# Automated Robot Operation: OptiTrack-Assisted End Effector Target Tracking in a Flexible Manufacturing System

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*Abstract*— **The Flexible Manufacturing System (FMS) utilizes an OptiTrack camera, a main PC, and an industrial robot to enable flexible and adaptive processes within a single cell. Unlike traditional robots with predetermined coordinates, the FMS employs real-time object tracking and coordinate streaming from the OptiTrack camera. The main PC processes the coordinate data and converts it into a suitable format for the KUKA KR300 R2700 robot. By generating commands based on this converted data, the PC enables the robot to maneuver the end effector toward the target position, providing flexibility in movement. The FMS allows for easy modification of the production process to accommodate changes in the environment or items being manufactured.**

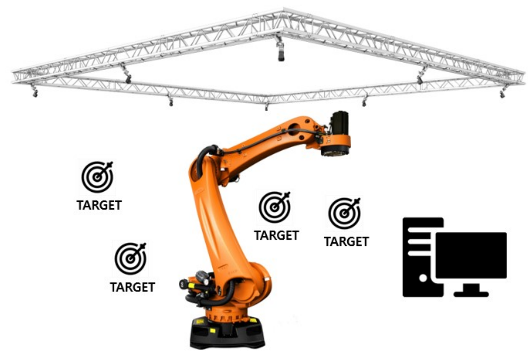


Fig. 1. The Flexible Manufacturing System (FMS) combines an object tracking camera and an industrial robot, enabling adaptive production.

## I. INTRODUCTION

Industrial robot operation often involves pre-programmed repetitive movements, which can be challenging to modify in response to changes in the production process or customization requirements. To address this issue, a 3D coordinate system has been employed, simplifying the redefinition of robot movements. In this context, the Flexible Manufacturing System (FMS) has been developed, utilizing 3D coordinates to instruct the robot's end effector, enabling efficient movement and adjustment to changes in production or consumer demands.

## II. METHOD

This section presents a method for configuring a Flexible Manufacturing System (FMS) by integrating OptiTrack motion tracking technology and a Kuka robot. The FMS comprises OptiTrack's origin (${}^{o}O$), OptiTrack's origin-based goal position (${}^{o}G$), Kuka robot's origin (${}^{k}O$), Kuka robot's initial end effector position (${}^{k}I$), and Kuka robot's origin-based goal position (${}^{k}G$). The OptiTrack system tracks the target (${}^{o}G$) and transmits the data to the Main PC in real-time using ROS (Robot Operating System) topics. OptiTrack provides position data in the format $(x, y, y, q_x, q_y, q_z, q_w)$, with units in meters for position and quaternions for orientation. The Main PC performs data type conversion to a format compatible with the Kuka Controller's message (${}^{k}G$), which is represented as $(x, y, z, \psi, \theta, \phi)$ with units in millimeters for position and degrees for orientation. To achieve this conversion, quaternion to Euler angle transformation is applied, yielding $(x, y, z, \psi, \theta, \phi)$ representation. Subsequently, the ${}^{o}G$ vector is transformed into a coordinate transformation matrix, aligning the OptiTrack coordinate system reference goal (${}^{o}G$) with the Kuka coordinate system (${}^{k}G$). After completing these calculations, the transformation matrix is converted into a vector with units in millimeters and degrees for ${}^{k}G$. Finally, adhering to the Kuka robot's constraints, a trajectory is generated to move from the initial end effector position (${}^{k}I$) to the goal position (${}^{k}G$). The trajectory data is communicated to the controller using the ROS Service of the RSI ROS Interface through UDP communication.

## III. RESULT & FURURE WORK

Using FMS, it became possible to bring the end effector close to an object in an arbitrary position. The reason for moving the end effector is to allow the eye-in-hand camera to hold the target[2]. With this camera, we will precisely control the robot arm through visual servoing and perform tasks such as drilling and picking.

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## REFERENCES

[1] I. Siradjuddin, L. Behera, T. M. McGinnity and S. Coleman, "A position based visual tracking system for a 7 DOF robot manipulator using a Kinect camera," in Proc. IEEE World Congr. Computational Intelligence, Brisbane, Australia, 10-15 Jun., 2012, pp. 1–7.

[2] G. Flandin, F. Chaumette, and E. Marchand, "Eye-in-hand/eye-to-hand cooperation for visual servoing," in Proc. IEEE Int. Conf. Robot. Autom. Symp., 2000, vol. 3, pp. 2741–2746.

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