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Real-Time Line Control System for Automated Robotic Assembly Line for Multi-PCB Models

Jong-Oh Park, Kwang-Ik Hyun, •Doo-Gan Um
Byoung-Doo Kim*, Sung-Jong Cho*, In-Gyu Park*, Young-Sik Kim*

Robotics and Fluid Power Control Lab.
Korea Institute of Science and Technology, Seoul, Korea
* Information Systems Business, Samsung Electronics, Gumi, Korea

ABSTRACT

The efficiency of automated assembly line is increased by realizing the automation of each assembly cell, monitoring the line information and developing the real-time line control system in which production flow is controllable. In this paper, the several modules which are important factors when constructing automated real-time control system, such as, line control S/W module, real-time model change module, error handling module and line production management S/W module, are developed. For developing these important programming modules, real-time control and multi-tasking techniques are integrated. In this paper, operating method of real-time line control in PCB automated assembly line is proposed and for effective control of production line by using multi-tasking technique, proper operating method for relating real-time line control with multi-tasking is proposed by defining the levels of signals and tasks. CIM-Oriented modular programming method considering expandability and flexibility will be added for further research in the future.

I. Introduction

The efficiency of automated assembly line can be increased by using real-time control for production flow control and management as well as automation of each cell, line information monitoring.

The PCB assembly lines have been installed merely with the functions of synchronization of each cells and information monitoring but recently due to complexity and development of information system of assembly line, system operator can not handle the line flow control easely and it's almost impossible for operator to handle such a complex operation completely and make a mistake easily.

To solve these problems, high level controllers are introduced to control the line and management of production schedule.

For the efficiency of line, this paper suggests design strategy of the PCB assembly line on the base of efficiency and real-time control technique. This paper carried out on the base of real-time control for incresing line efficiency which can make possible real-time model change, information integrated control, effective production management and analysis.

2. REAL-TIME LINE CONTROL

Recently, there are many cases for improving flexibility and expansibility of PCB assembly line. But, these efforts were generally ended only by synchronization of each cells and production monitoring. There are serveral problems to establish a flexible and expansible assembly line. The serveral problems described below;

- Integration and analysis of production information.
- Model change.
- Handling of time critical data.
- Error treatments.
- Consideration of lead/tact time.
- Cell flexibility and expansibility.
- Funtions of PCB assembly robot line.
- Integration of different Control Units.

And integration of these functions will be introduced another method of design technique and integration technique of line control. In fact, it takes almost more than 2-4 hours in the PCB assembly line to make a model change and if factory use these lines for PCB assembly with robot for the electric goods like what is a short life cycle item then it's non-effective method for production.

Real-time is solution which make it possible and can solve these problems and if we design the line by using modulization of program of PC S/W and PLC S/W and by designing high level functions of line. Generally, real-time line control method can be integrated for line flexibility and efficiency.

3. LINE LAY-OUT

This paper used SAMSUNG PC(SPC6000A) for line control and management. MS-Windows is applied for multi-tasking and used DDE(Dynamic Data Exchange) for data flow control between each applications. Factory LAN is interfaced with line control S/W for decision making and management of production information. The control logic is assigned to PLCs which are connected by computer link and connected to PC with RS232 Communication port.

PC(SPC6000A) controls line flow, treatments of errors and analysis of production information data. All the data from each cells of assembly line is concentrated to PC logic.

Fig. 1 shows system lay-out for PCB assembly robot line. For effective line management and control, this paper defined control and information task level and designed line control S/W with this concepts. Fig. 2 shows task level of designed S/W. we used several communication methods for integration of each cells and table 1. shows communication method we used.

4. LINE CONTROL S/W

Real-time line control technique is used for multi-PCB assembly robot line and line control S/W whichW is developed by using MS-WINDOWS.

The S/W is designed by using real-time concepts and can make several functions which cannot make it possible if real-time is not integrated.

4 port serial communications using MS-Windows are used and several applications are run by multi-tasking technique provided by MS-Windows.

4-1 S/W STRUCTURE

Fig. 3 shows S/W configuration for assembly robot line control. It contains several tasks and each task is communicated with DDK. Production information analysis task realized with MS-Excel. Novell Netware(OS) is used for exchanging data between plant host computer and line host PC via LAN.

