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Leap Motion Sensor Technology Based Robo-Control System

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Abstract – Through this paper, we tend to gift a Literature Survey, Proposed System & Software Requirements to code the demand of our Project. The main goal here is to form the interaction between a human hand and a robotic arm. This interaction between man & machine offers the connection between humans and pc. This idea shows the creation of a robotic arm as like the human arm as doable by not limiting the arm to at least one set of tasks. The robotic- arm is to be controlled employing a Leap Motion Controller in X, Y and Z direction, like a human hand with the robotic arm is that the basic aim of the project. There's conjointly an aim, that is to expand the practicality of the arm, once the essential model is made which might be used e.g.- a spot-welding golem. We measure more applications of this robot-like: These days, varied styles of robots are even utilized in medical industries, for the case of surgeries, the medico uses either direct or through pc management strategies to manage instruments needed. There are many additional applications which might scale back the Human efforts & result in automation like material handling, thermal spraying, welding, painting, drilling, Manhole cleaning and much more. It is known for the key problems of electro-mechanical coming up with of bilateral golem manipulators. One among the main developments that emerged within the recent past is Hand gesture, a dominant way of golem manipulators on the slave aspect of the bilateral system exploitation. The Leap Motion Controller (LMC) that relies on gesture detections is developed with the assistance of this analysis. This paper shows the optimizing of the joint mechanism designing. To use this technique in surgical sort applications, we should always implement it with high golem servos.

Keywords – Leap Motion device, Tip Imitating, Golem Manipulator, Servo Motors, Microcontrollers, Hand Gesture.

I. Introduction

As we have seen, the technological advancement of this era is in rapid development. The bilateral systems are often found in many types of research & available for both master and slave designs in industries. HMI or (Human Machine Interface) is one of the main features of these systems, which, makes it convenient, reduces time delay, and goal-oriented design of the slave side.

Methodology	*Effectiveness*
Hand Gesture Vision Attentive	60
Brain Control Interface (BCI)	20
Joystick/Remote Control (RC)	35

| Hand Gesture Glove Based | 30 |
| Voice Control | 30 |

Table 1 shows the effectiveness of some necessary methodologies in bilateral systems. An immediate parameter used for decision making here is Contactless that identifies the operator independence, level of wear and tear, response, and high repeatability of the methodologies. On the opposite hand, we all know that human & laptop interaction has been principally supported by information or writing vogue devices. E.g.- whereas we tend to use a mouse, we can grab something we would like and rotate it victimization the mouse, which operates in an exceedingly two-dimensional type. The operation bestowed by this movement is instinctual and users may have several tries to know however it works. However, originally, the rotation task is natural and so is easy to maneuver hands to rotate any object within the desired method. Thus, it's helpful to develop a mechanism to discover the gesture and so manage the golem consequently. Tip imitating robot was the primary step of the development. The newest sensors give information that may be with success accustomed establish gestures and thus management something. There are presently many devices that yield information helpful for gesture recognition. An example of such a controller is that the Microsoft Kinect, which provides a three-dimensional purpose cloud of the ascertained scene. It had been designed for applications that interpret the movement of the complete body of the user, that is the reason why it lacks the required accuracy for hand gesture recognition. The same device designed to trace the movements of hand and fingers is Leap Motion Controller (LMC) developed by Leap Motion, Inc. free in the year 2013. It's a little device, which might be placed ahead of a Laptop or a Computer. It permits a replacement method of interaction with the technology, nonetheless to be evaluated. The LMC could be a tiny device that may be connected to a laptop employing a USB, this will sense hand movements within the air, and therefore the movements are recognized and translated into actions for the PC to perform. LMC is claimed to be sensitive to terribly tiny movements and is capable of mapping movements of the complete hand higher than it. It aims to provide an economical & cheap technology application that may be simply accessed by the Industries of those staff. This project includes a high-level aim of manufacturing an Application that may acknowledge the hand movements. The reasons for selecting LMC because the 3D sensing element for the hand gesture detection is low value regarding alternative & their 3D sensing element modules, vary of the sensing element (1m) fits for the applying, the sensing element module is specially designed for hand gesture, free SDK or computer code Development Kit and library availableness, the availableness of the free support like forums, free testing computer code and applications and blogs for identical. The planning orientation for each the hardware and computer code of the Project could be a hand gesture application development. Also, the preceding options are promptly out there with the system and cause the choice of this device. Also, in a survey it is distributed among the alternative 3D cameras. The hand gesture controller is predicated on stereo vision technology. Stereo vision is supposed to be the extraction of 3D info from digital pictures. It's artificial stereopsis that's followed by 2 cameras to get depth and 3D structural info. Literature survey reveals that 3D information acquisition immensely will increase with the potential industrial applications inside the previous few years. Accuracy and strength of sensors were enhanced & whereas the value was born. Principally, 3D sensors are used for object chase, 3D scene reconstruction, motion analysis, and gesture-based user interfaces.

