Image Recognition Based 3D Object Detection for Pan-Tilt System

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Abstract -- **In this paper it is demonstrated how 3D object detection can be achieved using Python image recognition algorithm along with a pan-tilt system. This topic addresses understanding the research methodology and procedures utilizing mechanisms of robotic manipulators equipped with a camera system on the end effector. The main objective is to survey various kinds of robot manipulators and their applications as well as image processing algorithms to produce collaborative robotic systems for either assembly line or industrial applications. Also, this topic could include some levels of understanding and addressing robotic manipulator control, modeling, and programming along with microprocessor control and algorithm development.**

I. INTRODUCTION

One of the main perception tasks of a pan-tilt unit is the collaborative motions of row, pitch, and yaw axes. This multi-axis system is often used for surveillance cameras (see Fig. 1). The main object of this project is to experience research methodologies through engineering approaches. To effectively do that, a topic in mechanical axis systems, motion tracking algorithm, and image recognition algorithm are selected.

For mechanical axis systems, gear sets for row, pitch and yaw axes were considered so that each axis can move with appropriate torque and revolution. Also, motion tracking algorithm and image recognition algorithm are collaborating functions because they will allow the system to do its motion as an object captured with the camera moves. For example, when the system is installed on a fire drone, the camera can capture the image of fire in a certain area. Then as the drone circles around the area, the position of camera will follow the image of the fire. The motion of the camera will be controlled by row, pitch, and yaw axes.

There were some difficulties in setting up the pan-tilt system in the beginning of the research. Further will be discussed in the next section.



Fig. 1. Example of a surveillance camera

II. DESIGN PROCEDURES

In the first design, a built pan-tilt system that was made in China was selected (see Fig. 2).



Fig. 2 A Pan-tilt System

In order to operate the machine, 12V DC power supply, tools for RS485 communications, and microprocessors that controls both the DC motors. However, due to lack of operation manuals, it was too difficult to set up the machine along with the Arduino systems. Also, even though the RS485 communication was available only between the microprocessors, it was very challenging to figure out how to send signals directly to the machine. Thus, rather than using such machine, creating a new pan-tilt system seemed

more appropriate considering the time consumption and the efficiency for the project.

The significant feature for the second design was to consider the largest DoF of the three axes, row, pitch and yaw. It is because for each axis, it requires a DC motor which means that there needs to be enough spaces for each motor so that they can perform motions. Also, the torques of the motors had to be considered because if there is not enough torques on the motors, the machine would not be able to perform the most motions. Additionally, larger torque means larger motors. Thus, the size of the machine and the minimum power supply will increase for more higher torques. Considering such features, 12V DC motor with about 10kg/cm of torque seemed appropriate for the system.

First of all, for the pitch motion, a mechanism with two columns connected with a cylinder-shaped plate was selected (see Fig. 3). The shape of this mechanism looks similar with a robot named “R2D2” from the movie “Star Wars” (see Fig. 4).

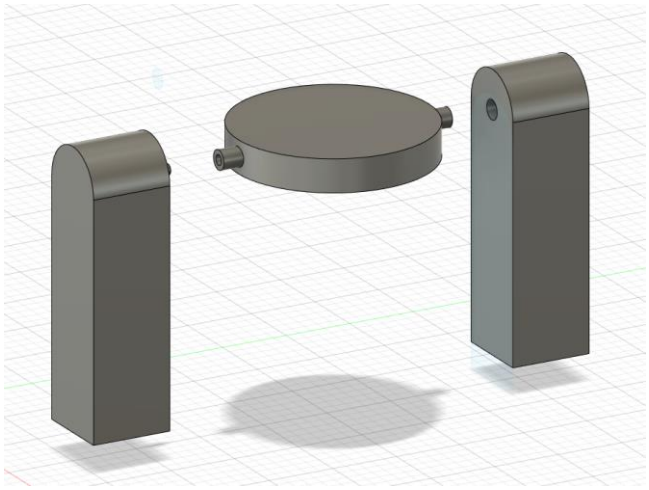


Fig. 3 Pitch Mechanism



Fig. 4 R2D2 from the movie “Star Wars”

The cylindrical plate in the middle will be the base for the next motion, the yaw mechanism. The plate is connected to the two columns where one of them contains a motor with a gearbox. Through the center of the plate there will be a connecting rod which will be attached to the motor shaft with a set-screw. The rod and the cylindrical plate are a single body so that they move together as the pitch motion operates.

Moreover, similar to the shape of “R2D2”, the yaw mechanism will be attached with a dome shaped body (see Fig. 5).

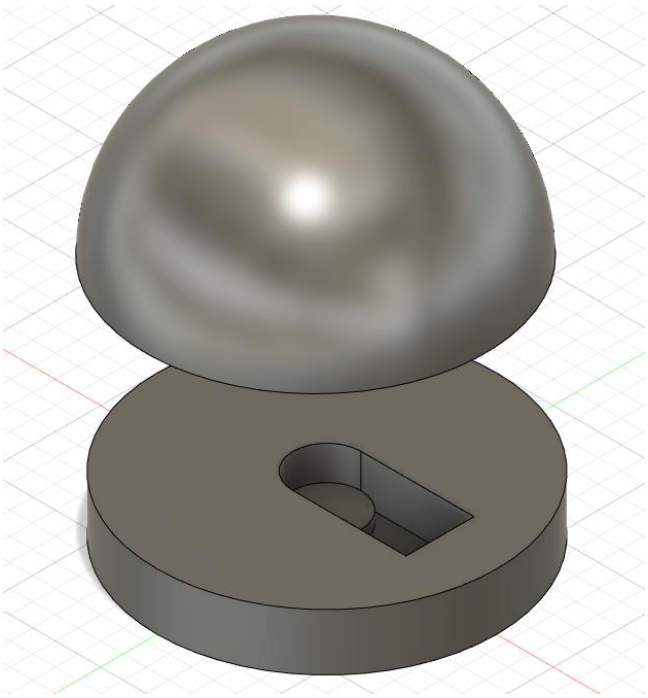


Fig. 5 Yaw Mechanism

The base of the yaw mechanism is same with the cylindrical plate from the pitch mechanism. As shown in Fig. 5, the part of the plate is carved for the space for the motor. The motor with a worm gear will be used for this axis, connected it to the dome above. It is not shown in the picture, but there is a hole in the center of the dome in order to attach the motor shaft inside it.

Finally, the row motion will be attached inside the dome just like the robot, “R2D2”. The specific design has not yet been created, but the plan is to install a motor without a gear inside the dome so that the camera can be connected on the motor shaft of the row motion.

The creation of these three mechanisms will be built with a 3D printer, and the motors and the gears made with metal will be purchased in an online market. Rather than making the gears with a 3D printer, a metal gear was selected because of the longer durations and larger rigidity of the metal.