

ABSTRACT

Anthropomorphic arm is similar to a human arm with respect to the number and position of the joints. The unit is small, light, and easy to transport. It is usable in any orientation and is inexpensive. Master rig is fitted to the user's arm it is possible to easily control an anthropomorphic robotic arm. The force being exerted by the arm is measured and fed back to the user who is operating the master. The Wireless Communications and Control Module (WCCM) of robot controller need to design with project portability in mind. The proposed master control unit is cost effective and will have wide-ranging applications in the fields of medicine, manufacturing, security, extreme environment, entertainment, and remotely operated vehicle teleoperation in undersea recovery or extraterrestrial exploration vehicle. To carry out automated service tasks at different places within large working environments, a robot system able to navigate autonomously and to execute commanded manipulation tasks is needed.

KEYWORDS: Dynamaid, sensors, anthropomorphic, drives, robot, controller.

INTRODUCTION

Domestic tasks require three main skills from autonomous robots: robust navigation, object manipulation, and intuitive communication with the users. Robust navigation requires a map of the home, navigational sensors, such as laser-range scanners, and a mobile base that is small enough to move through the narrow passages found in domestic environments. At the same time, the base must have a large enough support area to allow for a human-like robot height, which is necessary for both object manipulation and for face-to-face communication with the users. To detect and recognize such objects the robot needs appropriate sensors like laser range finders and cameras. Intuitive communication with the users requires the combination of multiple modalities, such as speech, gestures, mimics, and body language.

HARDWARE DESIGN

Anthropomorphic Robot design on low weight, sleek appearance, and high movability. These are important features for a robot that interacts with people in daily life. With its omnidirectional driving and human-like reaching capabilities, Dynamaid is able to perform a wide variety of mobile manipulation tasks. Its humanoid upper body supports natural interaction with human users.

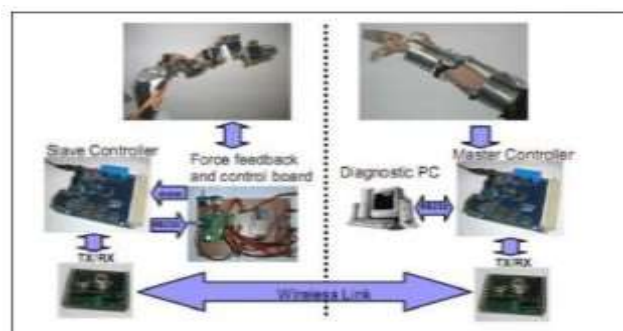


Figure 1 shows wireless link hardware design structure

OMNIDIRECTIONAL DRIVE

Mobile base consists of four individually steerable differential drives, which are attached to corners of a rectangular frames of light-weight aluminum sections. Pair of wheels is connected to the frame with a Robotics Dynamixel RX-64 actuator, which can measure the heading angle, and which is also used to control the steering angle. The actuators report back position, speed, load, temperature, etc. The main computer system communicates over the process with the microcontroller. It implements omnidirectional driving by controlling the linear velocities and orientations of the differential drives. For navigation purposes, the base is equipped with a SICK S300 laser range finder. It provides distance measurements of up to 30m in an angular field-of-view of 270°. The standard deviation of a measurement is approximate 8mm. Two ultrasonic distance sensors cover the blind spot in the back of the robot.

