Industrial Control Applications in Thailand: Electronic and Machinery Sectors

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ABSTRACT - This paper presents a comprehensive technology status review on the current situation of industrial control applications in Thailand. The review focuses on two main industries of the country, i.e. electronics and machinery. It acquires insight of applications to explore the underlying technology. The findings reveal that there is great interest and effort in utilizing control approach to solve industrial problems in both industries. Rapid growth of control applications is driven by the microprocessor-embedded system technology, which is very cost-effective, user-friendly, and available worldwide. Furthermore, recent trends of control system technology that would be relevant to future industrial needs are analyzed.

KEY WORDS - survey, control system technology, industrial control applications, manufacturing automation, embedded system technology.

1. Introduction

Since an economics recession occurred in Thailand, most of private sector in the country has been losing international competitiveness due to declining productivity and rising cost of production [1]. According to industrial restructuring plan recommended by the ministry of industry, Thailand should enhance the industrial productivity. One approach is increasing technological capability in strategic industries and related supporting ones. To support this national policy, both public and private sectors have initiated many research and technology projects with focuses on all strategic areas [2~4].

This paper examines current status and trends of industrial control applications in Thailand. The scope of investigation will focus on electronic and machinery sectors. The outline of this paper is as follows: First, we will describe the characteristics of both industries. Then we will highlight the roles of control engineering, especially in alleviating level of product and process technology in both industries. These roles will be subsequently elaborates in details by using industrial applications as examples.

2. Electronics Industry

For almost half of the last century, electronic industry has long been an important productive sector in the Thai economy. Electronics Industry is not only the largest industry in Thailand measure by export value, but also very strong manufacturing base [5]. One of the most active R&D areas in the country today is that of electronics. The reason is clear: a high technological capacity to generate or to utilize electronic technology is one of the keys to core competency of the industry.

Since the last decade, there were significant changes in market requirements leading to local design and development needs in this industry sector. Most of control applications appear in two areas; power conversion and motor drive, which are of relevance to the Thai industry.

In power conversion, pulse-width modulation(PWM) converter technology has been already popular in Thai electronic industry since it supports various kinds of industrial applications such as switching power supply, battery charging, welding and uninterruptible power supply(UPS); e.g., see Fig. 1. Specifically, PWM methods under voltage or current feedback control are utilized to realize the desired output waveform in spite of load variation and measurement noise. The corresponding control techniques widely used in this area are

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proportional-integral-derivative(PID) control and lead-lag compensation. For instance, PI control with current feedback has been successfully applied to high-performance electronic welder [6]. The control system are shown in Fig. 2. Moreover, this classical feedback technique can be applied to improve performance of photovoltaic power conditioning system as well; see Fig. 3 [7] [8].

