Study on Modeling and Simulation of Logistics Sorting System Based on Flexsim

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Abstract—**Applying Flexsim system simulation software to build the simulation model of logistics sorting system. Before the introduction of automatic sorting equipment and technology in the sorting system, through the establishment of the Flexsim simulation model to simulate, analyze and evaluate the design scheme.**

Keywords-Sorting system; Flexsim; Simulation

I. INTRODUCTION OF FLEXSIM SYSTEM SIMULATION SOFTWARE

Flexsim system simulation software is a set of processing technology gathering computer three-dimensional image processing technology, simulation technology, artificial intelligence technology, data processing technology as a whole, which can establish object system three-dimensional model in the inner of computer, and then make a variety of system analysis and engineering validation for the model, and ultimately get the optimal design and transformation program. Software provides a wealth of physical units, the establishment of the physical simulation model can be used to show three-dimensional animation, providing an effective means of visualization for planning design or transformation of the logistics center. Because Flexsim provides a realistic graphical animation for displaying a complete operational performance report, and through operation of the model to provide related feedback information of a variety of programs for analyst, so analysts can compare the merits and inferior in a short period of time on the of various programs, to assess various pre-selection programs.

II. DESIGN THOUGHT OF LOGISTICS SORTING SYSTEM

Logistics sorting system is widely used in an automated operating system, directly impacting on the cost, efficiency and quality of service of the entire logistics center. Therefore, to improve the overall efficiency of the logistics center, the design and development of the sorting system is the key. But if the entire logistics center are introduced the automated sorting equipment in one-time, then the beginning of the fixed investment is relatively high, with big capital pressure. In view of this, this article takes express business for example, putting forward this design idea "automatic sorting file class express, manual sorting non-file class express" to ease the introduction of automated sorting equipment in the beginning of the higher investment pressure. The establishment of a sorting system model with Flexsim software allows you to validate the viability of its operational strategy before introducing automated sorting equipment, enabling business decision makers to make a feasibility assessment of the operational plan in a shorter period of time.

III. ESTABLISHING A SORTING SYSTEM MODEL

A. Sorting Process

Based on the above "automatically sorting file type express, manually sorting non-file tyep express" vision, as well as the express sorting process analysis, designing sorting process as shown in Fig. 1:
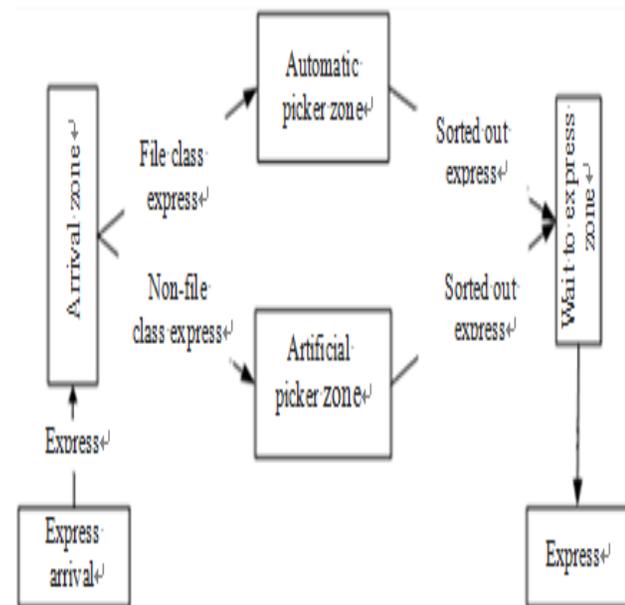

Figure 1.   Sorting process

B. In The System Model, The Main Used Entity And Its Role In The Model Shown In Table 1:

TABLE I.   MAIN SUBSTANCE DESCRIPTION

Name	Notes
generator	Used to generate express mail
storage cache	Temporary storage of express mail
Conveyor belt	Send express mail
Sorting conveyor belt	Sorting express mail
Operator	Handling, sorting, processing and so on
Resolver	Classification express
Handling machine	Carry sort of good shipment
Absorber	Release temporary entity (express)