ANTHROPOMORPHIC UPPER BODY

Dynamaid's upper body consists of two anthropomorphic arms, a movable head, and an actuated trunk. All joints are also driven by Dynamixel actuators. Each arm has five joints. Each arm is equipped with a 2 degree of freedom (DOF) gripper. From trunk to gripper an arm consists of a 3 DOF shoulder, an 1 DOF elbow, and a 3 DOF wrist joint. EX-106 servos actuate the shoulder roll, the shoulder yaw, and the elbow pitch joint. The wrist consists of RX-64 actuators. All servos connect via a serial RS-485 bus to an Atmel Atmega128 microcontroller which forwards joint configurations like target joint angles, maximum torque, and target velocity from the main computer to the actuators. Another sensor in the wrist perceives objects inside the hand. Finally, one sensor is attached at the tip of each finger. In the trunk, URG-04LX laser range finder sensor is mounted on a RX-28 actuator to twist the sensor around its roll axis which is very useful to detect objects in the horizontal and in the vertical plane. The trunk is additionally equipped with two joints. One trunk actuator can lift the entire upper body. The head of Dynamaid consists of a white human face mask, a directional microphone, a time-of-flight camera, and a stereo camera on a pan-tilt neck built from 2 Dynamixel RX-64 actuators. The stereo camera consists of two PointGrey Flea2-13S2C-C color cameras with a maximum resolution of 1280x960 pixels. A MESA Swiss-Ranger SR4000 camera is located between the two stereo cameras, it measures distance to objects. The design of arm's components has been done by using 3D-CAD software to optimize the integration of mechanical and electronic elements. The geometries of all mechanical parts were shaped using AutoCAD and Solid-Works 3D mechanical design software.

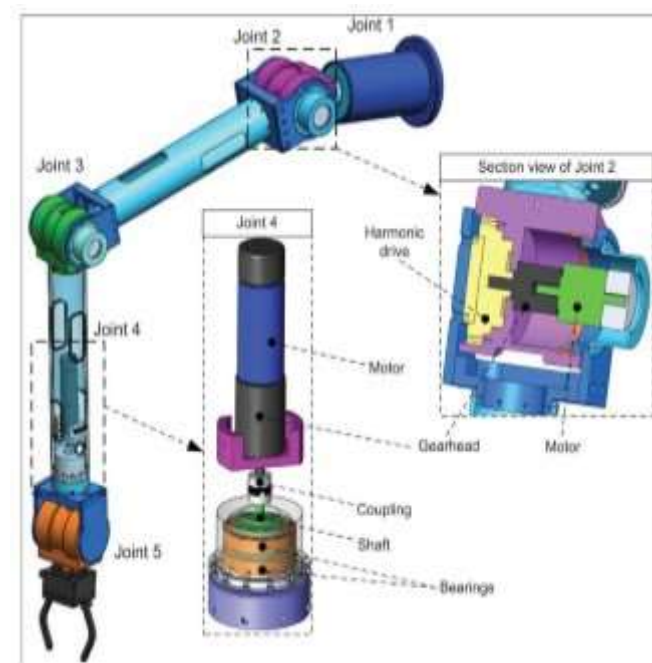


Figure 2 shows kinematics of upper body

REDUCTORS, MOTORS AND BRAKES

A Lightweight harmonic drive gear has been used in every joint, for a very good output torque-to-weight ratio. This type of gear gives us excellent features, allowing us to achieve stable, reliable and robust movement.

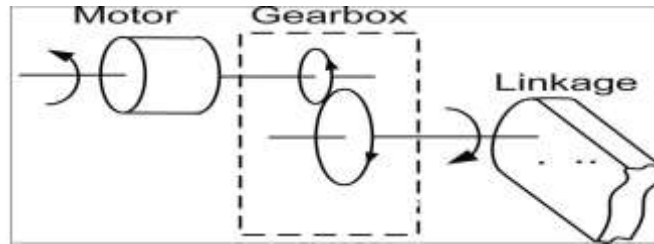


Figure 3 Shows Motor – Gearbox and Linkage Assembly

INTERNAL CABLING

All electronic components and the wiring needed for operating the system are integrated into the closed links arm structure; no external circuits or cables are needed any more. This is especially important for service robots, which should be able to manipulate in obstructed environments. The tubular and closed link structure, built in carbon fiber, allow lodging all the power and control cables in a safe and clean way. As the lightweight robot does not consume much energy, small cables can be used.

