A brief survey on research test bench robots

Introduction

Though theoretically we develop system equations and design controllers the bottle neck is really in the hardware implementation of these algorithms. Technically speaking for a conventional manipulator the desired motion is achieved by controlling the motor. Motor control is a separate area of research in itself working on the deriving desired output precision and accuracy for a given input typically by controlling the armature current or voltage. Ideally we would want to get hold of torque control of a motor as the control algorithm in terms of torque is much simpler to obtain from the equations of motion formulated. But implementing the same by controlling current is a much tougher problem. Typically multiple loops of PID are used for motor control. But the aim of this brief report is to examine the higher level control or the control the end user is allowed to work with from the range of robots. The robot market is not limited by the following robots but they are a mere representation of various classes available. The discussion of payload is skipped in this report.

Industrial robots

The typical control strategy for an industrial robot given to the end user is position control (It should rather be called planner than a controller as we do not control it throughout the motion). The user can specify a set of way points and the controller plans the path and executes it with the required speed in a given time. Position control is much easier for a non-technical person to work with than an abstract torque control. For most of the industrial applications this strategy might be sufficient. This reason for this limitation can be attributed to safety of the robot and the worker. Demanding higher torques might result in the failure of the motor itself or might end up causing damage to the worker, property or the robot itself.
Once the required position to be reached is given to the robot, the controller plans its path and calculates the input torques (current) required throughout the motion and executes the path. Once neither tamper with the torques directly or get hold of the data from the robot. The only input and output available is the Cartesian coordinate of the end-effector and the joint angle values.
Ex. KUKA, ABB, FANUC, Yaskawa etc.

Commercial robots

Lynxmotion[1]: This is a cheap desktop robot for simple applications and educational instructions and experimentation. This represents the class of all DIY and cheap robots.
Cost: $370
DoF: 6
Motors and Control:

They are fitted with servo motors similar to the micro-servo motors. They can be controlled for desired configuration and also for the duration of execution of tasks. The mode of control of these motors is by sending a PWM pulse to the motor which range from 0.75ms-2.25ms. Thus this gives position control and the command time step.
Remarks: The control is very noisy and shouldn't be used for precision applications. The arm does not have any sensors attached to it and nothing about the joint angles (for feedback) can be found directly.
Communication and simulation can be done via ROS.
Research: [8]
Input: Image of the environment
Remarks: Worked in real world and implementation shown

Kinova MICO arm[2]: This is one of the most popular robots among the research community. This 6 DoF robot is lighter and easy to work with than the bulky industrial counterparts.
Motors and Control: Custom motors called K75+ and K58 which allow of position, velocity and torque control capabilities. The actuators are also equipped with sensing of temperature, position, velocity, torque and acceleration.
Weight: 4.6kg
Cost: ~$50,000
Reach: 700mm
Remarks: This aims at the collaborative robot market space. Having a low payload of 2.1kg and flexible control strategies it is apt for research labs for experimentation and testing.
It is compatible with simulation softwares like Gazebo and V-rep and can be communicated via ROS.
Research:[9]
Input: Image of the environment
Remarks: They were able to show real results. They also transfered policy from simulation to real world.

Baxter[3]: It is a collaborative robot from Rethink Robotics suited for warehouse applications. This is a double arm architecture robot with 7 DoF per arm.
Motors and Control: Series elastic motors and the control is limited to position control* and it has force sensing capabilities required from a collaborative robot.
Weight: ~140kg
Reach: 1210mm
Remarks: This robot is one of the first ones to enter the collaborative robot market space.
*not from an authentic source
Research:[10]

Input: Image of the environment
Remarks: They have mentioned that their work is based only one position control and real world applications would required much complex control algorithms using velocity and torque control.

KUKA LBR iiwa[4]: This is from KUKA's collaborative robot line of products and is used widely for research.
Motors and Control: The robot motors are industry grade (suspected to be either Kollmorgen or Siemens)
Weight: 3-10 kg
Reach: 800-820 mm
Remarks: Since it comes with a wide range of sensing capabilities it is a nice platform to work on human-robot collaboration.
Research:[11]
Input: Consists of joint angle position
Remarks: The algorithm outputs the joint angle position or the next state.

PR2[5]: This robot is from the Willow Garage and hosts a complete set of sensors for all kinds of robotics research ranging from perception and grasping to navigation and planning.
Motors and Control: Maxon RE40 motor with single-stage planetary gear-heads[6]. Internally the control is done through motor controllers controlling the voltage. Even the end user is given with position, velocity and torque control. It is one of the few robots with torque control enabled.
Cost: ~$300,000
Weight: 220 kg
Remarks: The complete technical guide can be found here[6]
Research:[12]
Input: Consists of joint angle position and velocity
Remarks: The algorithm directly controls the robot at every time step via joint torques and taking the current states as input.

Fetch Mobile Manipulator[6]: This is a research robot for the warehousing solutions company fetch robotics.
Motors and Control: Fetch motors
Weight: 113.3 kg
Reach: not mentioned
Remarks: Among many other robots this is one that supports ROS for communication and control making it more open for research.
Research: [13]
Input: goal position, current Cartesian coordinate of the eef

References

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