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Nonlinear correction of bilateral remote control systems within a mobile robot pipeline

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Abstract

We consider the problems of non-linear correction efforts reflection channels and position control systems, two-way position-force control of the mobile robot movement in the pipeline with variable geometry.

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Keywords: bilateral; teleoperation; compensation; control; nonlinear; force control; position-force control; robot; structure; variable-structure.

One of the directions of development of modern robotics and mechatronics - development of mobile robots (MR) for the technical diagnosis of the state, non-destructive inspection and repair work inside the pipeline system. Construction ICBMs significantly different from the structure of manipulation robots. Generalized MR structure consists of four main parts (Figure 1.)

- mechanical device (propeller), which is the final link in a working body - the wheel module (WM) or other type of device movement;
- unit drives including power converters and actuators engines;
- computer control unit which receives the input of a human operator command or control upper level computer;
- information device with a sensor-slip designed to receive and transmit data to the computer controller of the real movement of the MR and the actual state of its subsystems.

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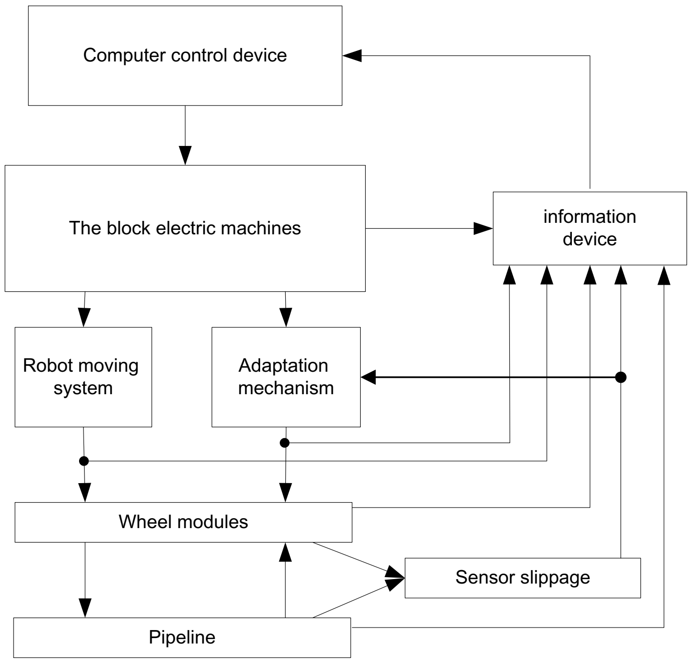

Fig. 1. Generalized structure of mobile robots pipeline.

MR moving in different splitters and tees pipeline divided into robots with the hinge system of movement and robots with a 3-pin, radial kinematics and differential control. To create the desired value of the normal force of reaction of the pipeline surface at the contact point with the CM used passive or active mechanisms for adapting compression of the works[1-3].

Transport device MR is seen as a mechanical multi-section 9-wheel system with superimposed holonomic and nonholonomic (conditional) one-way links (Figure 2). Control of such a system in traffic conditions unset surface of the pipeline makes it necessary to force-torque sensitization and implementation of bilateral remote position-force control (PFC)[4,5].

In terms of implementation of the FPC systems are classified into one system - (OSO) and bilateral (BSO) operations with automatic, remote and automatic control remotely. For OSO systems are command systems, copiers and semi-automatic control without reflection forces. As a master device (MD) are used, respectively, special remote panel, anthropomorphic memory, cinematically like IU and control handle equipped with devices forming the reference signal: $F_0, S_0, \dot{S}_0$; S_0; or $\dot{S}_0$; F_0; and*I* or ($S_0, \dot{S}_0$), etc. Feedbacks in the system are organized on the situation (S_{oc}), speed ($\dot{S}_{oc}$) and power (F_{oc}).

By the BSO system (SBSO) are two-channel system with different types of reflection forces agent who carries out copying, semi-automatic or remote control of the MR[6]. All varieties SBSO divided into symmetric and asymmetric systems. At the core are symmetrical SBSO actuators (EM) with the main positional feedback, located both in MD and on the EU. The asymmetrical SBSO direct switching position EP are located on the EU and the main EP feedback on time - on MD.

Thus, a remote control system ought to MBR with ample flexibility (dexterity) in performing one class of tasks or steps, and to lock it into doing one job or a limited variety of jobs in other class of tasks or steps. It is not always possible to achieve these goals with dynamic compensation based on linear compensators. A need therefore arises to resort to nonlinear compensation based on nonlinear four-terminal networks, nonlinear control laws, and nonlinear devices which comprise the unvarying part of the system.