BEHAVIOR CONTROL ARCHITECTURE

Domestic service tasks require highly complex coordination of actuation and sensing. The control modules are organized in four layers -

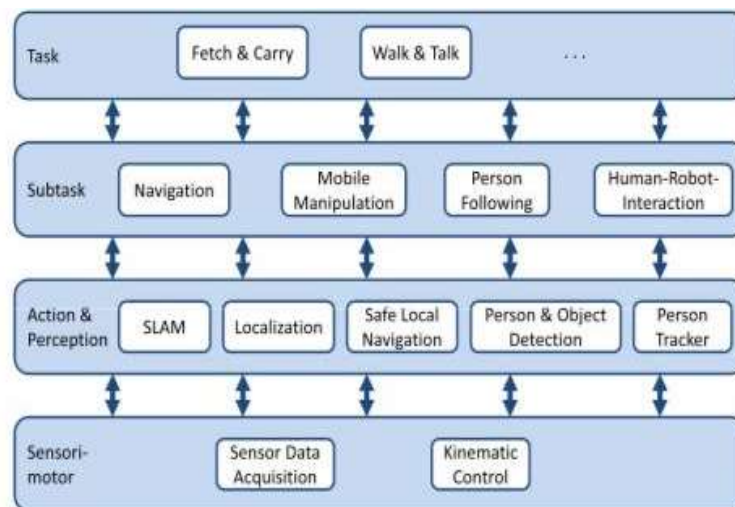


Figure 4 shows control modules behaviour architecture

On the *sensorimotor layer*, data is acquired from the sensors and position targets are generated and sent to the actuating hardware components.

The *action -and-perception layer* contains modules for person and object perception, safe local navigation, localization, and mapping. These modules use sensorimotor skills to achieve reactive action and they process sensory information to perceive the state of the environment.

Modules on the *subtask layer* coordinate sensorimotor skills, reactive action, and environment perception to achieve higher-level actions like mobile manipulation, navigation, and human-robot-interaction.

Finally, at the *task layer* the subtasks are further combined to solve complex tasks that require navigation, mobile manipulation, and human-robot-interaction

LIMITATIONS

Industrial manipulators that are heavy are not in any case adequate candidates for this kind of robot. There are some important issues to bear in mind:

1. System autonomy is limited because of the excessive weight of the manipulator and its industrial controller, which require high power consumption.
2. Mobile manipulator stability depends heavily on weight distribution. The weight of the manipulator and its controller lead to an unstable system, due to its relatively high center of gravity.
3. A closed controller for a commercial manipulator system leads to problems for communication and real time software control.
4. To operate in today's environments as service robots, the manipulator robot must coexist with humans. Thus, safety issues need to be carefully considered.

FUTURE OUTLOOK

The convergence of technologies involving computing, communication, and intelligent interfaces with autonomous robotics suggests that networks of intelligent, autonomous robots may become the next disruptive technology.

The concept of networking everyday objects and appliances in an ambient intelligent environment is not new. But the focus has usually been on the creation, delivery, and sharing of information, and not on the performance of physical tasks.

Autonomous mobile robots may one day perform complex medical procedures, including surgery, on patients in dangerous or remote locations from battlefields to space, with little human guidance. Advances in miniaturization and bio-nano-technology could lead to a new generation of nano-robots, which would revolutionize the medical industry. Nano-bots may provide treatment at the cellular level, perhaps clearing clogged arteries, repairing genes, battling cancer cells, and delivering drugs.

Cognitive robots can become available as office helpers or as robotic companions for guiding the blind and assisting the elderly. General-purpose anthropomorphic robots, with human-like hands, can be used in transforming manufacturing from resource-intensive to knowledge-intensive, and creating totally unmanned factories. Agricultural robotic scouts may roam the fields of the future to care for the plants, use sensors to provide detailed real-time information about the status of the crop, and apply data fusion techniques for making management decisions

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