Information and telecommunication system of digital factory and smart factory Industry 4.0

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Abstract. The task is to create information and telecommunication system of digital and smart factories of Industry 4.0. Components are defined for information and telecommunication system, their properties and purpose are described. The scheme of digital factory information and telecommunication system is given. This scheme includes the physical equipment (machines) and virtual machines (cloud services and models) to support project activity of the designer. The scheme of smart factory information and telecommunication system is given. The scheme unites the cyber and physical production equipment and test equipment used for manufacturing on the basis of digital informative technologies. The given schemes are important in practice to organize the informative exchange among cyber and physical systems and designers of the project companies and operators of production companies to manufacture and transfer into exploitation the items of instrument-making, tool engineering, and mechanical engineering.

1. Introduction

Industry 4.0 digital and smart factories project and production activity require [1, 2] to create a company infrastructure oriented for electronic documents and implementation of digital production technologies. The base of such an infrastructure is information and telecommunication system [3, 4] to support the main stages of the item life cycle for its projection and manufacturing and document accompanying in the item exploitation.

Digital and smart factories information and telecommunication systems have [5, 6] two main components: technical means and program means to support net technologies of the company. Technical means of the information and telecommunication system could be [7, 8]:
- company server equipment for deployment of project and production data storage;
- routers, splitters, brandmauers and other communication means to organize the interaction of personnel in local and global nets of the company;
- personal computers (instrumental computer) and office equipment (plotters, printers and other) which is the part of the designer automatic work places for technical documentation;
– technical equipment (cyber and physical systems) oriented to function in automatic production sections, control programs and data which are transferred in the company net;
– individual communicators for production operators to access the remote net resources;
– physical lines of information transfer or fiber optical channels and a device which receives and sends for wireless data exchange among the company personnel and other.

Program means of the information and telecommunication system could be [9, 10]:
– automatic projection systems to develop and create construction (CD), program (PD) and technological (TD) documentation for the item;
– system of automatic control of the production technological preparation when they launch the new production lines;
– automatic control system of item engineering data to support the company production activity;
– budget system and electronic document creation in a company and other.

To make technical and program means function synchronically they have to develop and implement new solutions [11, 12] oriented to work with the digital economy standards.

2. Digital factory information and telecommunication system
Industry 4.0 digital factory is a new type of projection company oriented to prepare item digital technical documentation. The digital factory scheme of information and telecommunication system is given in figure 1.

Digital factory information and telecommunication system unites two components: virtual and physical. Physical component of information and telecommunication system could be [13, 14]:
– physical means of projection of items (industrial computers, server equipment and other) which is the part of device equipment designer automatic work place;
– physical technologies of projection which designers apply to create the item technical documentation. Physical technologies also include inter-disciplinary calculations, mathematical modelling, results and means of natural tests, algorithm of project activity automatizing and other;
– physical result of digital factory project activity is an item digital replica.

Item digital replica is prepared according to the requirements of:

Figure 1. Industry 4.0 digital factory scheme of information and telecommunication system (CAD - Computer Aided Design).
– unified system of construction documentation;
– unified system of program documentation;
– unified system of technical documentation.

Virtual components of information and telecommunication system could be:
– virtual means of projection which are cloud services of program, virtual machine, platform, infrastructure types;
– virtual technologies of projection to support informatively the company project activity. The virtual technologies of projection include the technology of industrial Internet of Things (IoT), BigData, Humane-to-Machine (H2M) technology, and other;
– project activity virtual result is the item digital shadow (digital twin).

Physical and virtual results of the project activity is a general digital product which will be transferred to the smart factory to be manufactured and stored in archive of the digital factory. Digital factory archive as a physical machine is a server base and in the virtual level it is a data cloud storage.

3. Smart factory information and telecommunication system

Industry 4.0 smart factory is a new type of production company oriented to create item in automatic mode. The smart factory scheme of information and telecommunication system is given in figure 2.

![Figure 2. Industry 4.0 smart factory scheme of information and telecommunication system.](image)

Smart factory information and telecommunication system unites two components: virtual and physical. Physical component of information and telecommunication system could be:
– physical means of production (cyber and physical equipment to manufacture the item, test equipment to check the item resistance to the external influencing factors and other);
– physical technologies of production to organize the functionality of technological sections in automatic mode to manufacture the item without humans. Physical technologies of production include additive technologies, technologies of cyber and physical systems (CPS) safety, technologies of numeric control and other;
– physical result of the smart factory production activity is a ready for use item (a group of items) with its electronic documents for exploitation.

Virtual component of information and telecommunication system could be:

– virtual means of production which are cloud services of program, computer, platform, infrastructure types;

– virtual technologies of production to manufacture items automatically. Virtual technologies of production include artificial intelligence, industrial Internet of Things, technologies of Systems-to-Systems (S2S), Machine-to-Machine (M2M), BigData and other;

– virtual result of production being developed in time to create an item digital shadow (digital twin). Item digital twin is done according to the standards of digital economy which is popular for the production activity with electronic signatures of technological operations executives and digital quality certifying system of the item being manufactured.

Physical and virtual results of Industry 4.0 smart factory production activity is a general digital which is the item and its informative model being developed in time. Item informative model is completely similar to the original item and is stored in the smart factory cloud. The development of informative model (digital twin) is explained with exploitation environment and its influence on the item and model adaptation mechanism (technical documentation) of the new factors influences which were never met before in a digital factory or a smart factory of Industry 4.0.

Smart factory cloud in physical level is a server which is the part of the company electronic archive.

4. Conclusion

Information and telecommunication system of the project and production activity of Industry 4.0 company is an infrastructure object to unite physical and virtual components. Physical and virtual components help each other and are informatively the same based on application of adequate physical devices of mathematical models. The division of objects and technologies to the components that match is done with dualism approach to create perspective companies oriented to function with digital economy standards.

Development of Industry 4.0 company information and telecommunication system is based on implementation to the infrastructure new protocols to transfer the data and new formats of data which are good for methods and means of the numeric control program for a cyber and physical production.

The application of information and telecommunication systems in item designing companies helps to organize the key technological operations completion without humans. Human personnel role in production is to control remotely with communication environment means.

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