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Modeling and Key Technologies of Intelligent Assembly System for Mechanical Products

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Abstract: *Manufacturing is country's pillar industries and the core driving force of national economic development. Among them, the machinery manufacturing industry provides technical equipment for the development of the whole country, which plays a decisive function of the development of the national economy and the progress of science and technology. As the increased competition in the global market, the machinery manufacturing industry is facing unprecedented severe challenges. Assembly has a great impact on product quality and the characteristics of complex operating processes, as it is the last part of the mechanical product manufacturing process and therefore often determines the level of mechanically manufactured products. The purpose of this paper is to improve the intelligence level of assembly systems through the development and application of Internet of Things technology. Take the mechanical product assembly system as the research object, the research methods are as follows: First, on the basis of analyzing the connotation and characteristics of manufacturing associations, proposed the manufacturing environment of the Internet of Things. Then, constructed the overall operation framework, network physical environment and topology structure are of the system, and refined the key technologies of system modeling. Object-oriented Petri nets and VisObjNet simulation techniques are used for abstract modeling and simulation systems. Finally, developed the prototype of the intelligent assembly system of mechanical products under the Internet of Things background, and further verified the feasibility and effectiveness of the method proposed in this paper. The research results show that the prediction accuracy of the online monitoring system can reach 98.8% by collecting acceleration and noise in real time. The efficient and green processing parameter optimization system greatly optimizes the original processing efficiency. The method proposed in this paper effectively improves the transparency of the mechanical product assembly process. It provides a reference model and implementation path for building a smart assembly system for mechanical products under the IoT environment.*

Keywords: *Mechanical Products, Assembly Systems, Model Building, Internet of Things*

1. Introduction

In order to adapt to the increasingly fierce market competition environment, enterprises constantly seek new production, operation and management mode around time, quality, cost, service and environmental objectives. This series of changes gave birth to the emergence and development of new manufacturing models. The new industrial revolution, called industry 4.0, is based on the development of information and communication technology, which brings new challenges to the scientific community and industry, but also specific challenges to demonstrate this new industrial platform in a learning factory environment [1]. An important and interesting theme in the evolution of industry 4.0 is the use of RFID (radio frequency identification) systems to track manufacturing performance. Therefore, create a system called RFID-enabled manufacturing execution system (MES). RFID technology can not only identify certain products, such as barcode technology, but also write data attached to the RFID tag of the product (about process time, ERP product data or similar data)[2]. This real-time tracking of manufacturing execution can significantly improve production planning, especially for small batch and single product production, which is the type of production for which learning plants are oriented in most cases. However, RFID technology also has its limitations. Manufacturing systems and methods used to manufacture products include storing product-related information with products. Product-related information can be stored on one or more tags, which are fixed to a certain part of the product and can be used to promote or control certain aspects of production [3]. During manufacturing, product-related information may be updated, for example, to reflect the completion of manufacturing operations [4-6].

With the development of production mode and manufacturing technology innovation, especially the development of information technology, the complementary integration of different fields becomes more and more obvious, and information technology begins to penetrate into the manufacturing industry [7]. The accelerating process of global economic integration not only brings convenience and development, but also makes the manufacturing industry face more fierce competition and more severe challenges [8]. In order to adapt to the complex and changeable market environment, countries have put the development of new technology-driven intelligent manufacturing at the core of national industrial development strategy [9]. Manufacturing industry in our country belongs to the one of pillar industries, machinery industry to provide technology and equipment for the whole national development, the development of national economy and the progress of science and technology has a decisive role, therefore, the development and application in mechanical assembly intelligent assembly system, will certainly to promote the development of mechanical manufacturing, further liberation and development of the productive forces has important value[10].

