AUTOMATIC ASSEMBLY OF COMBINED CHECKING FIXTURE FOR AUTO-BODY COMPONENTS BASED ON FIXTURE ELEMENTS LIBRARIES

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Abstract: In this paper 3-D models of combined fixture elements are designed, classified by their functions, and saved in computer as supporting elements library, jointing elements library, basic elements library, localization elements library, clamping elements library, and adjusting elements library etc. Then automatic assembly of 3-D combined checking fixture for auto-body part is presented based on modularization theory. And in virtual auto-body assembly space, Locating constraint mapping technique and assembly rule-based reasoning technique are used to calculate the position of modular elements according to localization points and clamp points of auto-body part. Auto-body part model is transformed from itself coordinate system space to virtual assembly space by homogeneous transformation matrix. Automatic assembly of different functional fixture elements and auto-body part is implemented with API function based on the second development of UG. It is proven in practice that the method in this paper is feasible and high efficiency.

Keywords: combined checking fixture; automatic assembly; auto-body part

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1. INTRODUCTION

During auto-body parts and components are assembled and wielded, the spatial shape of parts and components are complex, meanwhile the match precision of matching parts is required to be high, so the quality of parts and components need to be inspected comprehensively after the process of stamping and forming and before the process of welding and assembling, then rejects are avoided to flow into next production process. Conventional Equipments for checking quality of auto-body parts and components are special checking fixtures, the data obtained through special checking fixtures are relative values based on some special datum elements, and those data can not be compared with the data obtained through Coordinate Measuring Machine measuring parts of white auto-body in the auto-body coordinate system, so engineers can not judge that the checking error is because of parts manufacturing error or fixtures benchmark error. Thus to certain measuring points based on special checking fixtures only the qualitative appraisal can be given. Meanwhile as special-purpose checking fixtures, they can only be suitable for some specific components, when product remodeled, those special fixtures would be discarded.

In this paper according to the auto-body components' shape characters, clamp characters, localization characters and the checking technological requirement, the assembly space of automobile body coordinate system is simulated, solid models of combined fixture elements are created, based on the CAD automatic assembly technology, automatic assembly of combined fixtures are studied based on UG/API, the feasible scheme of virtual assembly can instruct operator to assemble fixture in practice. Those combined fixtures obtained through that method can overcome the above special-purpose fixture's shortcomings, and realize the special-purpose fixture's function completely and can meet requirement of product update.

2. ESTABLISHMENT OF MODULAR FIXTURE ELEMENTS LIBRARIES

Solid models libraries of combined fixture elements are established based on auto-body part characteristic parameters. According to their different functions those libraries can be divided into: ①Foundation elements library E_f; ②Supporting elements library E_s; ③Adjusting elements library E_a; ④Location elements library E_l; ⑤Connection elements library Ec; ⑥Clamping elements library E_c; ⑦Auxiliary elements library E_a. When elements solid models are created, two principles (one is easy to describe the geometry characters of solid models and one is easy to solve the assembly direction of parts) should be ensured. So the assembly direction of models

and the direction of datum axle should be parallel. In order to realize automatic assembly of combined fixtures, besides massive 3D parameterizations models of elements, assembly rule databases adapting to product design should be constructed, such as installment way database, installment antecedent database, related connection database, disassembly antecedent database and so on.

3. CALCULATION OF PARTS POSITION IN THE ASSEMBLY SPACE OF AUTO-BODY COORDINATE SYSTEM

solid models of elements and parts are created in the original themselves coordinate system at first, in order to assemble each element solid model of part should be transformed to the assembly space of auto-body coordinate system through transferring matrix, and then 3D model of part transformed is saved as .prt files, meanwhile that model of part is loaded into the assemble space of UG, thus the virtual assembly space of auto-body coordinate system is constructed. In this virtual space, all elements assembly position of fixture is determined by auto-body part position.

Size parameters of fixture bottom plate are determined according to auto-body parts 2D size in the first location plane, then those size parameters are used as input, corresponding fixture elements libraries are accessed based on input parameters, and interrelated fixture elements are identified, transferred and loaded into the virtual assembly space of auto-body coordinate system from elements libraries. And all other fixture elements are called, installed, localized, and connected by above method. At last combined checking fixture of special function is formed. After the auto-body have produced for a period of time it maybe need to be remodeled, corresponding combined checking fixtures can not be used any more, but they can be disassembled into individual fixture elements, and which can be reassembled for new type of auto-body.

During design of combined checking fixtures modularization idea is followed, locating function or clamping function of one point is carried out by combining different types fixture elements, this combination is a function module of checking fixture. Position of every function module in 2D plane of bottom plate is determined by location restriction mapping, in other words the assembly position of each fixture function module in bottom plate is determined by mapping of part location point in space to fixture bottom plate. The mapping flow is showed in Fig1.

