ROBOT LANGUAGES:

Robotic languages are at different levels of sophistication depending on their design and application. This ranges from machine level to a proposed human intelligence level. High-level languages are either interpreter-based or compiler-based. Interpreter-based languages execute one line of the program at a time. Each line of the program has a line number. The interpreter interprets the line every time it is encountered (it converts the robot program to a machine language program that the processor can understand and execute) and executes each line sequentially. The execution continues until the last line is encountered, or until an error is detected, at which time execution stops. The advantage of an interpreter-based language is in its ability to continue execution until an error is detected, which allows the user to run and debug the program portion by portion. As a result, debugging a program is much faster and easier. Compiler-based languages use a compiler to translate the whole program into machine language (which creates an object code) before it is executed. Since the processor executes the object code, these programs are much faster and more efficient.

MICROCOMPUTER MACHINE LANGUAGE LEVEL:

This is the lowest level of programming. The program is written in machine language, which is made up of 0s and 1s. It is very fast and efficient, but hard to read and understand. All programming languages eventually get converted into machine language so that the computer can run them. But when we use higher-level languages (like C, Python, Java), we write the program in an easier and more understandable form, and then it gets translated into machine language by a compiler or interpreter.

POINT-TO-POINT LEVEL:

At this level, you give the robot a list of positions (points) one after another. The robot simply moves from one point to the next in the order entered. This method is very simple and easy, but not very powerful.
It cannot use sensors, cannot make decisions, and cannot use if-else conditions. It just follows the points what we give.

PRIMITIVE MOTION LEVEL:

At this level, we can write more advanced programs for the robot. The robot can use sensor data, make decisions, and use if-else conditions. Most languages at this level use an interpreter, which reads and runs the program line by line.

STRUCTURED PROGRAMMING LEVEL:

At this level, robot programs are written in a well-organized and powerful way. These languages use a compiler, which translates the whole program at once. They allow you to write complex and advanced programs, but they are harder to learn compared to simpler levels.

TASK-ORIENTED LEVEL:

This level means you just tell the robot what task to do, and the robot should figure out all the steps by itself. The user doesn’t need to program every small movement. But in reality, this type of robot language does not fully exist yet.

COLLABORATIVE ROBOTS:

Collaborative robots (also called cobots) are designed to safely work and collaborate with humans. Therefore, it is necessary that these robots have sensors and the intelligence needed to work safely around humans (or other robots and machines), to prevent injuries, damage, or mishaps Most early cobots (collaborative robots) were made to move slowly so they would be safe around humans. Because they moved slowly, they were less productive, but they didn’t need safety cages. Some modern cobots can work fast like normal robots or slow like cobots, depending on the situation. Today, most industries want more speed and higher output, many new cobots can move almost as fast as regular robots, even when working with humans. Cobots are designed to be able to determine the presence of a human around them. This can be accomplished by a vision system and a camera that is mounted on the arm and can see the workspace of the robot and to avoid harming the user.In the medical field, cobots play a crucial role by assisting doctors, surgeons, nurses, and therapists with precision-based, repetitive, or physically demanding tasks.

NEED FOR COLLABORATIVE ROBOTS IN MEDICINE:

- Modern hospitals demand high precision, reduced errors, and improved patient care.
- Surgeons often face fatigue during long procedures.
- Manual operations like patient handling, rehabilitation, or repetitive laboratory work require extra manpower.
- Cobots help overcome these limitations by providing consistent, fatigue-free, repeatable performance.

TYPES OF COLLABORATION MODES (ISO/TS 15066):

- Safety-rated monitored stop – Robot pauses when a human enters its workspace.
- Hand guiding – Human physically moves the robot; useful in surgical positioning.
- Speed and separation monitoring – Robot changes speed based on distance from a human.
- Power and force limiting – Robot restricts force to avoid injury.

ADVANTAGES:

- High accuracy in surgical and diagnostic tasks
- Enhanced patient safety due to controlled forces
- Reduced workload on medical staff
- Repeatability and precision without fatigue
- Improved efficiency in hospitals
- Faster recovery for patients due to consistent therapy

LIMITATIONS:

- High initial cost
- Need for skilled operators and training
- Integration complexity in hospital environments

- Limited speed/force due to safety constraints
- Regulatory and approval issues