With the development of global automobile industry, environmental pollution and driving safety have become major problems [11-12]. Yu Hongxiao and his team proposed a new integrated anti-lock braking system (ABS) controller for hybrid electric vehicle (HEV) anti-lock regenerative braking system (ARBS) and anti-lock mechanical braking system (AMBS) on different roads. Using intelligent tire system tests on different road surfaces and friction information and optimal slip ratio, moreover, has also established a hybrid car ABS control eight degrees of freedom dynamic model, including tire LuGre model, based on wheel slip are studied, the battery charged state of (SOC), motor torque and the speed of the adaptive regressive and finite state machine controller, in order to maintain the best wheel slip and renewable energy, and develop the regenerative braking and mechanical braking system switching rules [13]. For manufacturing of the complexity of the use of the Internet of things, MA Jing and his team through the analysis of the application of Internet technology and mechanical products IOT assembly system (IOT - asmp) the running mechanism of the Internet of assembly system is studied by using the information entropy theory in manufacturing complexity in Internet environment, on this basis, this paper proposes a IOT based the Internet contains configurational entropy and entropy of the complexity of the entropy measure method, the Internet configurational entropy and entropy of the model is established. The feasibility and effectiveness of this method are verified by an example, which provides an important reference value for the design, control and optimization of iot based manufacturing system [14]. In order to improve the assembly accuracy and stability of complex mechanical products, m. -Z. Liu and his team proposed an online control threshold optimization method based on mutual information and game theory. Based on the analysis of the characteristics of complex mechanical product assembly, on the basis of quality control points based on mutual information is set up, the coupling relationship between stability of assembly quality measurement model is established, on the premise of guarantee the assembly accuracy, in order to minimize the assembly costs (quality loss cost and assembly cost) as the goal, discusses the assembly cost and control the relationship between the threshold value, based on game theory, the conflict between the stability of assembly and assembly cost factor to problem into a mathematical model, to predict the optimal assembly quality control threshold [15]. In order to improve efficiency, reduce cost and guarantee quality effectively, the research of CNC machine tool mainly focuses on virtual machine tool, cloud manufacturing, wireless manufacturing and so on. However, the low level of information Shared between different systems is a common drawback. In order to ensure the integrity and update of processing data, LI Yao and his team established a processing database with data evaluation module. Online monitoring system based on Internet of things and multi-sensor signals in the process of "perception" CNC machine tool characteristics, in order to state in the process of "perception" processing, intelligent CNC system was applied to production, established a highly efficient, green machining parameter optimization system of "execution" service-oriented manufacturing, intelligent manufacturing and green manufacturing database, CNC machine tool database can effectively in the processing and data sharing between different systems and management, through real-time acquisition acceleration and noise, the prediction precision of the on-line monitoring system can reach 98.8%, high efficiency, green machining parameters optimization system greatly optimized the original efficiency [16]. Assembly has always been the bottleneck of advanced manufacturing technology, and virtual assembly is an important way to solve this problem. Q. Tang proposed the connotation and system structure of the virtual assembly system, and then elaborated the key problems and solutions of the virtual assembly system in detail. Finally, a virtual assembly example of the two-stage involute cylindrical gear reducer based on WTK was presented [17].

Assembly has a great influence on the characteristics of product quality, management and complex operation process. Because it is the last part of the manufacturing process of mechanical products, it often determines the level of mechanical products. The purpose of this paper is to improve the intelligent level of the assembly system through the development and application of the Internet of things technology, and take the assembly system of mechanical products as the research object. Then, the overall operating framework, network physical environment and topology structure of the system are constructed, and the key technologies of system modeling are refined. Object-oriented Petri nets and VisObjNet simulation techniques are used to abstract, model and simulate systems. Finally, the prototype of intelligent assembly system of mechanical products in the Internet of things is developed, which further verifies the feasibility and effectiveness of the method proposed in this paper. Through research, the conclusion is drawn: the method proposed in this paper effectively improves the transparency of mechanical product assembly process, and provides a reference model and implementation approach for constructing intelligent assembly system of mechanical products under the manufacturing Internet of things environment.

2. Proposed Method

2.1 Internet of Things

Internet of Things (IOT) refers to information obtained through various sensors, RFID technology, global positioning system (GPS), infrared sensors, laser scanners, and other devices and technologies. It is acquired, connected, and interacted in real time. An object or process that collects sound, light, heat, electricity, mechanics, chemistry, biology, location, and required information through a variety of possible network accesses to implement an intelligent sensing system that identifies and manages human-related content. In The Road to the Future, Bill Gates has already mentioned the concept of the Internet of Things, but it was limited by the development of wireless networks, hardware and sensing devices, and did not attract the attention of the world. The Internet of Things (IOT) is based on traditional telecommunication networks. An information carrier that allows all common physical objects that can be independently addressed to form an interconnected network. IOT (Internet of Things) is "the Internet that connects to everything." It is an Internet-based extension and extension network. It combines various information sensor devices with the Internet to form a huge network that enables people, machines and things to be connected anytime, anywhere.