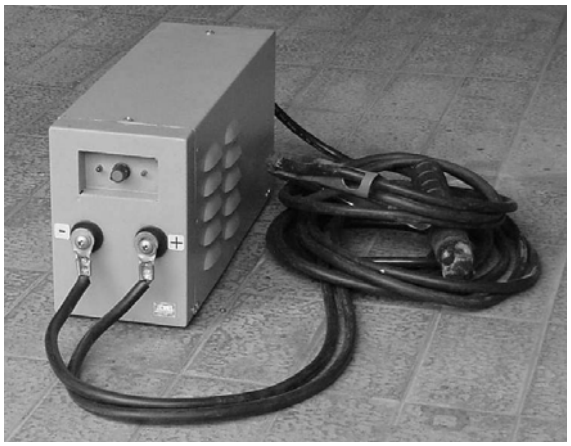

Figure 1. NECTEC Electronic Welder

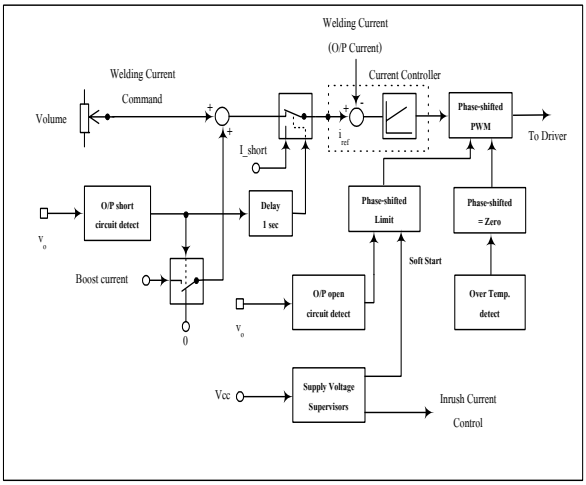

Figure 2. Control Block Diagram

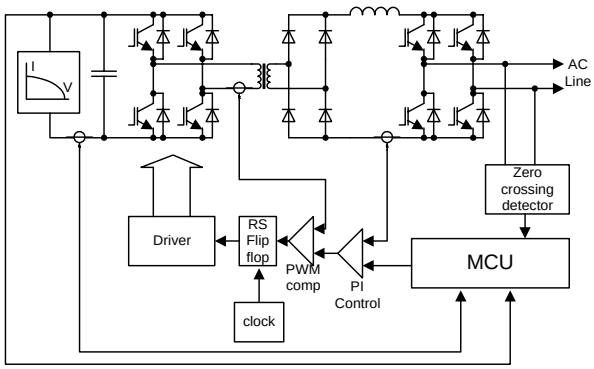

Figure 3. Photovoltaic Power Conditioning System

The more complex application is motor drive control. Besides the drive output feedback, it is found that the motion output such as position or speed should be fed back to achieve better control performance and higher reliability. Fig. 4 shows some industrial applications in DC and AC drives [9][10]. Especially, flux vector control can be well applied to both induction and synchronous motors. Incremental encoder is satisfactory for the induction motor control, whereas absolute shaft position sensor is required for the synchronous one [11][12]. Control approach is mainly PID with additional compensation to cope with nonlinear dynamics of motor. In addition, controller implementation is based on microprocessor-embedded system.

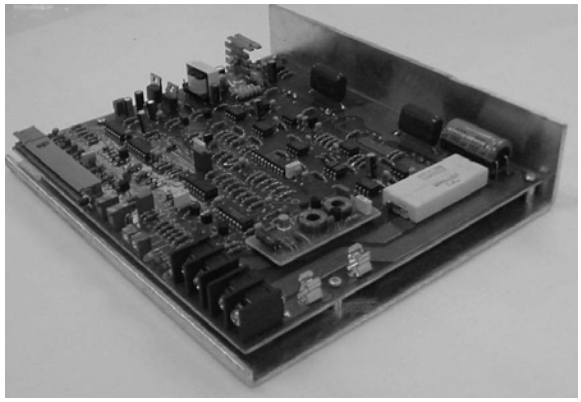

Figure 4(a). NECTEC DC Servo Drive

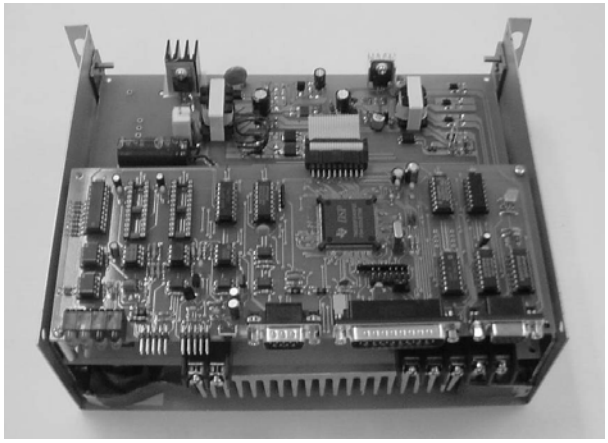

Figure 4(b). NECTEC AC Servo Drive

For further application with increasing market trend, motion-sensorless AC drive control would be relevant for Thai industry to reduce sensor cost. A key issue underlying this application is how to design and implement observer-based control system in presence of high-frequency dynamics. At present, considerable amounts of research and development are in progress in this area; e.g., see [11][13][14]. Digital signal processor(DSP) based control would share significant contribution in near future.

