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Assessment of Robotic Arm and it's Parameters

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***Abstract*- This article addresses robotic arms and their applications. It provides a technical overview of some of the most recent studies in this area. This is an active field of research with several unanswered questions that are still being looked into. There are several different types of robotic arms on the market today. Some of them have great repeatability and precision. In this essay, we examine the various features and uses of an arm. My survey may be used for knowledge and recommendations for future research projects. The paper ends with research gaps and some suggested work. Robotic arms are utilized in a wide range of settings, including the home, the office, and workstations.**

Keywords*- *Robotic arm, degree of freedom, axis, kinematics, payload, speed and acceleration, end-effectors.

INTRODUCTION

A robotic arm is a sort of mechanical arm that is typically programmable and has capabilities comparable to those of a human arm. The arm may be the entire mechanism or it may be a component of a more complicated robot. Robotic arms are mechanical goods that are produced and sold in large quantities all over the world. A robotic arm with labelling is shown in Figure 1. There are countless varieties of arms on the market that were created by various businesses. Because robots are now utilized for specialized tasks and in areas where people are unable to operate owing to situations like extreme heat, polluted air zones, heavy weight lifting, and other factors, industrial usage of the robotic arm outnumbers residential use. High accuracy is also used by the robotic arm in situations where mistake is not acceptable. When given a job, the robotic arm completes it correctly in a variety of environments. A robotic arm is made up of a number of firmly joined bodies that may be arranged in various ways and moved between them while adhering to strict velocity and acceleration guidelines. The size of the fixed bodies, the kind of joint, the order in which the joints are attached, and the range of motion permitted at each joint all varies in an industrial robotic arm. Links are the names given to the many permanent bodies. Robotic arms are made utilizing a variety of characteristics, including the number of axes, degree of freedom, working envelope, working area, kinematics, payload, speed, acceleration, accuracy, among others. This review paper provides an overview of some of the parameters of robotic arm.

Figure 1. A robotic arm with labels [1]

A. *Axis*

Three axes are utilized to represent any location in space, one for a line, two for a plane, and one for movement indication. The primary controls for a robotic arm's axis are roll, pitch, and yaw. For complete control, use them. Robot arms were useful before to 1987. Two and three axes are present in [2]. The availability of [3] 4-axis, [4] 5-axis, [5] 6-axis, and [6] multi-axis robotic arms has increased, nevertheless. A six-axis robotic arm is seen in Figure 2. A rotating axis arm must be positive interactive for optimal stability in three dimensions, while free movement is good for two dimensions. The mass of the arm should be decreased for less moment of inertia at various joints; a lighter arm performs more dynamically than bulkier arms at the same stability level. Industrial robotic arms are ideal for major building projects since they can handle heavy tools and have a high weight. Robots can become lighter and more flexible by using multiple axis arms.

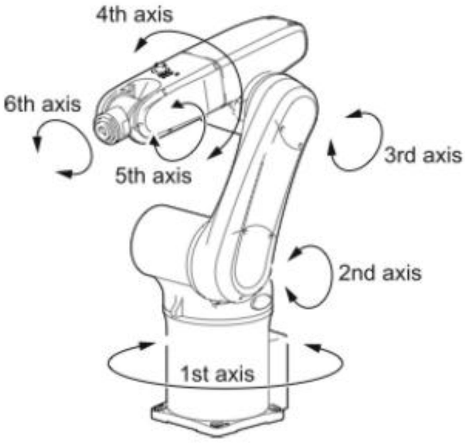

Figure 2. A six-axis-robotic arm [7]

B. *Degrees of Freedom*

Robotic arms use their degrees of freedom to manipulate all points (directionally). Human arms have seven degrees of freedom, compared to up to six degrees of freedom for articulated arms. A robotic arm is made up of numerous solid pieces that are attached to one another by an n-number of joints, giving the arm n degrees of freedom if there are n joints (DOFs). A robotic arm with seven joints is shown in Figure 3.

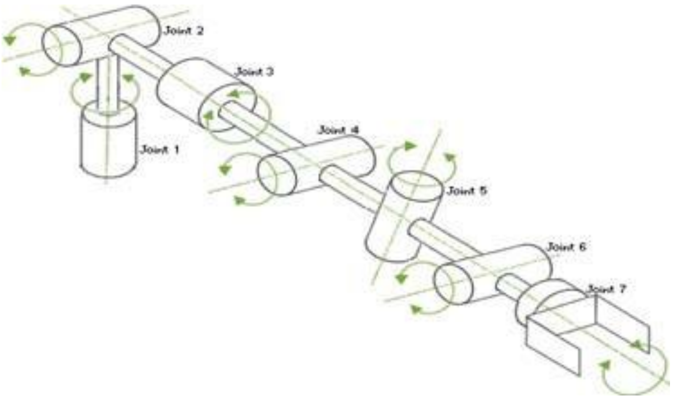

Figure 3. A seven joint robotic arm [9]

