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## Abstract:

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### *A New Approach for Robot Arm Manipulation Using Depth Cameras and Inverse Kinematics*

A new robotic arm manipulation technique for offshore envi-ronments such as ocean-floor exploration is presented. Exist-ing manipulators such as Titan IV work on forward kinemat-ics where the user needs to control each joint of the robotic arm manually. Usually the commercial robotic arms come with a master controller/joystick which is used to control the arm. Users of these controllers require a lot of training and experience before they apply their skills in the field. There are, however, simulators which train users on particular ma-nipulator arms. For example, GRI Simulation's Manipulator trainer (see Figure 2a) [3] does this job for a variety of ma-nipulators. Commercial simulators work using forward kine-matics and require a high degree of skill from the operator and thus extensive training. This poster presents an approach in which the user just needs to point to the target and the ro-botic arm reaches the target on its own using Inverse kinemat-ics. The user input is captured using a depth camera and passed to the controller module which calculates the joint angles or controls the end-effector. Speech and gestures commands were added so that the user can control the end-effector to pick, drop and rotate the objects, more intuitively and easily. The presented approach requires less training and hence is less expensive as compared

The block diagram of the overall system is shown in Figure 1.

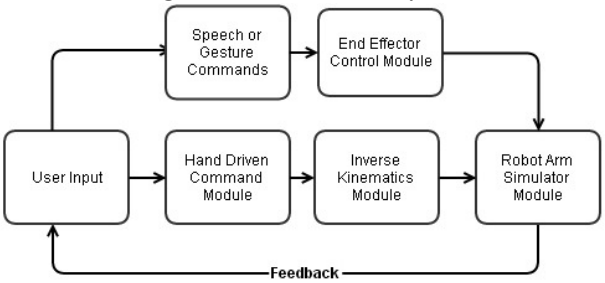


**Figure 1:** System Overview

The user specifies the target position by moving his/her hands in front of a depth sensing camera The depth camera returns the coordinates of the user's hand and the coordinates are passed as target position to the inverse kinematics module, where the joint angles for the arm simulator are calculated. After the joint angles have been calculated the robot arm sim-ulator module applies the rotations calculated and the end-effector reaches the target. Once the target position has been reached

the user can issue a voice or a gesture command to interact with the end-effector control module to pick and drop the objects.

### 2.1 Hand-Driven Commands using Depth cameras

Intel's Creative™ depth camera SDK [4] was used to get the user's hand position. The hand position is used to control a target ball which moves in a sphere which is mapped to the camera field of view. The user can then move the target ball within the sphere in X, Y, Z directions. The 3D coordinates of the ball are passed as input to the Inverse Kinematics module.

### 2.2 Inverse Kinematics

Inverse Kinematics is a technique in which the user specifies the target position and the joint angles to reach the target are computed by the algorithm. For this research Cyclic Coordi-nate Descent algorithm [1, 2] was used for its simplicity and computational efficiency.

### 2.3 End-Effector control module

This module uses the Intel SDK's[3] speech processing and image processing APIs to let the user interact with the end-effector using speech commands like "Pick" ajd "Drop" for picking and dropping the objects from end-effector. The user can also use a "Thumbs UP" or "Thumbs down" gesture for these commands.