Automation and Robotics in Construction XII
E.Budny, A.McCrea, K.Szymanski (Editors)

MICROCOMPUTER CONTROLLED TEST STAND FOR BACKHOE EXCAVATOR

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Abstract

This paper describes the mechanical equipment, hydraulic and measuring system for the microcomputer controlled test stand for backhoe excavator. Stand has been developed in Institue of Heavy Machinery Engineering. The paper also presents main features of hardware and software of the on-board system.

1. INTRODUCTION

The improvement of working conditions, safety of the machine and machine utilisation through the optimization and automation of the operational sequences are the major requirements for heavy machines founded in construction, agriculture, forestry and mining. Since 1985 the Institute of Heavy Machinery Engineering had supervised several projects concerning heavy machine's diagnostics, computer controlled measuring system and automatic control of working equipment moments (including optimization according to several criteria). The computerized operator assistant system (HMOAS) has been implemented on a K611 backhoe excavator [1]. As a result of current research program the microcomputer controlled stand for backhoe excavator was developed.

The stand allows for: (i) automation of working equipment movement, (ii) automatic control of the hydraulic system, (iii) automatic control of the Diesel engine, (iv) investigations for optimal working tool trajectory and (v) data acquisition for research purposes. The hardware and software of the system which has been implemented to control the test stand has been developed in the Institute of Computer Science at the Warsaw University of Technology.

2. DESCRIPTION OF TEST STAND

2.1 Machinery

The test stand is based on K121 mini-excavator from Bumar-Excavators. Almost complete mini-excavator has been implemented except the driving axes, wheels and cub Fig.1. Additionally the test stand is equipped with soil container.

The stand was designed in 3D-CAD system what makes that the verification of construction (for example collision between the working equipment of excavator and the other parts of test stand) can be done much faster.

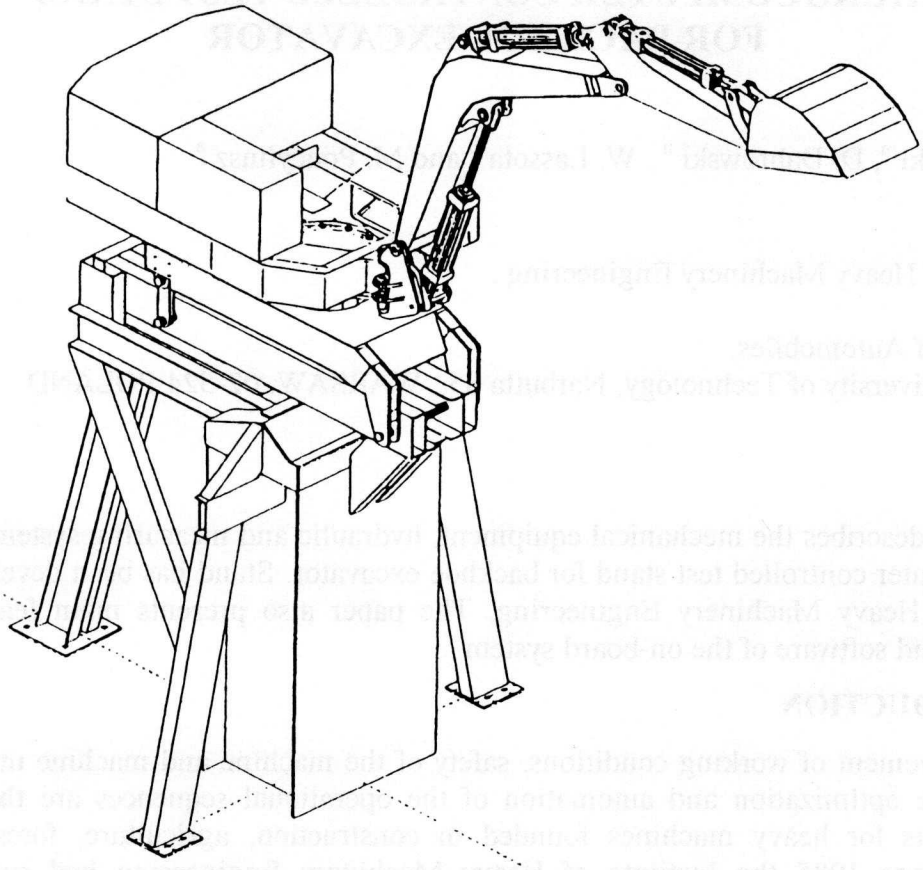

Fig. 1. The view of test stand machinery.