Joint coordinates, usually referred to as internal coordinates, are understandable. The relative velocity of neighbouring links is described by all coordinates, which are dependent on joints. According to [9], a robotic arm with three joints has eight degrees of freedom, and when the hand's five fingers are taken into account, it has seventeen. According to [10], a robotic arm attached on a wheelchair has six degrees of freedom and is controlled by a force and torque sensor, an effective user interface, and a colour vision system for accurate object detection. With seven degrees of freedom, monitoring an object without making firm assumptions is achievable in [11] 3D vision tracking of flight. [12] Offers a workspace layout for a capturing robot with two arms, each having seven degrees of freedom. [13] A robotic arm with seven degrees of freedom was created to mimic a human analogue motion and increase interaction with people. To compute the force applied at the arm, a force sensor that operates in six axes was coupled to the wrist sensor. [14] Robotic ball-catching devices employ a lightweight, versatile arm (DLR LWR 3) with 7 degrees of freedom. A four-pointed symbol with 12 degrees of freedom catches the ball (DLR hand 2). In addition, they utilize a camera and a quick image processing system, as well as a tiny basket with a 7-degree of freedom (DLR, LWR, 2) arm. [15] Two robotic arms mounted to a 7-degrees-of-freedom robot with four-fingered hands, each having 12 degrees of freedom, and a lightweight robot and robotic arm used for dynamic performance. Due to its design for collision avoidance, the robot employs a camera to follow balls, and both arms may capture at once. In [16], a catching hand is connected to a 7-degree-of-freedom KUKA LWR4+ arm that can catch a variety of things, including an empty and half-filled bottle, a tennis racquet, a cardboard box, a hammer, and more.

C. *Kinematics*

Robotic arms include a variety of joints, including parallel, spherical, articulated, and cartesian joints, which we arrange to control the motion of the robotic arm. The movement of many axes and various degrees of freedom is determined using robot kinematics. The robot's structure is built using a series of kinematics; Figure 4 illustrates arm kinematics and motion planning. In order to offer effective rotation, structure must first make sure that various components (rigid bodies) are correctly attached at joints. All rigid body parts in the robotic system are measured for velocity, acceleration, and position using robotic kinematics, as well as for all control movements. Additionally, it determines the precise force, torque, and contribution of motion, inertia, and mass at each part of a robotic arm for making an efficient arm. [21] Montana kinematics define the equation and transformation between working space and coordinates, which is used to calculate the fixed body, motion, and rate of change of connected coordinates. It helps to maintain the arm and use it for velocity analysis, but it's limited to one analysis. [22] A non-redundant robot configuration solved kinematics problems, but it was difficult to solve accuracy and dynamic effect; these problems were solved by redundancy. A redundant robot cannot work in a unique manner, so it's difficult to define its next move. This problem is solved by the real-vision function monitor. The distributed positioning is used to quantify the kinematic fatigue, also known as integral kinematic involvement, of human arm motion and joint interference. They discussed some support and findings in this effort. In this work, they offer some fresh approaches to problem-solving and suggest a few fresh local redundancy ideas. With modelled and controlled joints, they aid in regulating the motion of a robotic arm. [23] In order to solve trajectory planning, they employ inverse kinematics to determine the intended goal's ultimate location. They locate the objective, forecast the final location, and then follow the objective's trajectory, delivering the needed position and velocity.

[12] Inverse kinematics is substantially slower than testing directions. It is employed to pinpoint the location of the direction vector and to minimize the calculation angles between the direction and the axis. [13] The current inverse kinematic technique, which incorporates diverse behaviours for the same coordinates and path like a pickup, writing, etc., is solved using fuzzy reasoning. They attempt to create several arm trajectories and suggest a construction for an arm that resembles a human arm and functions similarly.

[24] They put out the notion that a robot can mimic human motion, demonstrating how highly capable it is of picking up new motions. This method of learning, known as imitation learning, captures data from a human arm and utilizes kinematics to store motion data and adjust it periodically. The torque is small. [18] Inverse kinematics is frequently employed as the robot system's default frame in this inverse kinematics approach for hand-catching point mapping. However, they introduced some variation by adding cameras, and it then operated differently utilizing vision and inverse kinematics rather than a single fixed, predefined model.

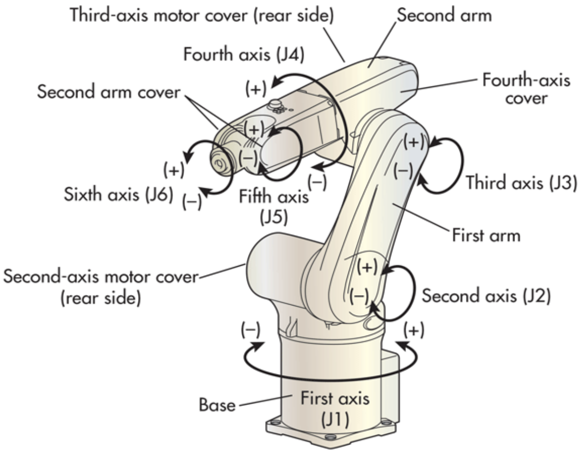

Figure 4. Arm kinematics and motion planning [25]

Figure 5. Weight (a car) lifting robotic arm [26]

D. *Payload*

The weight that an arm can lift and the movement that weight permits are simply referred to as a payload; Figure 5 shows a payload (a vehicle) being hoisted by a robotic arm. When an arm is implemented, it's crucial to maintain payload and assess how much weight it can lift. It also takes into account how much an arm weighs when it is loaded down with tools and how much an industry depends on using an arm. Given that the robotic arm will be utilized for heavy lifting, it should have a payload capacity of 1–10 kg under typical operating conditions. In order to calculate weight properly, certain instruments are required. The robotic arm's maximum payload is 500 gm. [10], its maximum payload is 7 kg [11], and industries arm has a higher payload than others.