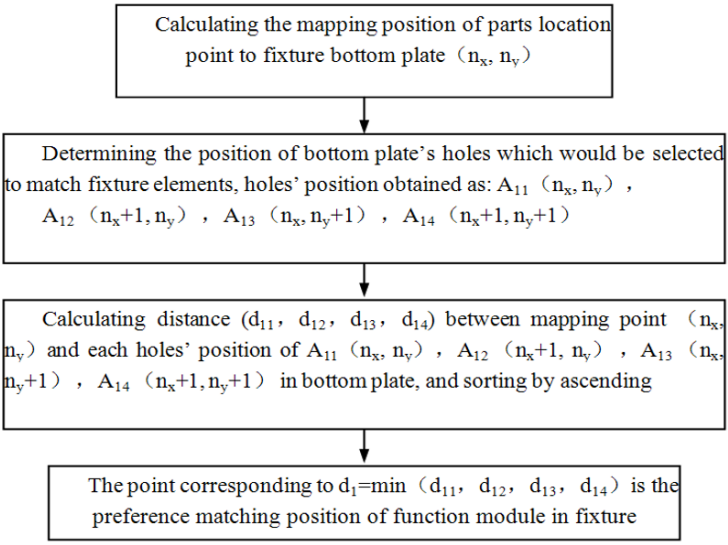

Fig1. Location restriction mapping flow

4. PARAMETERIZED DESIGN OF EACH FUNCTION MODULE IN COMBINED CHECKING FIXTURE

In this paper each locating or clamping module is approximately composed of 3 portions: supporting elements e_s, adjusting elements e_a and locating elements e_l respectively. After the install position of function module in fixture bottom plate is determined, parameters of each element of the function module should be determined, thus construction space of checking fixture can be expanded.

the following is the steps of determining element parameters for function module:

Step 1: position point is described as $P_l(x_l, y_l, z_l)$, location type is judged to be location plane or location hole;

Step 2: if the location type is location plane(the value range of master parameter S for location elements: 10mm≤S≤60mm);

Then the type of adjusting elements e_a is A, and the master parameter of A is H=50mm;

the parameter H_s (H_s=N×d) of support element e_s is determined as following:

N=（H`-H）/d (d is the distance of two nearest holes in fixture bottom plate);

If (10≤(H`-N×d)≤60) then select H_s=N×d

Else if ((H`-N×d) ≤10) then select H_s= (N-1)×d;

the high parameter of location element e_l is S= H`-H- H_s;

Step 3: if the location type is location hole, the type of adjusting elements e_a is B, the master parameter of B is H=50mm; the determining method of parameters for supporting elements e_s and location elements e_l is same as step2.

5. REALIZATION OF AUTOMATIC ASSEMBLY FOR COMBINED CHECKING FIXTURE

Automatic assembly of combined checking fixture could be carried out by programming and calling function of UG/OPEN API based on the above algorithm. The transformation matrix $[T]_i$ of each matching element and part should be generated before solid models are assembled, and so it is easy to determine the position of each element and part in virtual assembly space. $[T]_i$ is generated by searching and identifying and saving the features of the assembly solids. Then the DLL application program module of UG is activated by calling API function and the position ($[T`_O]_i$) of element in the assembly model can be calculated.

The following are some functions called many times in the program mentioned above:

UF_ASSEM_mating_condition_t ftf;

Int UF_ASSEM_ask_component_data(part, name, refset, instance, orig, csys_matrix, trans);

Int UF_ASSEM_solve_mc(&ftf, &status, &dof, transform);

Ret=UF_ASSEM_apply_mc_data(&ftf, &struct_status, &status);

Among parameters in functions above, Ftf is a structure type data parameter of assembly relation, at first ftf is defined, the parameter of part passes path and file name of user-defined object, features of solid model are searched by UF_ASSEM_ask_component_data（） and the transformation matrix is saved in the parameter of trans, which is 4×4 array, then match relationship is solved by UF_ASSEM_solve_mc（）, if it successes for solving, status=1. UF_ASSEM_apply_mc_data（） apply restriction relation to assembly solid model by parameters passed, in order to obtain assembly position matrix of assembly elements in assembly model, the data is passed by the parameter of transform and automatic assembly is realized.

So the elements libraries are called, identified and read. Different components have different position features, if some special location elements do not exit in location elements library, they must be created by calling UG/API function and according to position features.

6. CONCLUSION

Along with speeding up of automobile update, in order to control the manufacture quality of auto-body parts, the quality of corresponding checking fixtures are request more highly. Combined checking fixture is one of the best choices for remodeling frequently of automobile. In this paper the method of 3-D combined checking fixture automatic assembly for auto-body part is presented based on modularization theory. And in virtual auto-body assembly space, Locating constraint mapping technique and assembly rule-based reasoning technique are used to calculate the position of modular elements according to location points and clamp points of auto-body part. The model of auto-body part is transformed from itself coordinate system space to virtual assembly space by homogeneous transformation matrix. Automated assembly of different functional fixture elements and auto-body part is implemented with API function based on the second development of UG. It is proven in practice that the method in this paper is feasible and high efficiency.

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