Figure 1: Some Types of 3D Sensors [a] Bumble bee 2 Sensor [b] Mesa Swissranger 4000 [c] PMD Camboard PICO [d] FHOTONIC B70 [e] Microsoft Kinect Sensor [f] Leap Motion Controller

Mainly the Optical 3D sensors are categorized by their mechanism. Structured lightweight associate aliases the deformation of an identified pattern into an unknown surface to see the 3D form and therefore the Microsoft Kinect sensing element is shown in Figure 1. e is that a well-known example. The ToF (Time of Flight) 3D camera square measure supported the well-known time of flight principle that relies on part shift and MESA Swissranger 4000 shown in Figure 1.b, PMD (Photonic Mixer Device) Camboard Pico shown in Figure 1. c and PHOTONIC B70 shown in Figure 1.d square measure well-known examples. Stereo vision cameras square measure supported 2 optical 2nd cameras with identified adventitious parameters. The thought of determinative depth within the scene relies on looking out correspondence points in each 2nd picture and Bumble Bee's two

sensing elements shown in Figure 1. a and LMC showed in Figure 1. f square measure celebrated examples. In LMC, each binocular vision technology is integrated with structured lightweight technology.

Sensor	Approx Price (INR)
Microsoft Kinect	14,714.89
Leap Motion Controller	7,283.87
Mesa Swissranger 4000	1,61,790.22
Camboard PICO	58,859.56

Table 2 indicates the value evaluation of the 3D sensors with approximate promoting fees without the transport costs. The above desk suggests the affordability of the Leap Motion Controller for low-fee packages and developments. In-depth analysis of the above sensors shows that their ranges varied from centimeters to a few meters. Mainly the LMC (Leap Motion Controller) is working with 1m range. The distinctiveness of the Leap Motion is the layout orientation for hand gestural tracking.

II.   Literature Survey

At present there's a huge quantity of labour to spot the movement of the hand. Immeasurable articles are utilized in measuring the detection for the motion of the hand. The various fields of victimization of this method contain automatic hand language, special effects, automatic sketching, and conjointly industrial robots accustomed to work rather than humans. This paper offers the foremost flourishing technique to use artificial intelligence. During this space 2 kinds of techniques used:

1) Contact kind 2) Non-Contact kind: - 1) Contact type: Here, we have variety of devices containing information gloves, magnetic force pursuit system, frame, etc. *2) Non-contact type:* This type carries vision-primarily based totally system, speech recognition, camera-primarily based totally, etc. Our technique comes underneath non-contact kind since it uses a Leap Motion detector to trace the hand and fingers. Not like Microsoft Kinect, Leap Motion doesn't offer access to data within the sort of a cloud of points. Captured information is processed by proprietary drivers provided by the seller and accessible through API. Leap Motion changed into pre purported human-laptop interface, now no longer a popular purpose3D scanner, as a consequence, it is optimized for spotting human fingers and pointy objects. The more information instrumentality we tend to get from Leap Motion API could be a Frame. The typical frame rate whereas employing a dual-core portable computer and USB a pair of 0 interface, is fifty frames per second. One frame consists of hands, fingers, printables (directly visible by the controller), and extra info - like gestures recognized by an easy constitutional recognition mechanism, rotation, translation, frame timestamp, and scaling information. For this project, we have created our own data formatting. It contains solely info necessary for the us and permits us to simply save captured frames to file, and skim them later for process and testing functions. Associative degree articulated mechanism could be a mechanism with rotary joints. (e.g., a leg-like mechanism or associate degree industrial robot). Articulated robots will vary from straightforward two-jointed structures to systems with ten or additional interacting joints. They're powered by a spread of means, together with electrical motors. Some kinds of robots, like the robotic arms, will be articulated or non-articulated. The Leap Motion works with 2 infrared (IR) cameras and 3 IR LEDs as a depth detector during a restricted field of reading of eight blocky feet (approximately sixty-one blocky centimeters). Victimization of the binocular vision from each camera, the device will minimize errors from tools, fingers, and hand options and is made on a novel mathematical model to maximize speed and exactness. Because this device detects these options, it provides updates in frames of knowledge. Every frame incorporates a list of pursuit information like hands, fingers, tools, recognized gestures, and factors describing the general motion of the scene.
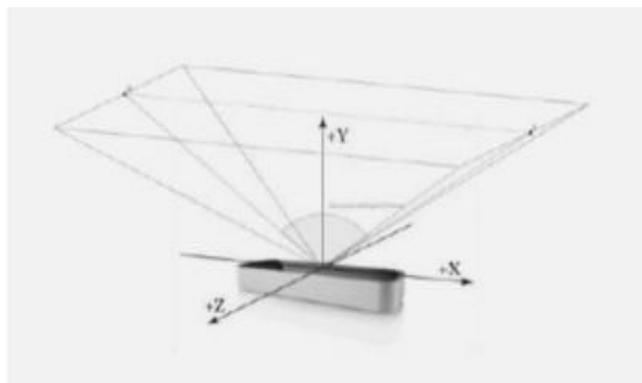