The Internet of Things is an important part of a new generation of information technology. First of all, the core and foundation of the Internet of Things is still the Internet, which is an extension and extension of the Internet. Second, its client extends to any commodity and commodity for information exchange and communication. Therefore, the definition of the Internet of Things is through information recognition devices such as radio frequency identification, infrared sensors, global positioning system (GPS), laser scanners, etc., according to the contract, exchange information on any items connected to the Internet in order to realize the intelligence of the network. Identify, locate, track, monitor and manage. From the perspective of communication objects and processes, the information interaction between objects and objects and between objects is the core of the Internet of Things. The basic characteristics of the Internet of Things can be summarized as overall perception, reliable transmission and intelligent processing. The overall perception means that various information of the object can be acquired through sensing devices such as radio frequency identification, two-dimensional code and smart sensors, and reliable transmission means that the information of the object can be accurately transmitted in real time through the fusion of objects. For information exchange and sharing.

2.2 Model Construction

In order to effectively improve efficiency, reduce costs, and ensure quality, information sharing is necessary, but the level of information shared between different systems is still relatively low. By constructing a smart assembly system model, this study breaks the common information sharing barriers in intelligent assembly systems and realizes the unimpeded communication and sharing of information. Model building is a complex process, the main methods are as follows:

(1) Hierarchical model of assembly situation

In today's era of fierce global economic competition, companies must be committed to designing,

designing and manufacturing new products quickly and agilely in order to remain invincible in the competition. The design cycle can be shortened through intelligent assembly systems, and rapid technological advances in many different areas of scientific computing provide support technologies for the creation of comprehensive intelligent assembly systems and visualization environments for assembly design and planning. In a smart environment, simple smart assembly tools can be combined into complex systems to detect potential assembly problems. In order to develop high-fidelity assembly simulation and visualization tools, it is possible to effectively detect assembly-related problems without using physical models. This paper describes the assembly situation from different angles and levels, and proposes a hierarchical model of assembly conditions. Each level of the model consists of several related sub-cases, each consisting of several related context items. Therefore, the hierarchical model of the assembly scene can be represented as a tuple:

$$\mathrm{AC} = \sum_{i=1}^{n} \mathrm{SubC_i} = \{\mathrm{SubC_1}, \mathrm{SubC_2}, , \dots\dots, \mathrm{SubC_n}\} \tag{1}$$

$$\mathrm{SubC_I} = \sum_{i=1}^{n} \mathrm{itemC_i} = \{\mathrm{itemC_1}, \mathrm{itemC_2}, , \dots\dots, \mathrm{itemC_n}\} \tag{2}$$

In formula (1), AC represents the assembly situation model, $\mathrm{SubC_i}$represents the i-th assembly sub-scenario; in formula (2), $\mathrm{itemC_i}$ represents the i-th assembly context item.

(2) Product value context model

The purpose of establishing a value context model is to describe the peripheral information of the product and reflect the functional overview of the product, such as value level and physical attributes, from different angles. In this paper, the value scenario is summarized into three scenarios: demand location, similar product comparison and value estimation, demand context item to represent the original motivation of product design, and comparison context item to indicate when the product is compared with other products. Advantages and Disadvantages; The valuation context item is used to represent the value proposition of the described product.

Therefore, the value scenario can be expressed as follows:

$$\mathrm{Evaluation} = \{\mathrm{Requirement}, \mathrm{Comparison}, \mathrm{Value}\} \tag{3}$$

In formula (3), $\mathrm{Requirement}$ is the demand situation item, which is used to indicate the original motivation of product design; $\mathrm{Comparison}$ represents the comparative situation item, which is used to indicate the advantages and disadvantages of the product when compared with other products;Value represents the valuation situation item, used to Represents the value proposition of the described product.

(3) Assembly situation model

The attached scene model is the second level of the assembly scene. It uses the intelligent assembly of the part as the basic unit. Its function is to describe the situational content related to the physical, engineering and structural attributes of the assembly. In this paper, the assembly situation is divided into eight context items, including material information, geometric information, hierarchical information, tolerance information, feature information, constraint information, mechanical information, benchmark information and functional information. Among them, geometric information, feature information and material information belong to the category of one-dimensional situational projects, and several others belong to the category of multivariate situational projects. The assembly situation is expressed as:

$$\mathrm{Assembly} = \begin{cases} \mathrm{Geometry}, \mathrm{Feature}, \mathrm{Material}, \mathrm{Hierarchy}, \mathrm{Constraint} \\ \mathrm{Tolerance}, \mathrm{Mechanical}, \mathrm{Role}, \mathrm{Reference} \end{cases} \tag{4}$$

The meaning of the parameters is shown in Table 1.

