December 1973 B73-10496

NASA TECH BRIEF

Ames Research Center

Master/Slave Manipulator System

The problem:

To provide an anthropomorphic master/slave manipulator system with capabilities equivalent to the mobility, dexterity, and strength of the human arm.

The solution:

Combine an arrangement of torque motor, harmonic drive, and potentiometer which allows all power and control leads to pass through the center of the slave with a position-transducer arrangement of the master, and incorporate a "stovepipe joint" for manipulator applications.

How it's done:

The manipulator system is based on acquiring planar motion at arm joints (shoulder, elbow, wrist) by the utilization of "stovepipe joints" (see Note 1), that is, conical wedge sections which rotate on bearings. Since all motions of the slave are resolved only into rotational movements of the joint elements, simple rotary electromechanical drives are used; each drive consists of a dc torque motor (100, 55, 28 in-oz) coupled to a special harmonic drive with a gear ratio of 160:1. Position reference for the joint elements is provided by a positive transducer located internal to the drive system. The motor shafts and the wave-generator couplings are hollow so that all power and control leads can pass through the center of the arm, thus eliminating the need for large loops or slip rings.

Because of the geometry and kinematics of the stovepipe joint, a mechanical advantage approaching infinity can be realized depending on joint position. For example, at an elbow joint flexion (typical of shoulder and wrist also) at the maximum range of motion (80° included angle), all rotational axes of the drive mechanisms are coplanar. Since the load is carried by drive bearings, no motor power is required to hold a load in this position; therefore, the lift or load capability of the system depends on arm and joint position.

Four modes for operation of the manipulator system are provided: manual (each station on the slave can be moved independently from a control console), master/slave, tape control, and computer control.

Notes:

1. The pseudoconic stovepipe joint is described in NASA Tech Brief B72-10297; see also U.S. Patent 3,636,564.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP 73-10496

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

NASA Patent Counsel
Mail Code 200-11A
Ames Research Center
Moffett Field, California 94035

Source: Hubert C. Vykukal, Reginald F. King, and Wilbur C. Vallotton of Ames Research Center (ARC-10756)

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