Figure 2: Leap Motion Sensor's Field of View

This lets in Leap Motion's renowned hand functions like hand palm orientation, fingers length, width, hand opening, and orientation, and different non-hand functions along with gear and shows display screen location. Furthermore, it includes in its Software Development Kit (SDK) the recognition of more than one gesture along with the "Circle Gesture", swipe and faucet. For controllers like Nintendo Wii Remote and Microsoft Kinect, greater targeted on frame and frame members, Leap Motion affords a fine-grained hand manage, that is virtually promising for constructing newer DMIs. Although it is a confined area to discern, hand monitoring is very extraordinarily precise. The Leap Motion SDK comes with 3 one-of-a-kinds pre-sets of monitoring: Low useful resource mode, Robust mode, and Auto orientation tool mode. Furthermore, it also has 3 one-of-a-kind overall performance sets: High Speed, High Precision, and Balanced monitoring. By deciding on the High-Speed mode, it loses a perceptible quantity of precision with monitoring, However, reduces the time to 5 ms (about two hundred fps). Withinside the High Precision mode, the dataflow affords circa 50 frames in keeping with the second (fps), representing approximately 20 milliseconds (ms) of time withinside the laptop. With the Balanced monitoring, its fps will increase with the aid of using a detail of two, decreasing the time to 10 ms, mixed with nonetheless top precision. Motion management can be a sub-subject of automation, but at some point, of which the placement or pace of machines has managed the use of a few types of tools like a hydraulic ram, linear actuator, or motor, normally a servo. Motion management is a vital part of robotics and CNC gadget gear, however, in those instances, it is greater complicated than whilst used with specialized machines, in which the kinematics are commonly simpler. The latter is commonly known as General Motion Control (GMC). Motion management is extensively applied withinside the packaging, printing, textile, semiconductor production, and meeting industries. But, lately, the principal goal of the movement management is that the unique management generation of movement structures with electric powered actuators like DC/AC servo Automobiles. Control of robot manipulators is moreover blanketed withinside the subject of movement management due to the fact that maximum robot manipulators are pushed with the aid of using electric servo automobiles and consequently, the important thing is the goal, that is the management of the movements. A movement controller to get the set points and close a facet or pace remarks the circuit. Machine imaginative and prescient (MV) is the generation technique to offer imaging-primarily based totally automated inspection and evaluation for such programs as automated inspection, system manage, and robotic steering withinside the industry. The scope of MV is broad. MV is stated to, even though good from, a laptop, more imaginative and prescient. Machine imaginative and prescient techniques are described as each of the techniques of defining and growing an MV solution, and due to the technical system, that takes place at some point of operation of the answer. Here the latter is addressed. As of earlier, there has been little standardization withinside the interfacing and configurations applied in MV. This consists of consumer interfaces, interfaces for the integration of multi-element structures, and automated records interchange. Nonetheless, the number one step withinside the MV collection of operation is the purchase of a picture, usually the use of lenses, cameras, and lighting fixtures that has been designed to deliver the differentiation required with the aid of using next processing. MV software program applications then rent numerous virtual photo processing strategies to extract the required statistics and once in a while make decisions (pass or even fail) supported by the extracted statistics. A robot arm can be a robotic manipulator & commonly programmable, with comparable capabilities to a person's arm. Such manipulators are linked with the aid of using joints permitting both rotational movement (in an articulated robotic) or translational (linear) displacement. The links of the manipulator are often considered to make a kinematic chain. The business enterprise prevents the kinematic chain of the manipulators, referred to as the top effectors and they are far analogous to the human hand. The pinnacle effectors are regularly designed to carry out any favoured venture like welding, gripping, spinning, etc., relying on any appliance. The robotic hands are regularly self-sustaining or managed manually and perhaps want to carry out a variety of obligations with excellent accuracy. The robot arm is regularly constant or mobile (i.e., wheeled) and can be designed for commercial or domestic programs. Recognizing hand gestures for interplay can assist in reaching the benefit and naturalness favoured for the human-laptop interplay. Users normally have to use hand gestures for the expression of their emotions and notifications in their thoughts. The researchers in their paintings said that the hand has been extensively applied in evaluation to different frame elements for gesturing due to the fact it is able to be a herbal type of medium for conversation among human to human, therefore, can quality fit for human-laptop interplay. A hand can be extensively applied in evaluation to different frame elements as a medium for conversation among human to human - Hand 21%, Fingers 10%, Head + Fingers 2%, Object + Finger 4%, Hand + Object 5%, Body 7%, Hand + Head 7%, Multiple palms 13%, Others 9%. The values display the numerous frame elements or gadgets diagnosed withinside the literature hired for the gesturing.
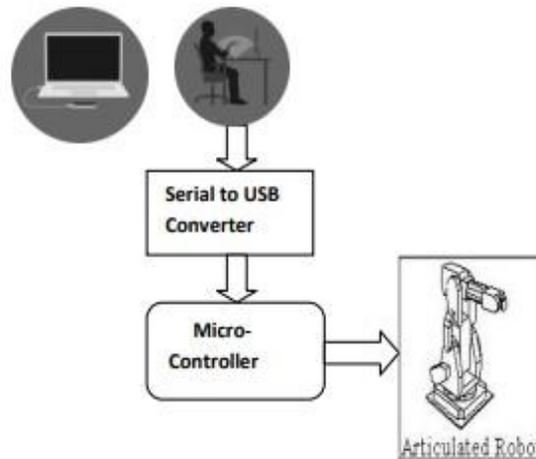
III.   Proposed System