2.2 Description of the System

The hydraulic system of the mini-excavator was completely redesigned. It has been equipped with variable delivery multi-piston pump. The hydraulic cylinders of the working equipment and swing motor are controlled by proportional valves with internal feedback from the slider position. The main structure of hydraulic system is performed in Fig. 2.

System employs the sensors and actuators. Sensors can be divided into two sub-sets:

1. Diagnostic sensors used for monitoring of technical state of the machine. This group includes binary and analogue sensors.

2. Sensors for measuring working equipment position and forces acting on the excavator cutting tool:

- ultrasonic displacement sensors inside of each of the hydraulic cylinder rods drive the equipment.

- force sensors the strain-gauge bridges built in hydraulic cylinders ears each of them coupled with an amplifier/voltage converter reduce the noise influence on a measurement.

- pressure sensors are mounted in hydraulic system .

- dual axis clinometer positions the machine on the slope.

Actuators can be also divided into two sub-sets:

1. Amplifiers for hydraulic valves and variable delivery pump.

2. Controller of engine governor.

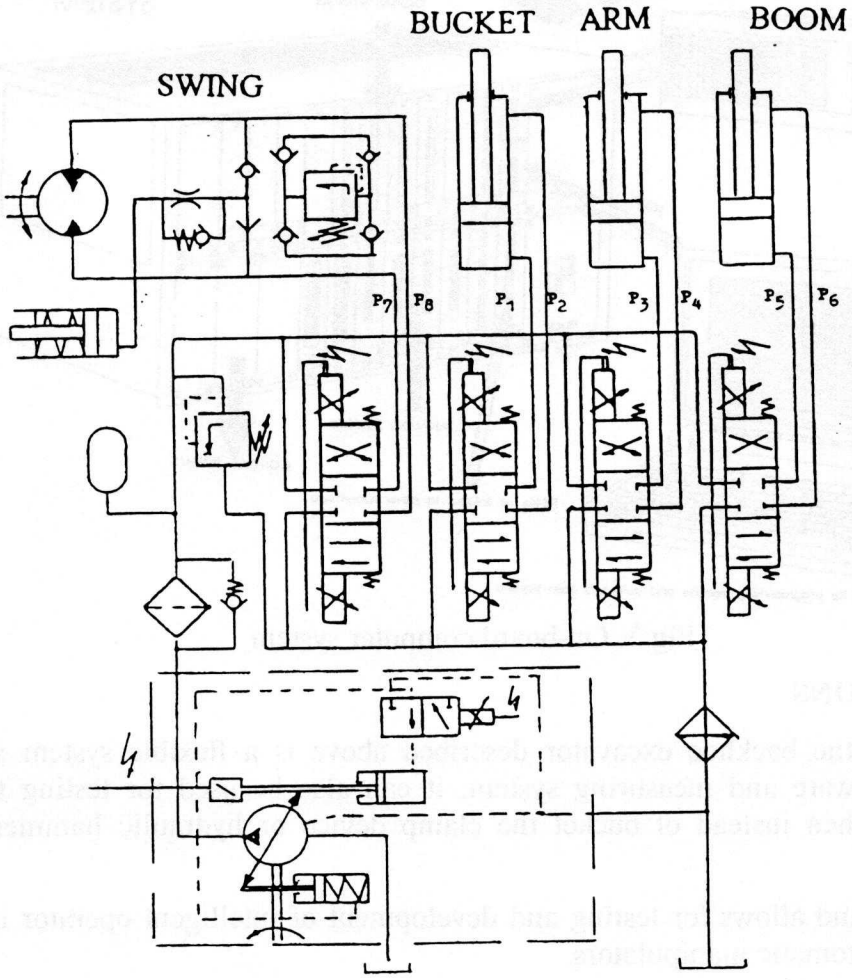

Fig. 2. Hydraulic system of the test stand excavator.