C. System-Related Parameters are as Follows:

*1) Express arrival part:*The arrival frequency of the sorting center express (8 hours of peak hours) follows the normal distribution function: normal (0.38,0.1,0) s;

For all express, 60% of them are the file class express, the others are the package or special pieces. The Express category ("File Class Express" or "Non-File Class Express") is subject to the Bernoulli Distribution Function: bernoulli (60,1,2);

Assuming that all the express in the sorting center are sent to 36 large areas and they are random, the target destination of the express is subject to an integer uniform distribution function: duniform (1,36).

2) Automatic sorting part and manual sorting part: The "preset" time of the sorting tray follows the normal distribution function: normal (45,10,0);

Time of Sorting the shipment of the express and packaging obeys the normal distribution function: normal (60,10,0);

Automatic sorting conveyor speed is 1.5 m / s; manual sorting zone conveyor speed is 1 m / s;

The operator's parameters are based on the system default settings.

IV. BUILDING FLEXSIM SIMULATION MODEL

Combined with our established sorting system model and related system parameters, using Flexsim software to design simulation model, sorting system simulation model is shown in Fig. 2:

A. Purchase Area

In the model, the generator area is placed with a generator for generating various categories of "express" (temporary entities) that convey the resulting "express" to the sorting area via the conveyor.

We define the generation model, type, and label of express (Temporary Entity) by system attribute and custom code. The key code is as follows:

(*38, 0.1, 0); / * "Express" arrival time interval is a normal distribution with a mean of 0.38 and a standard deviation is 0.1 *

Setitemtype(item,bernoulli(60,1,2)); / * generated "Express" have 60% chance of being a file class Express * /:
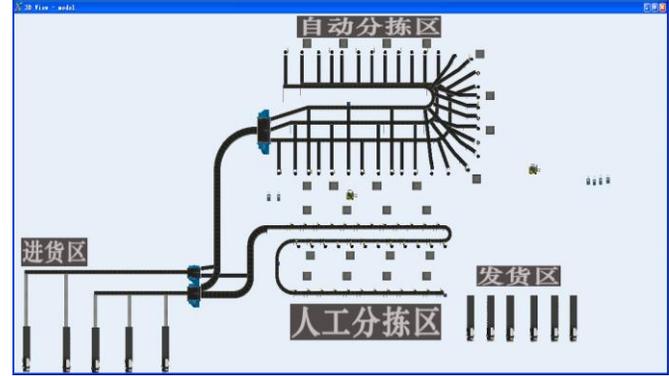

Figure 2.   Flexsim 3D simulation model view

B. File Class And Non-File Class Separation

Because this link of the "file class and non-file class separation" are not the focus of this model discussion, so in the process of setting the model we will set this part of the automatic processing, that is, "file class and non-file class separation" is done automatically by the resolver with the following key code:

```
Int value = getitemtype (item);
switch (value) {
case 1: return 1;
case 2: return 2;
default: return 0;
}
```

C. Automatic Sorting Area

There are three main automatic sorting conveyors (automatic picking conveyor 01,02,03) in the automatic sorting area. A total of 36 sorting outlets are set up, which means sorting the express mail sent to 36 different areas.

Resolver temporary entity flow in the auto sorter properties - The key code sent to the port is as follows:

```
Int value = getlabelnum (item, "letters");
```

Double mod_01 = fmod (value, 3); / * The tag value labeled "letters" is sent to port 1, dividing 3 to modulo, if 1, it is the temporary entity, and 2 for the temporary entity to port 2, It is sent to port 3 for other situations * /

D. Manual Sorting Area

The manual sorting area has only one main picking belt, with 36 sorting outlets, which means sorting the shipment to 36 different areas. In the "artificial _ main sort conveyor" sending conditions, preparing the following code:

```
Int port = parval (2);
Int label_value = getlabelnum (item, "no_letters");
Switch (port) {
```

Case 1: return label_value == 1; / * means that the temporary entity with the label name "label_value" of 1 is sent to port 1, the following synonyms. * /

... / * here omitted the middle part of the similar code * /

Case 36: return label_value == 36;
Case 37: return 1 == 1;
Case 38: return 1;
Default: return 1; / ** /
}
Return 1;

V. SIMULATION MODEL OPERATION AND RESULT ANALYSIS

Carrying out Simulation of the above sorting system, setting the simulation time of 10000s, run the simulation model several times, after each run, it generated the corresponding data, we extracted a sample from a number of data, then do data analysis.