Figure 3: Proposed System Diagram

The primary intention for creating a human hand monitoring machine is to create an interplay between the human hand and a robot arm. Man-system interplay offers the relation between human and computer. The concept suggests the advent of a robot arm this is as much like the human arm as feasible and now no longer to restrict the arm to at least one set of tasks. Also, the arm is to be managed with the use of a Leap movement controller in the X, Y, and Z direction. The similarity of a human hand with the robot arm is the primary intention of the mission but, there's an underlying intention that's to amplify the capability of the arm as soon as the primary version is created like for instance spot-welding robot. The above Figure 3 shows the proposed System, we're the use of simplest one Leap movement Sensor for X, Y, and Z axes movement, as it gets rid of the downside of the Image processing approach and Improves the velocity of labour in real-time, so we can locate this machine everywhere we need to locate. The bounce movement sensor is hooked up to the PC through a USB and the PC is hooked up to Microcontroller. It offers the placement of hand, fingers, and palm. Hence, the Captured Image frames from bounce movement sensors are processed in PC with the use of Java and it's far given to Microcontroller after which those alerts are dispatched to Articulated Robot. This System introduces the generation used to tune the Hand-Arm and interface it to govern the robot arm for special activities. The motions may be managed with the aid of using the consumer transferring our hand in any direction. This proposed machine could be very essential because it offers an intuitive manner to broaden human-targeted sorts of human-system interplay (HMI). At the equal time whilst we use picture processing techniques, it's far tough to govern as it desires special identity schemes of palms together with sample recognition, monitoring, colour identity, and giving X and Y-axis to the points. This downside is eliminated with the aid of using our machine. The Leap Motion Controller makes use of infrared (IR) imaging to decide the placement of predefined gadgets in a constrained area in real-time use. Technically, only a few information is recognized approximately to the suitable nature of the algorithms used because of patent and exchange mystery restrictions. However, from inspection of the controller, it's far clean that 3 separate IR LED emitters are used alongside IR cameras. Therefore, the controller may be classified as an optical monitoring machine primarily based totally on the stereo imaginative and prescient principle. According to reputable information, the Leap software program analyzes the gadgets located in them. The Leap Motion Controller makes use of infrared (IR) imaging to decide the placement of predefined gadgets in a constrained area in real-time. It acknowledges palms, fingers, and tools, reporting discrete positions, movement, and gestures. The controller's subject of view is an inverted pyramid targeted at the device. The powerful variety of the controller extends from about 25 to six hundred millimeters above the device (1 inch to two feet). The controller itself is accessed and programmed through the Application Programming Interfaces (APIs), with assistance for plenty of programming languages, starting from C++, C# to Python. The positions of the identified gadgets are obtained through these APIs. The Cartesian and round coordinate structures used to explain positions withinside the controller's sensory area and are proven. However, it needs to be cited that the sampling frequency isn't stable, can't be sent, and also varies significantly.
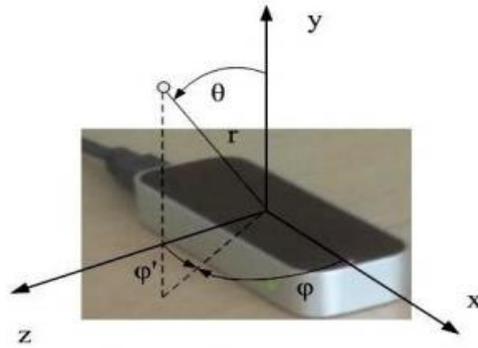
Figure 4: The Cartesian and spherical coordinate systems used for describing positions in the controller's sensory space

Leap Motion is a USB detection tool launched in July 2013 through the means of Leap Motion Inc., which is designed to offer real-time monitoring of palms and hands in a three-dimensional area with an accuracy of 0 to 1 millimeter. consumer to obtain rough recordings of objects placed inside the subject of sight of the tool (approximately 150 ranges with a distance no longer exceeding 1 meter). The Leap Motion gadget recognizes and tracks palms, hands, and finger-shaped tools. The tool works in intimate proximity with excessive precision and monitoring of the body and examines inconspicuous positions, gestures, and movements. However, it is recognized that the hardware includes 3 infrared LEDs which could be used for stage lighting, while cameras spaced four centimeters apart to capture photos with body charges of 50-200 fps whether or not 2.0 or 3.0 USB is used.

IV.   Software Requirement

4.1 Leap Motion Software - The Leap Motion software program will run as a provider (on Windows). The software program connects to the Leap Motion Controller tool over the USB connector to the Laptop. Leap-enabled packages get admission to the Leap Motion provider to get hold of movement monitoring statistics. The Leap Motion SDK offers forms of API for retrieving the Leap Motion statistics: A Local Interface and a Web-Socket interface. These APIs permit you to create Leap-enabled packages in numerous programming languages which include JavaScript jogging in a browser environment. In Figure 5, The local software interface is supplied through a dynamically loaded library. This library connects to the Leap Motion provider and affords monitoring statistics on your software. You can hyperlink to the library immediately in C++ and Objective-C packages or thru one of the language bindings supplied for Java, C#, and Python. We are using C# on a large-scale.
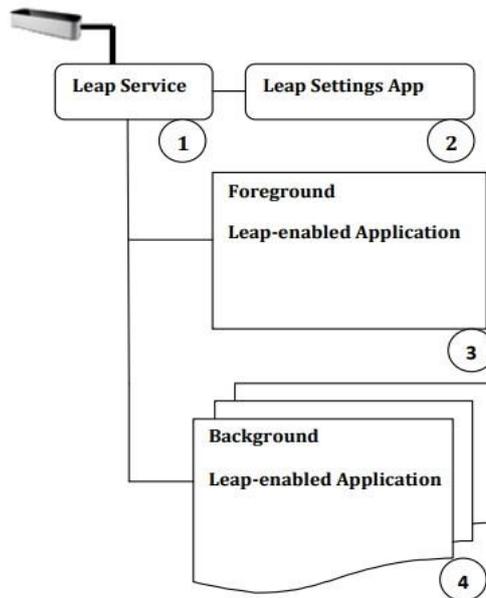

