

# Automation Techniques in MIAS-PKA System

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*Abstract:* This paper presents a novel control approach, which is the fusion of techniques of factory automation/management and functions of hardware for computer communication. We also describe the communication techniques between computer and programmable logic controller based on special system protocols. The developed controller innovated prior knowledge from some files, is considered as guides for the relevant controller designers and programmers, and a reference on establishing practical database for intelligent agents and on communication tasks.

*Keywords:* Protocol, communication, controller, road surface, PLC, VBA.

## I. INTRODUCTION

Automatic control techniques are proposed for a control system that could be found more significance in establishment of social foundation for persons with visual impairment [1]. The aim of this research is to create experimental conditions changing experimental tactile road surface indicators for making ISO standardizations in this field [1].

This system is designed to create various experimental walking environments by substituting different road surfaces. A road surface has the weight about maximum 2000 kg, is 1200mm in width, 3900mm in length and a maximum height of 60mm. There are total ten road surfaces. Five of them are symmetric with respect to the long axis of their support in their stocks down the ground. Normally, nine of those road surfaces should be under the ground and only one is on the support as shown in Fig. 1.

To such a system, the control objects are the positions and motions of the support carrying assigned road surfaces. A demanded road surface should be taken from its stock, carried it to the assigned position with a maximum deviation of 10 millimeter in a slow constant speed. Or the current demanded surface is sent to its position in the stock, and a new assigned surface are taken, then the road surface is moved to a required position under or up the ground. So the controller should be capable of: a) taking a road surface from its stock and put it onto the support; b) or putting the road surface from the support into its stock, taking a new one and putting the new one onto the support, and then go to a experimental position in height; c) the support carries its road surface to a required height directly, down or up. In normal case, there always is one road surface on the support instead of empty it as shown in Fig. 1 (down) for safety.

The system construction is illustrated in Fig. 2. It mainly consists of: a host computer, a MELSEC-A<sup>1</sup>

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Fig. 1: Road surface and its support.

series programmable logic controllers (PLC) that central process units (CPU) is A<sub>3</sub>SHCPU, motors, link unit A1SJ71UC24-R2 (MIAS) [3], some relevant interface units and sensors.

The computer communicates with PLC through the link unit MIAS by RS-232C cable. Though every protocol will be different with various link units and PLCs, but the control principles presented here are useful to other systems. In this paper, we will give details about the unique approach that apply prior knowledge into automatic control (PKA), describe how to realize the communication between host computer and the main PLC through the MIAS.

The VBA (Visual Basic for Applications) is a powerful technique in factory automation and managements in kinds of fields [4]. It is innovated by us to develop the system controllers. This technique will bring us a new idea to build human knowledge data bases for ma-

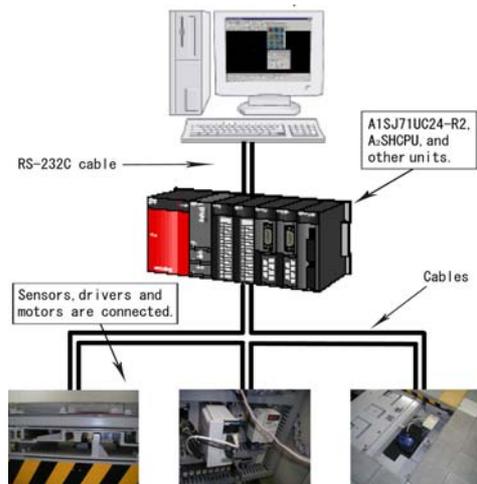


Fig. 2: Control system.

chines. In this system, we keep commands or knowledge in form of documents. The knowledge in these documents gives conditions of the experiments. The system works according to this knowledge to change road surfaces and adjust the positions. Also the results of experiments can be saved into the documents.

This paper is organized as follows. Next section introduces the precious works. In section 3 we describe the MIAS protocols and Section 4 presents the controllers. Section 5 analyses the working process. The conclusions are given in the last section.

## II. PRECIOUS WORKS

The road surfaces can be operated by control buttons on board in the distributing center shown in Fig. 1. The system has the ability of a maximum 10mm position error in height when designed. However, as a system, there are three problems are remained: the system is out of remote control and computer control; the operator's requirement to implement the experiments by the commands in some documents made in advance is impossible. These problems make us discuss the control techniques presented in this paper. The necessary mechanical and civil engineering have been finished [1], but out of the topics of this paper.

## III. MIAS PROTOCOL

As illustrated in Fig. 2, the connection between the host computer and the PLC is in so-called 1:1 way through the link unit A1SJ71UC24-R2. This link unit has its own special protocols, and its communication interface with the computer is RS-232C.

