

A dual-arm, hydraulically-actuated robot for operations in radiologically contaminated environments

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Content

Nuclear decommissioning environments are an ideal example of where robotics can be utilised incredibly constructively. Decommissioning generally can be an unpleasant manual task with traditional civil engineering hazards, such as high temperature or extreme noise, alongside the radiological ones. Thus, the use of robotics in such environments is a popular one – even if there are many difficulties which may not be obvious initially. Electrically actuated robots are the most common and easiest robot type to use, but suffer from low payload limits and are vulnerable to high radiological fluence. Another problem is in teleoperation of the robots – a highly skilled operator is required to work for long hours and human error often increases with fatigue.

We present here a hydraulically actuated two arm robot, each possessing seven degrees of freedom and a payload of 75 kg. Each of the joints within the arms feature potentiometer based feedback which can be used to inform any software algorithm of the position and orientation of the arms at any time. Further, the end effectors can be equipped with a variety of tools such as saws, grippers or buckets. The two manipulators can be controlled tele-operationally via twin joysticks, although this is often a highly complex operation requiring significant experience. The alternative is semi-autonomous control which is implemented here via three elements. Firstly, a commercially available vision system, the Microsoft Kinect, which has been widely utilised in numerous fields in research. The information from the Kinect is fed into the MATLAB software environment, with user interaction allowing the location and orientation of cut to be determined. This position and required orientation data is fed into National instruments LabVIEW software, where the inverse kinematic mathematics are performed and the required joint angles of the robotic arm are determined. Finally, a Compact Field Point (CFP) controller is used to physically move the joints of the arms into the required positions, thus desired operations can be undertaken.

The example task chosen is the cutting of a single plastic pipe at an unknown orientation and location. The intention is that the right arm grips the pipe at the location chosen by the user in the MATLAB program, while the left arm, equipped with a small circular saw, performs the actual cutting operation. Both tele-operational and semi-autonomous control of the system was employed here in order to compare the two systems, with times taken to cut the pipe compared as well as the quality of cut.