Figure 5: Native Application Interface

1. The Leap Motion carrier gets information from the Leap Motion Controller over the USB connector. It encodes that statistics and sends it to going for walks Leap-enabled packages. By default, the carrier best sends monitoring information to the foreground software. However, packages can request that they get hold of information withinside the background.

2. The Leap Motion software runs one by one from the carrier and lets the pc person configure it in their Leap Motion installation.

3. The foreground Leap-enabled software gets movement monitoring information from the carrier. The leap-enabled software can hook up with the Leap Motion carrier & track the usage of the Leap Motion local library. The software can hyperlink in opposition to the Leap Motion local library both directly (C++ and Objective-C) or via one of them to be had language wrapper libraries (Java, C#, and Python).

4.2 Processing Software - Processing is an easy programming surrounding that changed into creating & made it less difficult to expand visually orientated packages with an emphasis on animation and imparting customers with immediate remarks via interaction. The builders desired a method to "sketch" thoughts in code. As its talents have elevated during the last decade, Processing has end up being used for greater superior production-degree paintings similar to its sketching role. Originally constructed as a domain-unique extension to Java centered toward artists and designers, Processing has advanced right into a full-blown layout and prototyping device used for large-scale setup paintings, movement graphics, and complicated records visualization. Processing is primarily based totally on Java, however, due to the fact application factors in Processing are pretty easy, you could discover ways to use it even in case you do not know any Java. If you're familiar with Java, it's miles fantastic to miss that Processing has something to do with Java for a while, until you get a hold of the manner the API works. A crucial intention for the mission changed to make this form of programming reachable to a much broader audience. For this reason, Processing is unfastened to download, unfastened to apply, and is open source. But tasks advanced the usage of Processing surroundings and middle libraries may be used for any purpose. This version is equal to GCC & the GNU Compiler Collection. GCC and its related libraries are open assets below the GNU Public License (GPL), which stipulates that adjustments to the code have to be made available. However, applications created with GCC (too severe to mention) aren't themselves required to be open source. Processing consists of:

• The Processing Development Environment or PDE. This is the software program that runs while you double-click on the Processing icon. The PDE is an IDE or Integrated Development Environment with a minimalist set of functions designed as an easy creation for programming or for checking out one off-thoughts.

• A series of functions (also called as instructions or methods) that make up the middle programming interface, or API, in addition to numerous libraries help greater superior functions which include sending records over a network, analyzing photos from a webcam, and saving complicated imagery in a PDF format.

• A language syntax, equal to Java however with some modifications used.

The Processing method has additionally been implemented to electronics via the Arduino and Wiring tasks. Arduino makes use of a syntax stimulated with the aid of using that used with Processing and maintains to apply a changed model of the Processing programming surroundings to make it less difficult for students to discover ways to apply robotics and other endless different electronics tasks. The number one free of the Foundation is to expand and distribute the Processing software program.