3. Machinery Industry

Thai machinery industry started as small-and-medium enterprises more than 30 years ago. Rapid demand growth of machinery happened in last two decades; board of investment of Thailand has committed to support and promote investment in manufacturing industry sectors. Hence the related supporting industry, including precision machinery and machine tool, have gradually expanded. Most of in-demand industrial applications are motion control with focus on computer-controlled machines for manufacturing automation. We therefore categorize the motion control applications into two areas; point-to-point motion control and continuous motion control.

Point-to-point motion control is used not only in general-purpose tasks such as pick-and-place processes, but also in specific ones in conjunction with event synchronization. Fig. 5 shows some recent control applications such as leather stitching of which control is of PID type. In addition, an event synchronizer is installed so that the controlled motion of work piece appropriately synchronizes up-and-down movement of the needle.

Figure 5. Leather Stitching Machine

Figure 6. Surface Grinding Machine

On the other hand, continuous motion control is normally used in processes, which requires the motion output to follow desired trajectory. In Addition to conventional PID motion controller for each axis, more complicated trajectory generation and trajectory following control are required. This concept has been proven with satisfactory results in several applications including surface grinding, plasma cutting, and milling, e.g., see Fig. 6.

For multi-axis machines, the resulting controller is generally in form of two-level structure. Specifically, high-level control handles man-machine interface while the low-level one handles multi-axis motion control. Most of the low-level controllers are decentralized. It is also found that motion controllers widely used in Thai industry are microprocessor-embedded systems, and hence digital. For example, a motion controller developed by NECTEC is DSP-based system, as shown in Fig. 7. The control technique available for each axis is PID or PI with velocity

feedforward. Another example is control of automatic lapping process to produce high-precision magnetic headers of hard disk drives; as shown in Fig.8. The control algorithm is developed by Institute of Field Robotics Development (FIBO), King Mongkut's University of Technology [15].

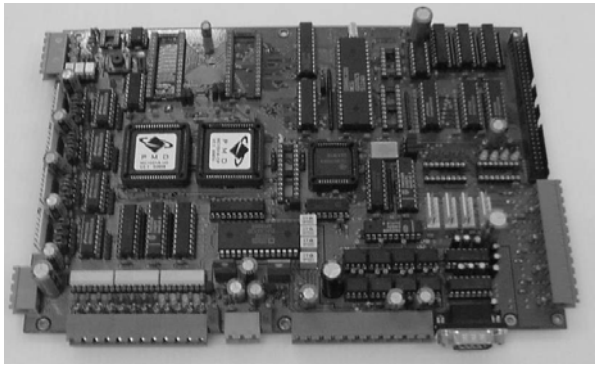

Figure 7. Multi-Axis Motion Controller

Figure 8. Automatic Lapping Machine

As a present trend, it appears that the concept of open system and standard are going to be popular in machinery industry because it increases interoperability as well as business opportunity. It is also expected that with further research in mechatronic system control, along with the evolution of high-speed and multifunctional microprocessors, digital motion controller will find the larger marketplace in this industry.

4. Conclusions

For years, control system technology has involved both new invention and improvement in Thailand. It is shown that microprocessor-based control technology become applicable in the fields of electronics and machinery industries. One reason behind this would be the recognition that control engineering can alleviate technological capability level, which is one of the core competitiveness of those industries. Another reason is that recent availability of reasonable cost-performance DSP's, RISC processors, and ASIC chips have supported the control engineers to solve their own problems with shorter time-to-market and more suitable to industrial needs.

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