Table 1: Parameters and their meanings

Parameter	Meaning
Geometry	Geometric information, including all parameters and properties related to the assembly wireframe model
Feature	Feature information, including voxel information with engineering semantics for all component assemblies
Material	Material information, representing the material information of the part and the mechanical properties of the material
Hierarchy	Hierarchical information that describes the hierarchical structure of the assembly

Constraint	Constraint information, including all constraint information between assemblies
Tolerance	Tolerance information, including tolerance information of parts and transfer operation
Mechanical	Mechanical information, including the assembly of parts assembly force information
Role	Functional information, describing the function of a part or assembly in a product
Reference	Reference information, which describes the reference information of the assembly operation

(4) COPN model construction

Based on the analysis of the characteristics of the intelligent assembly system of mechanical products under the Internet of Things, combined with the coloring data chain of the product assembly process, various micro-mechanical TCOPN models were established. Let the discrete random variable x have n possible samples (x1, x2 ,..., xn), and the probability of each value is (P(x1), P(x2), ..., P(Xn)), then the entropy of X is defined as:

$$H(X) = -\sum_{i=1}^{n} p(x^{k}) a^{n-k} \tag{5}$$

Resource allocation bribe is an object-linked entropy function used to describe the internal constraint relationship of MIOT-IAUMP. MIOT-IAUMP1 consists of m intelligent management resources MCIIRi. Each intelligent control resource MCIIRi has the same probability of stability to MIOT-IAUMP1. According to the definition of information entropy, the resource allocation entropy of MIOT-IAUMP1 is calculated as:

$$\mathrm{HMCIIR} = m \left(\frac{1}{m} \log_2 \frac{1}{m}\right) = \log_2 m \tag{6}$$

Since the production capacity (static entropy) of MIOT-IAUMP is not considered, considering the MIOT-IAUMP's own physical connection, it is only necessary to consider the input between the number of intelligent control resources MCIIRi that constitutes MIOT-IAUMPi and the intelligent control resource MCIIRi. Output relationship (as shown in Equation 7):

$$\mathrm{HSCS\_C\_S} = \mathrm{nm\_i}\left(\frac{1}{n_{m\_i}} \log_2 \frac{1}{n_{m\_i}}\right) = \log_2 \frac{1}{n_{m\_i}} \tag{7}$$

Since the MCIIRi structure of the same relation path number is different, it is necessary to measure the difference between all the pre-order MCIIRi-1 and the subsequent MCIIRi+1 of the intelligent management resource MCIIRi, and the amount of information required for calculating the difference is as shown in Equation 8:

$$\mathrm{Hi\_c} = \mathrm{pm\_i} \log_2 p_{in\_i} \times p_{out\_i} \log_2 p_{out\_i} \tag{8}$$

The center of formula (8) is the number of input MCIIRi of intelligent control resource MCIIRi, n_{o_i} is the quantity of output MCIIRi of intelligent control resource MCIIRi, $n_{I\_i} + n_{O\_i} = n_{m\_i}$, so according to formula (7) and formula (8), the calculation formula of intelligent control resource MCIIRi configuration is obtained, such as Formula (9):

$$\mathrm{Hc} = \frac{H_{s\_c\_s}}{H_{i\_c}} = \frac{\log_2 1 X \log_2 n_{m\_i}}{P_{in\_i} \log_2 P_{in\_i} X P_{out\_i} \log_2 P_{out\_i}} \tag{9}$$

According to the definition of information droplets and the definition of the intrinsic entropy of the mechanical assembly unit, MIOT-IAUM's resource allocation entropy metric is shown in (10), where $P_{s\_s\_i}$ is the intelligent management resource MCIIRi in the mechanical product intelligent assembly unit MIOT-IAUM The entropy weight in .

$$\mathrm{Hc\_c} = -\sum_{i=1}^{m} P_{s\_s\_i} \log_2 P_{s\_s\_i} = -\sum_{i=1}^{m} \frac{H_c}{\sum_{i=1}^{m} H_c} \tag{10}$$

In the establishment of MIOT-IAUMP, based on the physical structure, based on the physical structure and operation of each MIOT-IAUMP logic, a state transition diagram (STD) is established based on the establishment of various unit models. TCOPN Each M10T- IAUMP represents an assembly system with one or a class of objects with similar functions and actions, the behavior and state of the packaged components, and the processes associated with and associated with other objects. The functions are independent of each other, between MIOT-IAUMP collaboration components. It is implemented through a messaging interface.