2.3 On-board computer system

The outline of system's hardware, discussed in [2] is shown in Fig. 3. System was based on single VME -Bus. System contains two processors 68EC030 and 68882 FPCP. The massive storage is necessary to provide the data collection. The floppy and hard disks could not to be accepted considering the vibrations occurring on board of the machine.

They were substituted by the virtual disks (battery backed up SRAM and EEPROM/Flash on the separate module and as solid state diskette using PCMCIA interface). Apart from the on-board computer, a separate engine controller is linked to the system. Its main task is to stabilise the engine's rpm according to orders received via serial interface.

The small programmable terminal was applied as operator's console. The whole system is controlled by OS-9/68k v.2.4. real time operating system. Programs describing individual processes were written in C and compiled with v.3.2 C-Compiler and Ultra-C v. 1.1. All programs as well as the operational system itself are stored in the EPROM.

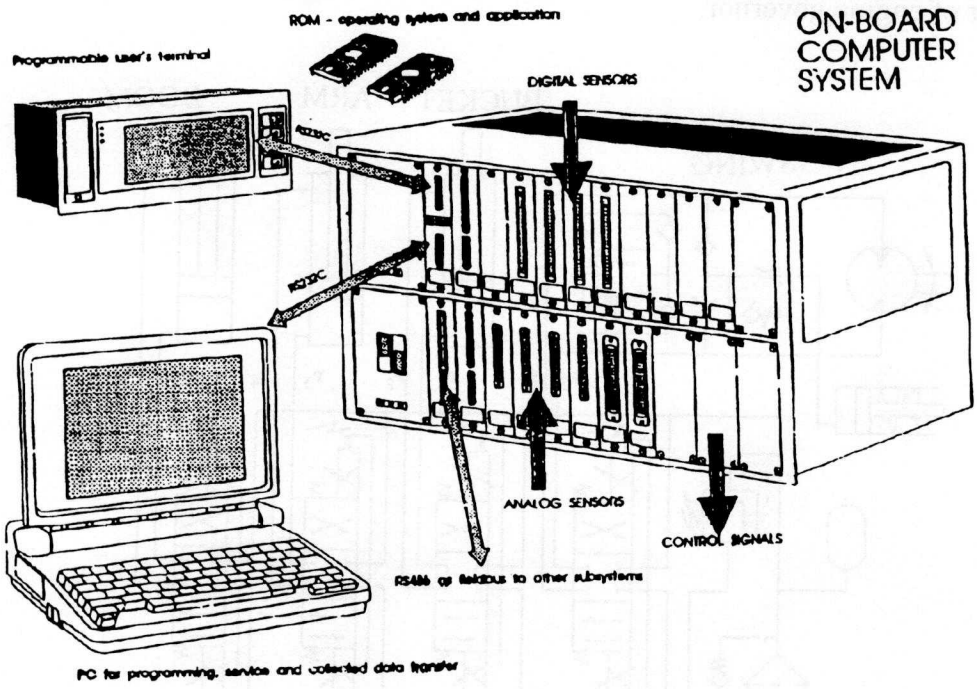

Fig 3. On-board computer system

4. CONCLUSIONS

Test stand for the backhoe excavator described above is a flexible system and after changes of software and measuring system, it can also be used for testing the other manipulators when instead of bucket the clamp device or hydraulic hammer will be mounted.

Also the test stand allows for testing and development of intelligent operator interfaces for advanced automatic manipulators.

5. References

[1] Dabrowski D., Dobrowolski H., Poncyliusz M., Selenta A., Szlagowski J.,: The communication within heavy machine operator assistant system (HMOAS).,Proc. of 11th Int. Symposium on Automation and Robotics in Construction. Brighton 1994.

[2] Dobrowolski H. : Architecture of On-Board System for Heavy-Machines.(in polish), Proc. VI Conf. The Development of Basic Principles of Designing, Exploitation and Investigations of Heavy Working Machines. Zakopane 1993.