E. *Speed and Acceleration*

By each component and as a whole, it defines angular and linear movement.

[27]In this study, flexible and active motion is produced by exploiting the visual output of the current job to execute real-time high-speed catching with a high-speed vision camera system and produce quick results during an experiment. [28] The robotic arm can move at a maximum speed of 8 m/s. [29] Robotic fingers and arms are capable of moving at speeds of up to 360 degrees per second when all joints are functioning. [14] How soon the fingers close depends on how rapidly the robot catches flying things. The beginning timings for finger motion vary depending on the speed of the oncoming item, ranging from around 33 ms (top) to 50 ms (bottom).

Acceleration determines the final speed of an arm at any distance by calculating the number of axes and degrees of freedom and changing speed at each degree. [27] Robotic arms are capable of 58m/s2 of maximum acceleration. [28] Using an acceleration and velocity of 13 m/s, this arm can assist in reactionary movement. [14] Its total joint maximum acceleration is 860degree/s2. [30] Robotic arms with a 7 m/s velocity may alter their acceleration in response to the situation. Initial acceleration ranges from 0 to 9.81 m/s2 in [18] and vary depending on camera output.

F. End-*effecters*

Figure 6. Different end-effectors of a robotic arm [31]

The end effectors that DOBOT Magician is outfitted with enable it to carry out a range of activities. [32]The Dobot Magician is similar to many other 3D printers on the market and is accurate enough to produce things with fine details. Dobot also supports dual-color 3D printing thanks to its two extruders. Furthermore, it works with well-known open-source 3D printing programmes like Repetier Host and Pronterface. The Dobot Magician can draw slick lines because to its excellent accuracy and steadiness. Dobot's software allows for the feeding of customised graphics, which are subsequently converted to code and drawn on paper by the arm. Custom text may also be set in a similar manner. It may be a wonderful ally for artists. By simply swapping the pen for a laser end-effector, Dobot Magician can engrave not just straight lines but also shaded pictures. Harder materials like leather and wood may be engraved with its strong laser head. Making unique presents and artwork is easy with this tool. Dobot Magician's gripper and suction attachments enable it to move tiny items weighing up to 500 g. This may be used to create miniature factories for use in small-scale manufacturing or in teaching.

RESEARCH GAPS

I have spoken about a robotic arm with various settings. The following parameters are used to describe research gaps: the quantity of axes, degrees of freedom, kinematics, payload, speed, and acceleration, as well as end-effectors. The number of axes is a field that is always evolving, however there hasn't been much advancement in this area. A robotic arm's level of freedom is crucial. Every year, new technology is created to advance this sector, however there is a gap because the majority of arms now only have 6 or 7 DOF, although 6 DOF arms were accessible in 1996. It started with a half circle, and now the arm can easily cover half of the sphere, but it's feasible to cover more than 70%. The working space and working envelope are improving each time. Sphere. Kinematics also has certain gaps; some articles did not go into great detail regarding them. For industrial weapons, payload is crucial; it should range from 1 kg to 1000 kg, depending on the intended usage. Effective utilization of motors and stiff linkages may increase speed and acceleration. Before five years, accuracy and repeatability were not significantly better, but they have subsequently steadily improved. In a few years, motion control could improve significantly. The most important research gaps are these.

STRATEGY

We spoke about the robotic arm; now we'll talk about various ways to fill in its flaws and improve it. My survey's main goal is to create a variety of fresh approaches to fresh issues. By resolving these connected problems, we attempt to work in a multiple-axis robotic arm. Next, we attempt to improve the degree of freedom of a robotic arm by adding more joints and effectively using them. The working envelope and working space are enlarged after this work by increasing the number of axes and degrees of freedom (DOF), as well as by designing an efferent pattern for the arm to cover a greater region. Using the simulation tool, we are also attempting to enhance kinematics, precision, repeatability, payload, speed, and acceleration. We also see that a good robotic arm has to have effective motion control.

CONCLUSION

I have reviewed publications over the previous 25 years, addressed the many parameters of the robotic arm. Recognize the elements that influence a robotic arm's performance and how they make them more effective. Learn how different axes are used to alter an arm's mass, how DOF can be increased simply by adding joints, how to determine a working envelope and space based on the circumstances, how kinematics enhance robot movement, how speed and acceleration differ in various tasks, and how accuracy and repeatability are the most crucial aspects of any robotic arm. For a complete knowledge of the robotic arm, use diagrams as well. We then discussed research challenges and gaps, how it may serve as a roadmap for future studies, and how we might strive to enhance a robotic arm by developing efficient algorithms and simulations.

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