4-2 The charistics of line control S/W

The charistics of line control S/W described below;

- PC controlls assembly line process with real-time multi-tasking.
- PC and PLC program is modulized in order to synchronize each other.
- Real-time synchronization with each cells.
- Real-time model change to handle more than one model in one line.
- Error diagonosis, treatments and monitoring with real-time operation.
- Flexibility and expandibility by using computer link and design of input-output module in the PLC program.
- Distribution of control and concentration of information by using optimal S/W logic design.

4.3 Function of S/W

Table 2 shows monitoring data gathered via PLC logic and analyzed by PC. Table 3 shows control data which is controlled by PC with real-time logic operation.

4.3.1 Model Change

Real-time model change operation is realized in this system. Model change can be made by operator, order from LAN data and completion of production, etc. Model change issue algorithm is showed in Fig 4.

When model change is occured, each cell must change several data and routines described below;

- Model change routine in the PLC program.
- Robot program.
- Information of production.
- Information of cell process.
- Information of line process.

Model change algorithm is showed in Fig 5.

4.3.2 Diagnosis and treatments

Cell break-down means that critical error occurs and the cell can not work at all. The break-down conditions described below;

- Robot Error
- Insertion error of all parts
- Conveyor error

- Repairment of cell
- impossibility of model change
- lack of all parts
- break-down of all feeder
- pause of cell working
- emergency stop

Cell error occurs when the cell can not work well but can carry out some insertion routines.

Error conditions are
- lack of parts
- break-down of feeder
- insertion failure, etc

4.4.4 Process Logic

This paper shows the strategy for design of S/W structure and design of process logic. This paper considered all of data and method described below for S/W design.
- Definition of information between PLC and PC.
- Definition if the data is the time critical or not.
- Definition of cell data and line process data.
- Definition of data for LAN information
- Definition of synchronization data
- Consideration of timing problems for line control.
- Definition of data for cell initialization.

5. CONCLUSION

This system solved several problems occured in the multi-PCB assembly robot line with real-time concept, and line control strategy is designed for flexibility and productivity so that the line has a good efficieccy.

This paper developed several important functions for assembly line described below;
- Function of real-time model change.
- Function of Diagnosis and treatments
- Function of real-time line control, management and production information analysis

These functions are integrated in this system and it shows good productivity and increases line efficiency.

Unit	Communication Method
PC - PC	Multi-Port With Serial Interface
PC - PLC	RS232C Optical Transfer Unit
PLC - PLC	Computer Link, DI/O
PC - Fact. Host	LAN Interface Unit

Table 1. Communication Method

Data of Production Information		
Total Station Information Data		Station #N Information Data
Time Data	Start Time of Line	No. of Input PCB
	End Time of Line	No. of PCB Error
	Duration Of Line	No. of PCB Completed
	Total Pause Time	Duration of Cell
	M T B F	Total Pause Time
	M T T R	Total No. of Ins. Parts
	Line Tact Time	Total No. of Fail. Parts
	Duration of Error	Good Parts Ins. Rate
Working Data	No. of Input PCB	M T B F
	No. of PCB Completed	M T T R
	No. of PCB Goal	No. of Error Occurs
	Line Productivity	Model Name
	Model Name	etc.
	No. of Error Occurs	

Table 2. Monitoring Data

Data of Control and Diagnosis		
Model Change	Diagnosis & Treatment	Status Control
Sel. Robot Prog.	Start Of Manual Cell	— Mode Selection
Sel. PLC Rou.	Redundent Conveyor Rou.	└── Operation
Initi. Ins. Para.	Diagnosis	— Stop
Conv. Wid. Control	Error Treatments	├ Pass
Robot Zero Ret.		└ Error
		Error Handling