3. Experiments

3.1Material Assembly Unit Behavioral Reasoning Process and Data Collection

In the assembly modeling process, standard components with typical assembly features (TAF) and some existing components are usually inserted directly into the assembly model of the product. If these components are effectively managed, design time can be reduced and production costs can be saved. In order to reduce the complexity of the assembly modeling process, through the research of the assembly process, the constraint types in the assembly process are summarized, and a convenient and powerful assembly mechanism is proposed according to the characteristics and constraints of the parts. On this basis, the component database based on flexible coding system and the system supporting rapid assembly modeling are developed, and the component retrieval method is given. Intelligent manufacturing process technology and smart devices provide an integrated application environment for IMS. Researching intelligent manufacturing process technology is of great significance to promote the development of IMS. From the perspective of the shop floor (manufacturing process), IMS mainly includes intelligent resource identification, sensing, interaction, decision optimization and execution technology. In order to solve the analysis and optimization problem of MCIIAS-IOT, the time-based color object-oriented Petri net (TCOPN) is abstracted into a collection of objects consisting of assembly units and functional modules, according to the process constraints and the logical relationship between modules and units. The message passing relationship of MCIIAS-IOT is determined, and the communication between the message-driven unit and module is realized. The TCOPN model of MCIIAS-IOT is established. Material assembly unit behavior reasoning process:

Step1: When the tray enters the unit assembly area, the area sensor base generates an induction. If the decision result jumps to the status library (the tray is empty), it will trigger the normal conversion and release the tray to the DQ of the unit output queue area.

Step2: The judgment result jumps to the state library (the tray is not empty), then the sensing servo controller activates and calls the sensing unit to read the work process data link in the tray identification unit; in order to prevent errors and defects, the intelligent assembly system The data can be compared to the knowledge base at any time, and the current intelligent assembly system integrity and eligibility can be checked as needed to determine if the assembly object is an unqualified part package;

Step3: The verification result jumps to the state storage (the qualification verification), and the material stock of the material library is higher than the safety stock, triggers the sensing servo controller (activates and controls the execution unit to load the component material, and calls the sensing unit Scan and identify material identity information; make decision changes based on the knowledge rules passed by the knowledge base to determine the process consistency between the smart assembly system and the materials to be assembled;

Step4: The assembly process of the material and the intelligent assembly system is inconsistent, the judgment result jumps to the state library, the rejection signal is sent, and a new operation is performed;

Step5: Determine the jump to the state library (that is, the material conforms to the product) assembly process, the perception of the servo controller (from the mapping of the intelligent assembly system data link assembly unit, a set of device drivers required for the current operation, make decisions and changes During the change process, the controller's perception can truly monitor the running state of the execution unit. If the execution unit fails, the unit abnormality command is executed to the other module through the assembly unit output interface;

Step6: The execution unit ends, triggering the common conversion and writing the assembly unit component data to the pallet workpiece process identification unit. When the write is successful, the sensor library in the output queue area (DQ) is displayed.

3.2 Classification and Coding of Manufacturing Resources

The intelligent assembly system directly affects the stable operation of the production system. The establishment of the intelligent assembly system model is not only the basis of the process analysis and dynamic optimization of the manufacturing system. In any manufacturing mode, the intelligent assembly system is no longer limited to its own resources, the sharing of the Internet. And integration makes the intelligent assembly system modeling research in different manufacturing environments realize resource sharing and complementary advantages, which is of great significance to the improvement of production efficiency. Different intelligent assembly system models can be established in different ways according to different manufacturing environments, manufacturing systems and modeling purposes. The intelligent assembly system is the basis of production system operation and information interaction. Based on the intelligent assembly system system, it can be divided into the exchange and intercommunication of physical manufacturing resources and information resources. The intelligent assembly system is the physical mapping and conversion of manufacturing resources, and the physical manufacturing resources can be divided. For software manufacturing resources (such as people, technology, software) and hardware manufacturing resources (such as materials, equipment), the experimental steps based on part coding and classification are as follows:

Step1: Define the concept of the production process of the intelligent assembly system. Most machine component grouping problems use the concept of production process analysis. In this concept, if a component is routed to the machine, the non-descriptive weight of the machine is 1, otherwise 0;

Step2: Form the machine cluster using appropriate similarity coefficients and grouping algorithms, introduce this concept into coding and classification, and use numerical coding to describe and weight the parts;

Step3: Use grouping algorithms to group the most similar components to minimize production and design setup time and cost;

Step4: For the resource and information coding problem, collect the target resource selection, integration and operation sequence, so that the algorithm of the intelligent assembly system is continuously optimized.