A. The Output Results for Part of the Operation was Shown in Table 2:

TABLE II.   ARTIFICIAL SORTING AND AUTOMATIC SORTING SIMULATION RESULTS

Simulation time	10000s		
Object	Type	Input amount	Output amount
Artificial _ main sort conveyor belt	MergeSort	10097	10002
Artificial error picking	Sink	1234	0
Automatic Pickup Conveyor 01	MergeSort	5249	5237
Automatic Pickup Conveyor 01	MergeSort	5167	5151
Automatic Pickup Conveyor 01	MergeSort	5306	5283
Artificial error picking	Sink	173	0

As shown in the above table, the manual sorting 10002 pieces of express mail in 1000s, the number of wrong picking is 1234, the wrong rate is $\frac{1234}{10002} \approx 12.3\%$, the automatic sorting in 10000s sorting 5237 +5151 + 5283 = 15671 pieces, the number of wrong picking is 173, the wrong rate is $\frac{173}{15671} \approx 1.2\%$. The sorting rate of automatic sorting is 11.1% lower than that of manual sorting, and the accuracy rate is greatly improved. And the wrong picking rate of the entire sorting center is $\frac{1407}{25673} \approx 5.5\%$. Obviously, the overall rate of wrong picking of the sorting center has decreased compared to 12.3% of the total picking rate. Besides, in the same 10000s, the automatic sorting can sort 15,671 pieces, while manual sorting can sort 10002 pieces, the number of automatic sorting is 1.5 times of the number of manual sorting, sorting efficiency has been greatly improved.

B. In the Manual Sorting Area, the Artificial Picker Needs to Identify, Sort and Classify the Express Mail.

In the automatic sorting area, the sorting personnel can only pack the express and the middle links are different, resulting in its showing a different state, the final amount of processing express is also a big difference, the specific situation shown in Table III:

TABLE III.   MANUAL PICKER VS AUTO PICKER STATUS

Report statue	Artificial picker	Automatic picker
Simulation time	10000s	
idle(free time)	5987s(59.9%)	5734.7s(57.3%)
utilize(working time)	2791.5s(27.9%)	4161.1s(41.6%)
travel_loaded（return）	138.2s(1.4%)	
loading（pick up express）	544.7s(5.4%)	
unloading（place）	296.7s(3%)	

This table reflects the status of the artificial picker and the automatic picker in the set time. The simulation results for artificial picker are: idle (idle time) is 5987s, the proportion is 59.9% (working time) is 2791.5s, the proportion is 27.9%; while the status of the automatic picker is: idle (idle time) is 5734.7s, the proportion is 57.3%, the service time is 4161.1s, the proportion is 41.6% of the total. The date of utilize is different greatly, the reason is that the middle part of the manual selection taking a lot of time, such as travel_loaded (return) need 138.2s, loading (picking up), unloading (placed) 544.7s and 296.7s, respectively. Through the analysis, compared with the artificial picker, automatic sorting staff work less with lower strength.

VI. CONCLUSION

In the overall planning and design, logistics center is one of the most important part of sorting system design. Application of Flexsim system simulation software can carry out effective simulation analysis before investing and constructing logistics center, analyzing the design deficiencies in order to find a reasonable design strategy will be able to greatly reduce the investment risk, bring more big benefit to the enterprise and the whole society. Flexsim system simulation software has great potential in the sorting system and the auxiliary design research field of the entire logistics center.

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