Table 3. Control Data

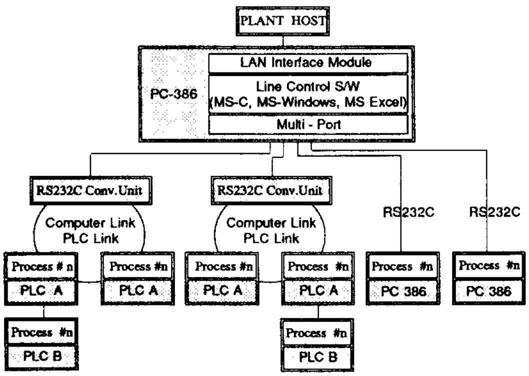

Fig 1. System Lay-out for Assembly Robot Line Control

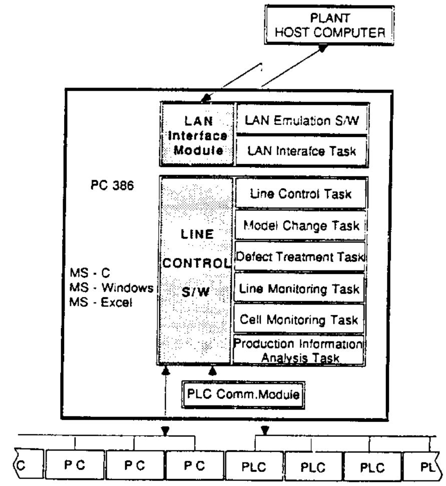

Fig 3. S/W Configuration for Assembly Robot Line Control

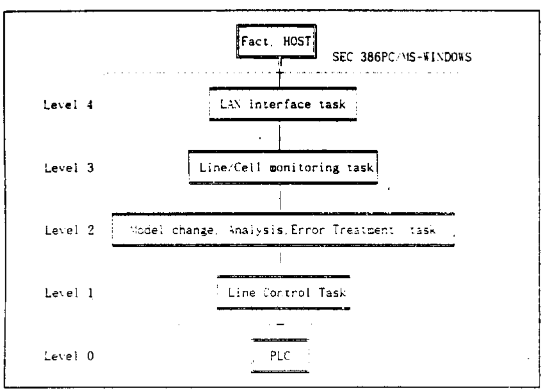

Fig 2. Definition of Task Level

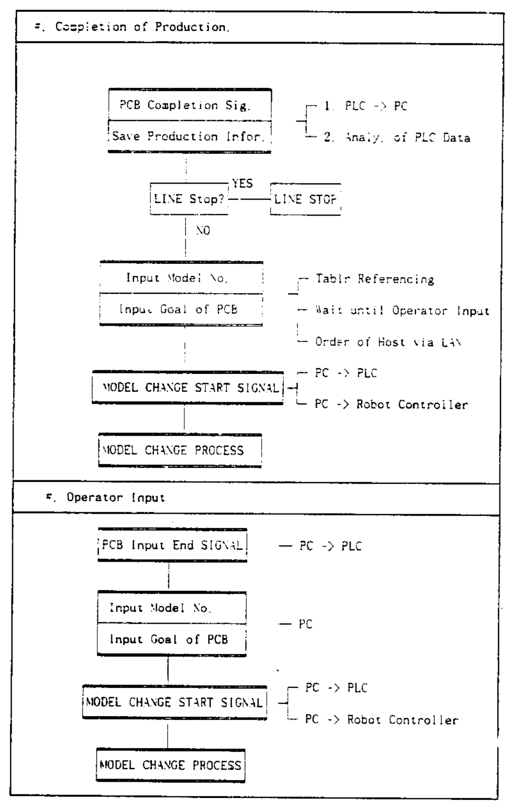

Fig 4. Model Change Issue Algorithm

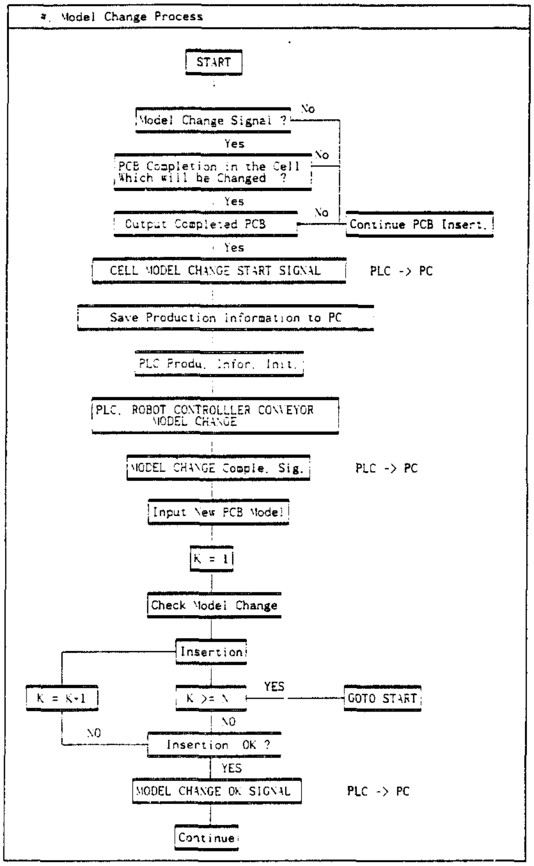

Fig 5. Model Change Algorithm