4. Discussion

4.1 Assembly Operations Guide Decision-making

This paper analyzes the requirements of decision support in the process of gearbox assembly, studies the content structure of four decision support libraries including database, model library, method library and knowledge base, and establishes the operation model of four decision support libraries on this basis, so as to realize the reasonable cooperation of four modules. Product assembly quality depends on the specific assembly process and specification, to ensure that the quality parameters, and the quality parameters as assembly operation, the optimal parameters of the quality change, therefore, to ensure that the product quality to achieve the optimal assembly, with product quality optimization control decision support system, mainly including on-line quality optimization analysis and the product quality inspection. The interface of online quality optimization analysis is shown in table 2 and figure 1.

Table 2: Xbar-R Control char

Time(Min)	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
Xbar-R	1	3	24	50	26	43	3	45	3	35	24	11	17	19	1

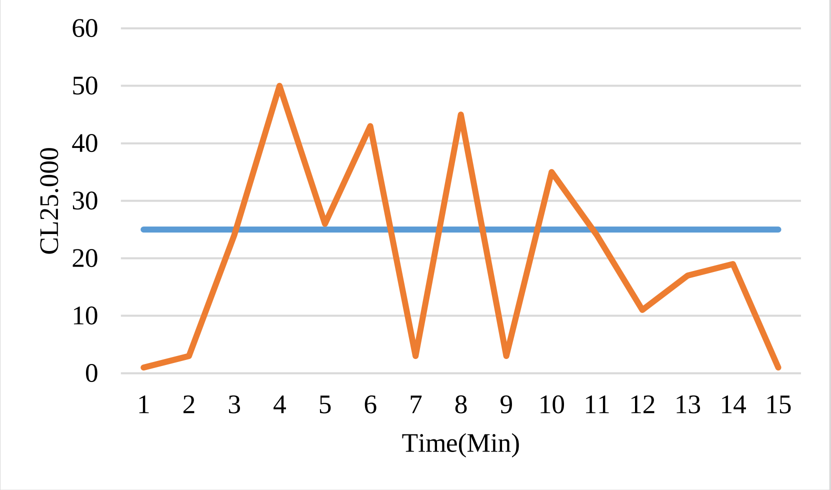

Figure 1: Xbar-R Control chart

4.2 Product Quality Optimization Control Decision

Based on the analysis of assembly process resources, control unit and process information, resource modeling and configuration are combined to build a resource information identification model and realize the identification mapping of assembly process resource information. Establish resource information perception standard interactive data structure and format, after studying the perception of the interactive hardware architecture, on the basis of combining the resources of the identification model, build assembly process information perception interaction model, realize the real-time perception, interaction of assembly process information control, assembly process of the intelligent decision support system provides the support of cognitive interaction model. According to the current assembly product information, the system provides assembly operation guidance and decision support for assembly personnel, as shown in table 3 and figure 2. Assembly operation guide mainly includes product information, assembly material information, operator step information, part scanning calibration status, quality data calibration status, operation process progress monitoring and visual operation guidance. According to the historical quality data processed by the equipment, the system optimizes the on-line quality control points to provide decision support for the quality optimization of equipment and personnel.

Table 3: Sample operation diagram

Value	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
Value1	23	17	29	34	28	10	39	20	39	39	39	10	10	6	38
Value2	23	11	49	35	38	29	38	10	27	10	39	39	3	39	28
Value3	25	12	1	17	29	28	29	28	28	50	20	39	4	39	28
Value4	26	19	14	18	39	40	20	38	20	29	10	20	9	20	30