4.3 The Interaction Box - The length of the Interaction Box is decided with the aid of using the Leap Motion discipline of view and the person's interplay's top setting (withinside the Leap Motion manipulates panel). The controller software program adjusts the scale of the container primarily based totally on the peak to hold the lowest corners in the discipline of the view. If you place the interplay top better, then the container will become larger. Users can set the interplay top primarily based on the peak they choose to maintain their fingers while the usage of the controller. Some customers want to maintain their fingers at a greater distance better above the tool than others. By the usage of the Interaction Box to map the Leap Motion coordinate gadget in your utility coordinate gadget, you could accommodate each style of customers. A person also can set the interplay top to alter automatically. If the person moves his or her fingers beneath the cutting-edge ground of the interplay container, the controller software program lowers the peak till it reaches the minimal top & likewise if the person moves above the interplay container, the controller raises the container.
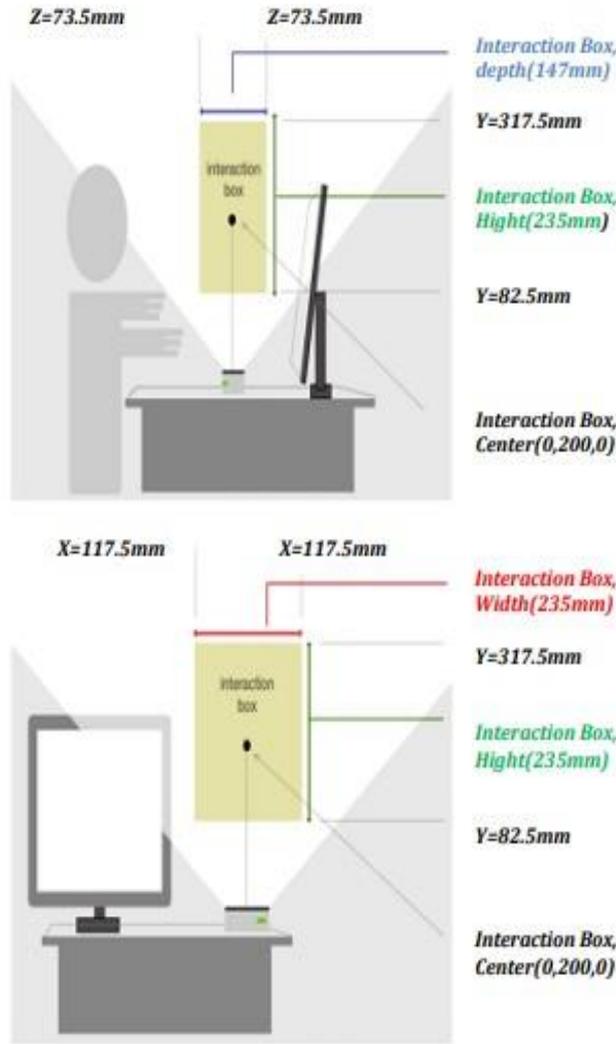
Figure 6: The Interaction Box

The Leap Motion API defines a class representing every tracked object.

V.   Conclusion

It is said that Robotics and Automation Technologies are growing very fast, studies and trends promise extra dependable and complicated improvements to make matters easy. The recent & nevertheless present pandemic like COVID-19 or in advance incidents like EBOLA confirmed the requirement of growing a great deal extra promising technology to lessen the dying matter in this kind of disastrous situation. In observation with the aid of using this PDSH Gunawardane, mentioned the competitiveness of the Master Designs and illustrates the effectiveness of gesture control. Among such a lot of to be had gesture technology, 3-D spectroscopic imaginative and prescient structures famous today, and the rising of gadgets like Microsoft Kinect and Leap Motion Controller indicates the development of technology. These novel technologies have opened new doors to many programs on top of things and mechatronics. It may be very vital to guarantee the fitness of the employees withinside the clinical quarter from epidemic environments. Therefore, this Hand Gesture Controlled Robot Manipulator for Medical Industry became evolved to play that position in a plague environment. Not the handiest to the clinical area, however, there also are many extra programs, as mentioned in advance. The Proposed System describes Controlling an articulated Robotic Arm with the use of Leap Motion Sensor. It facilitates us to benefit from deeper expertise in robots and the entire area of PC science. In this Proposed work, we get Proper Gestures (Hand Motion results). Using Leap Motion Sensor in Real-time, we Observed that our gadget is laboured efficaciously and in real-time, we get X, Y, and Z hand motions & statistics for the use of Leap Motion sensor with the aid of using the use of Java Programming, and these statistics mapped with Angle and ship with a serial conversation to Arduino Platform. The new development withinside the set of rules is important for small precision motion withinside the Robotics System.

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