity, and a format for storing 3D objects and animations. It is based on open XML schema, ie. we can easily read, create and edit in any text editor. Usually used with a (*.DAE).

Among other procedures were to create a program for the AR using Adobe Flash CS5.

The Adobe Flash CS5 was used object-oriented programming ActionScript 3 The big advantage is the ability to embed an existing library, which is substantially eliminated by the time for loading the program itself. Libraries:

- Flex SDK – it is an open-source environment for building and maintaining expressive web applications that are supported by many Web browsers, desktops and operating systems.
- Project Spark's Flash Augmented Reality (FLARToolkit) allows the detection of markers detected if the tracking marker, FLARE returns updated data on the position, rotation and scale (TransformMatrix).
- Papervision3D (PV3D) allows importing, positioning and rendering of 3D models. 3D model is loaded using the library and converted to 2D images for display on the monitor and the cut-out is inserted into the Stage. Loading and the conversion is carried out 30 frames per second, so the 3D model based on tracking marker looks brand satisfaction and relief.

3.1. Create markers (marker tracking)

Tracking Marker is designed in such a way as to be clearly defined area designation that is facing north-south-east-west, to avoid distortion and subsequent torsion or deformation of the 3D model. The sign should be simple enough to remember the program and then simply reading. After creating a unique brand, we use start-up software FLARE Marker Generator. Before running the software needed to engage a web cam. Software itself works on the principle of seeking the well-known shapes and clear transitions (in this case, transitions between white and black). The resulting tracking marker looked like this:

Figure 2. *Tracking marker.*

Adjustment and mounting signs tracking (Marker). The mark was placed on the center of a platform, which is attached to the arms of Parallel Kinematics

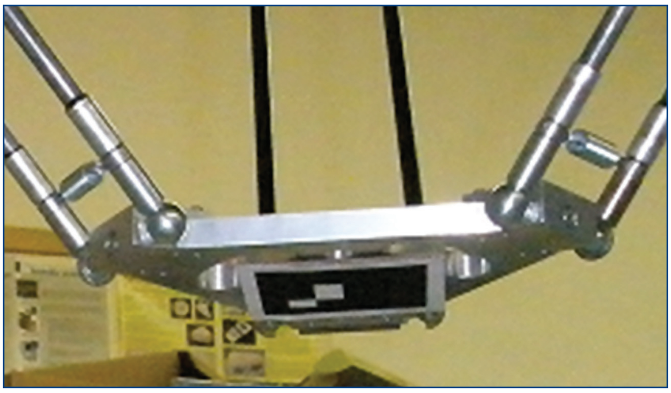

Figure 3. *Robotics platform with tracking marker.*

3.2. Setting up cameras in the workplace Parallel kinematics.

To adjust the viewing angle of the camera went from data provided by the manufacturer (Logitech C910). It was important to ensure visibility at any point to provide a platform for parallel kinematics and ensure that there is no conflict between the platform Parallel kinematics and the camera sensor itself. This motion was subsequently tested.

Figure 4. *Workplace of a delta-robot and augmented reality.*

3.3. Running the system itself and the virtual a model using AR.

After creating the model and the program is needed to run the program. When you start the program automatically questioned the involvement of webcams and searched for available devices to scan. The starting place for communication and web camera program and scan the first scene we created a camera looking marker. If the tracking visible marker to display a 3D object on a tracking marker. After being moved to a better visibility of the delta-axis robot to place

Figure 5. *The resulting image with the 3D object.*

this phenomenon and the platform was subsequently postponed and has been studied in the range of visibility model tracking marker. When starting delta itself, the robot also examined whether the extent of the imaging program can load a 3D object to the motion tracking marker platform. In this regard, we have come to certain limitations in imaging speed, and it is still necessary to consider how to ensure that a 3D object is always displayed on tracking brand and at no stage was deformed. As another option is to use a program that will simply load 3D model or simplified model using a coarser polygonal network.

4. Conclusion

Method in this article describes how to use augmented reality in the design of future systems and processes. In this case it was an existing installation of delta-robot developed at the Institute of Production Machines and Robotics. Delta robots in industrial applications, widely used as a manipulator of materials. For handling, it is important to create the appropriate type of end effector, which suffices to ensure that function. To select and design the end effector is financially take advantage of modeling CAD programs. The problem may arise if the facility is existing and it would be impractical to model it all. Therefore, the use of elements of virtual reality as a support element for design. Difficult question arises at high sliding or rotary movement of physical parts of the model in a virtual 3D model import. The main problem in this case is insufficient tracking and retrieval model tracking brand and model size (number of polygons).

References

[Bradac] Bradac, F., Holub, M., Pavlik, J., Opl, M., Novotny, T. and Tuma, Z. Manipulator based on parallel kinematics – Delta robot with three axes, VUT FSI.

[Dangelmaier] Dangelmaier, W., Fischer, M., Gausemeier, J., Grafe, M., Matysczok, C., Mueck, B.: Virtual and augmented reality support for discrete manufacturing system simulation

[Chong] J. W. S. Chong, S. K. Ong, A. Y. C. Nee , K. Youcef-Youmi: Robot programming using augmented reality:An interactive method for planning collision-freepaths

[Lee] Lee, H., Banerjee, A.: A self-configurable large-scale virtual manufacturing environment for collaborative designers

[Fründ] Fründ, J., Gausemeier, J., Matysczok, C. and Radkowski R.: Using Augmented Reality Technology to Support the Automobile Development

[Ong] Ong, S.K., Pang, Y., Nee, A.Y.C.: Augmented Reality Aided Assembly Design and Planning

[Pangl] Pang1, Y., Nee, A.Y.C., Youcef-Toumi, K., Ong, S.K., Yuan, M.L.: Assembly Design and Evaluation in an Augmented Reality Environment

[Peters] Peters, A.K.: Spatial.Augmented.Reality

[Portalés] Portalés, C., Lerma, J.L., Navarro, S.: Augmented reality and photogrammetry: A synergy to visualize physical and virtual city environments

[Seth] Seth, A., Vance, J. M., Oliver, J.H.: Virtual reality for assembly methods prototyping: a review

[Shen] Shen, Y., Ong, S. K., Nee, A. Y. C.: Augmented reality for collaborative product design and development

[Shin] Shin, D.H., Dunston, F.S.: Technology development needs for advancing Augmented Reality-based inspection

[Steinicke] Steinicke, F., Ropinski, T., Hinrichs, K.: A Generic Virtual Reality Software System's Architecture and Application

[Tuma] Tuma, Z., Novotny, T., Knoflicek, R.: Use augmented reality (AR) in teaching robotics

[Weidlich] Weidlich, D., Cser, L., Polzin, T., Cristiano, D., Zickner H.: Virtual Reality Approaches for Immersive Design

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