### A. Link unit

The link unit A1SJ71UC24-R2 is illustrated in Fig. 3. This unit takes advantages of: a) no special PLC programs are needed when commutation is required by

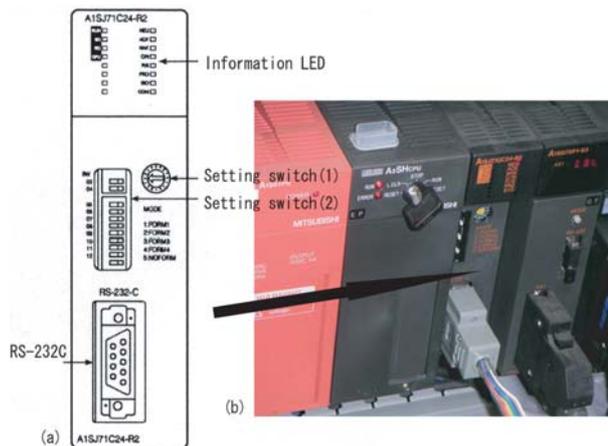


Fig. 3: Link unit A1SJ71UC24-R2.

the computer; b) A<sub>3</sub>SHCPU can also require communications; c) A<sub>3</sub>SHCPU send the requirement to link unit, and make the computer interpretation possible if necessary. It is necessary to set hardware of the link unit. These settings are by 12 switches and decide part of the system protocols. In Fig 3, *Setting switch (1)* gives the working model, which decides the length and construction of *data* in (1)-(4) in the section B; *Setting switch (2)* presents the transmission specifications by its 11 switches. Those states of the switches on the board are shown in Table 1, in which *station* (i.e. *station number*) is implied 00H.

Table 1: States of switches

model	station	transmission
4	00	10101101101

### B. Communication method

The system communication is in the form of *event driven*. In this system, signals including communication errors are feedbacked to the computer. The MSCOMM32 (MSCOMM32OCX) [2][5] techniques are used to transfer data and monitoring the system states. MSCOMM32 provides serial communications for applications by allowing the transmission and reception of data through a serial port where only a string of characters to the transmitting buffer is permitted. We use the MSCOMM32 technique as the control platform. The advantage of this selection will be low cost and make using knowledge documents written by *Microsoft Office* possible because the control codes are opened. Based on the MIAS protocols given in (1)-(5), the communication processes can be divided into the following two cases.

**Case 1** : the host computer reads the data from the PLC side. First, a command string should be sent to the link unit, which range of the address is indicated by the idem *data*.

For example, in order to read the data in the PLC from the dresses X40-X44 by *command*=BR with data type A, the hex code should be the 05303046464252415

Table 2: Control codes

signal	hex code	function
NUL	00H	NUL
STX	02H	Start of Text
ETX	03H	End of Text
ENQ	05H	Enquiry
ACK	06H	Acknowledge
NAK	15H	Negative Acknowledge
CR	0DH	Carriage Return
LF	0AH	Line Feed

830303430303534320D0A according to (1). The responses of PLC will be 0230304646303131303103453320D0A or 153030464630350D0A, which are corresponding to the normal and error cases based on the protocols (2) and (3) respectively.

$$\left( \begin{array}{l} ENQ \circ station\ number \circ computer\ number \\ \circ command \circ transmission \circ data \circ ETX \\ \circ detecting\ code \circ CR\ and\ LF\ codes \end{array} \right) \quad (1)$$

$$\left( \begin{array}{l} STX \circ station\ number \circ computer\ number \\ \circ data \circ ETX \circ detecting\ code \\ \circ CR\ and\ LF\ codes \end{array} \right) \quad (2)$$

$$\left( \begin{array}{l} NAK \circ station\ number \circ computer\ number \\ \circ error\ code \circ CR\ and\ LF\ codes \end{array} \right) \quad (3)$$

**Case 2** : the host computer sends commands to the PLC side. The command strings are similar to the Case 1 and they are based on (4) and (5).

$$\left( \begin{array}{l} ENQ \circ station\ number \circ computer\ number \\ \circ command \circ transmission \circ data \circ ETX \\ \circ detecting\ code \circ CR\ and\ LF\ codes \end{array} \right) \quad (4)$$

$$\left( \begin{array}{l} ACK \circ station\ number \circ computer\ number \\ \circ CR\ and\ LF\ codes \end{array} \right) \quad (5)$$

Both of the above cases in (1)-(5), we link codes by the symbol “o”. The *station number* is for the host computer to recognize the PLC’s numbers. The *computer number* is used to recognize different PLC users. The *command* gives “write/read”(W/R) and data unit “bit/byte”(B/W). The *transmission* is the necessary delayed time when communicating. The control data have A, B, and C three types with different data constructions. *checking code* sums the data values from *station number* to the end of *data*. In our system, the data type of the MIAS is C and 273 bits (included in address D100-D129) are used to communicate with the PLC devices.