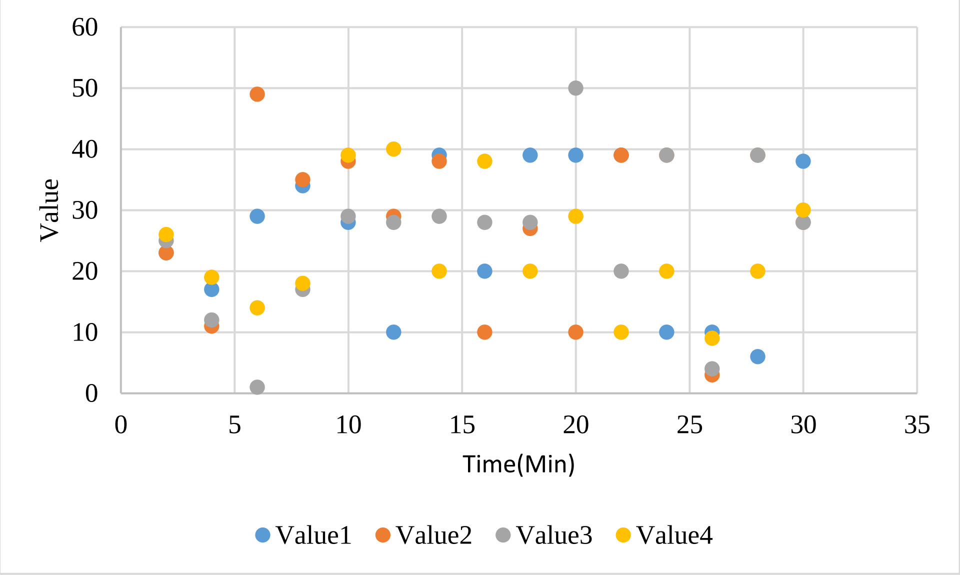

Figure 2: Sample operation diagram

4.3 Production Schedule Monitoring

In order to make it more convenient for decision makers to grasp the progress of the assembly, we design the system can realize the real-time monitoring of production schedule, try and progress can be displayed, as shown in table 4, the display content can cover and its models, order number, production number, etc., also can have a try order statistics is currently online and completed schedule, progress has been launched progress and the completed schedule as shown in figure 3, 4, respectively.

Table 4: Production plan visualization monitoring

Progress(%)	F5M40	F5M41	F5M42	F5M43	F5M44	F5M45	F5M46	F5M47	F5M48
Online progress	26	54	70	54	44	29	58	58	60
Completed progress	30	57	79	79	48	40	70	65	66