#### IV. CONTROLLERS

The system is designed to work in selected or automatic control models. In the selected model, the control inputs are road surface positions and should be selected in a scene on the screen (Fig. 4) by an operator.



Fig. 4: Selected model controllers (in Japanese).

In the automatic model, commands and experimental conditions are listed on the screen by open an assigned file (Fig. 5).

#### A. Selected model

In the selected control model, the control processes are the following steps:

1. Check—To check whether there is a load on the support. If there is nothing on the support, the new position of a road surface in the stork should be selected firstly.
2. Give light messages—When the system is ready to start, a big signal lamp on the top of distributing center (Fig. 1) sparks.
3. Set—To set the height of the road surface over or down the ground.
4. Start—If a road surface is on the support, the position of this road surface in the stork has to be selected. The support sends the road surface to its home, take an assigned new one, and then carry the new one to a required height. Special sound will accompany the rotating motors for people’s attentions.
5. End—Turn off the sparks, stop the sound and wait for new commands.

#### B. Automatic model

In the fields of factory automation, the information is needed sometimes in the forms of various documents. These documents as prior knowledge can be in various databases. One of the techniques connecting documents and controllers is VBA. This section introduces the road surface VBA controller. In the system, VBA is used to implement the following tasks: allow the experiment commands be the form of EXCEL documents; the documents should be renewed by the latest on line information. Before an experiment, a document file should had been ready in an assigned format. The scene of controller is shown in Fig. 5. The operators can select one or more information rows in the table. In Fig. 5, the *results report* column will give the dates and times when experiments are finished.



Fig. 5: Automatic model controllers (in Japanese).

When *Start* begins, the computer sends/receives the commands, and the PLC takes/puts road surfaces. In this system, no extra software resources is needed except VBA.

## V. WORKING PROCESS

The experiments have shown that the height is controlled from -499mm to +499mm up/down the ground with a maximum error 10mm. The control objects road surfaces are taken, put or moved. The A<sub>3</sub>SHCPU is capable of scanning 64 circuits in 3.51ms. This is enough for the interruption control to manage this low speed road surface system. The system consists of the following states: a) adjusting the height of the support down and up at the present state; b) taking a road face and carried it to required position. If other road face has been on the support, the present road surface will be returned to its stork underground; c) several commands can be elected at the same times and these commands will be implemented sequentially by application of VBA techniques. There are three timing pulses affecting the motor's run/stop directly: a) the command of returning to the reference position; b) the command of stopping pause; c) the command of automatic starting. The timing chart Fig.6 illustrate the steps in a complete process. From step 1-3 the system check the support whether is on the original position, the control pulse is not sent unless the support on its original position. Without this permission pulse of 3, the system cannot be start. If system is ready as shown in the step 4, permitting signal will be sent and the signal will be ended according to the pulse in step 8. The system also can be paused and restarted in running. For more information on how to use the control method to transmit and receive binary data, please see the concerning articles in [5].

## VI. CONCLUSIONS

In the past years, we have developed a large efficient management system by using the opened control codes of WORD, EXCEL and ACCESS to link their documents and I/O interface for various applications on-site. We have extended these past works in this research, combined the techniques of communication,

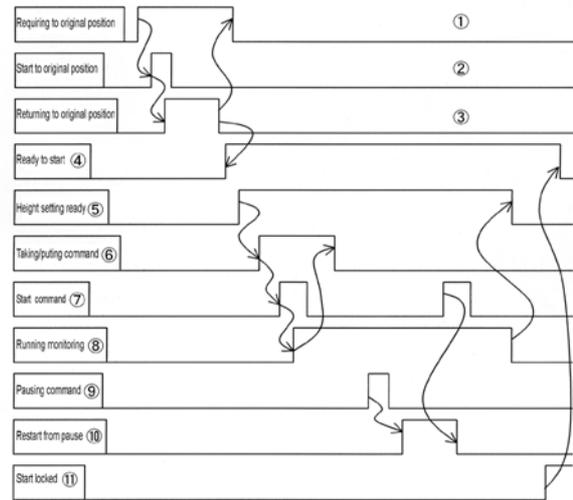


Fig. 6: Control signals. The step numbers are marked with circles.

programmable logic control, VBA, and formed the system controllers. This work realized the connection between computer and control object by very common software and components with reasonable cost. We also think the techniques described in this paper is very hopeful to those researches on series communication.

In this research, our prior knowledge is kept in the form of Excel document. In the automatic control model, the data are read from these Excel files and sent to the link unit. The on-line implement results of PLC are also written into the same file. The presented techniques are recommended as a reference on establishing practical database for intelligent agents, and on tasks of communication in peripheral interface controller and networks. These methods will also make easy the multi-sensor intelligent robot controls, and link a prior human knowledge database to the realize artificial intelligent systems.

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