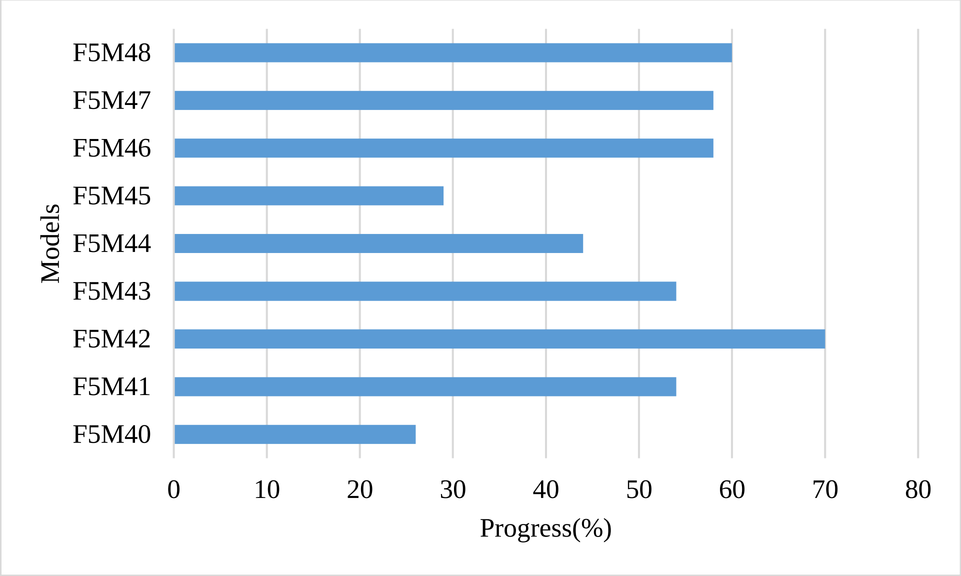

Figure 3: Online progress

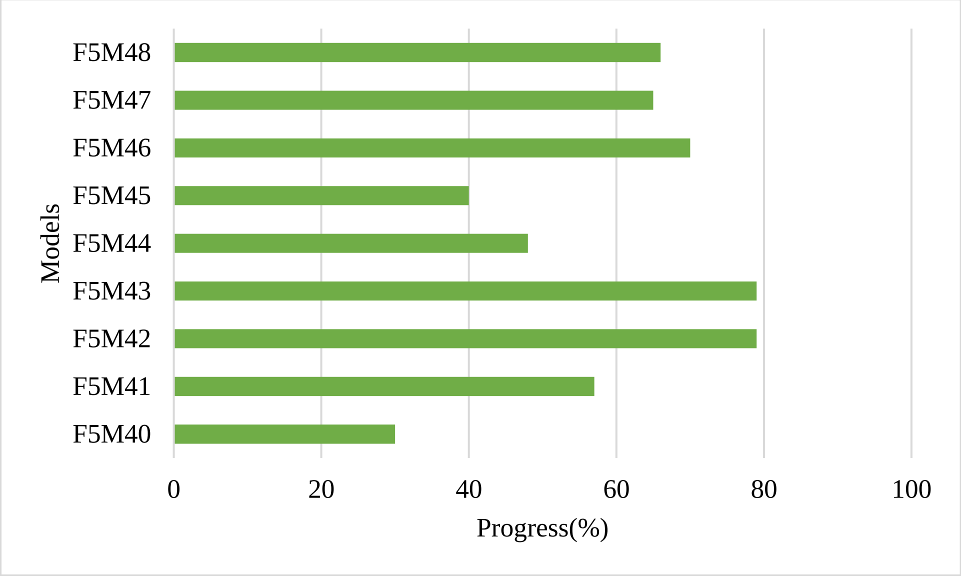

Figure 4: Completed progress

5. Conclusions

With the continuous progress of science and technology and the continuous innovation of technology, the complementarity and integration between different fields become increasingly obvious. Automation technology, information technology and manufacturing technology gradually realize mutual integration and penetration. At the same time, this trend also meets the requirements of the rapid development of global economic integration. As a result, we see not hard, mechanical assembly of scientific, quick, great progress has become one of the strategic high ground of the current world economic and technological development, it has the information technology is highly integrated, driving effect is strong, application effect is good characteristic, the development of Internet technology and application is of great significance to promote the development of manufacturing industry. The main research results of this paper are as follows:

(1) Based on the connotation of the system and the overall operation framework, this paper proposes the intelligent assembly system of mechanical products in the context of the Internet of things in the manufacturing industry, defines the characteristics of the IMOT-IASMP, and designs the overall operation framework, network physical environment and topology structure.

(2) in this paper, the IMOT - IASMP connotation and the overall framework is derived on the basis of Internet of things, is used to solve the mechanical product assembly manufacturing environment assembly, packaging, transfer and sharing of resources, this paper, by using semantic modeling theory and method of modeling, set up manufacturing material resources, such as the level of the model, the whole model, the semantic model, data model, the manufacture and use the resources of map matching and closed-loop feedback mechanism, build a IOT of manufacturing resource mapping model and configuration model, finally provides a standard for the operation of the IMOT - IASMP structured processing and derived object.

(3) this paper analyzes the data characteristics of the resource object manufacturing of the Internet of things to solve the perception, integration and interaction problems of multi-source heterogeneous data brought by the Internet of things technology, and designs the data structure and coding structure of object manufacturing based on this to support the storage and analysis of multi-source heterogeneous sensing data. In addition, on the basis of advanced data sensing technology, this paper constructs the data sensing and integration model of multi-source heterogeneous resources, and proposes an assembly data interaction system oriented to manufacturing Internet of things process to realize the sensing data application and data communication in manufacturing Internet of things environment.

(4) on the basis of the overall framework of the system and several key technologies, in order to verify the rationality of the method proposed in this paper, the paper first USES object-oriented time-colored Petri net technology to build the system TCOPN model; Secondly, the system TCOPN model is instantiated and verified by taking a mechanical product assembly process as an example. Finally, in order to verify whether the TCOPN model of the system has conflicts and deadlocks, the paper based on VisObjNet stochastic Petri net simulation technology to carry out simulation and analysis of the model, so as to prove the rationality of the system. In order to help designers in the early stage of product development, this paper develops an intelligent method to integrate design and assembly planning process, including product design, assembly evaluation and redesign, assembly process planning, assembly system design and assembly simulation. A new object-oriented unified knowledge based Petri net, called OOKPNs, is defined. It integrates knowledge based expert systems and fuzzy logic into common place transformed Petri nets for the presentation and modeling of distributed design processes. A prototype intelligent integrated design and assembly planning system (IIDAP) is implemented by using distributed blackboard structure and integrating multiple collaborative knowledge bases and software in parallel.

(5) In order to verify the rationality of the method proposed in this paper, based on the study of the overall framework of the system and several key technologies, the object-oriented time color Petri net technology is adopted to construct the TCOPN model. Then take the mechanical product assembly process as an example to verify the system TCOPN model. Finally, based on VisObjNet stochastic Petri net simulation technology, this paper conducts simulation and analysis of the model, and verifies whether the TCOPN model of the system has conflicts and deadlocks.

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