Artificial intelligence on extremity prosthesis and orthosis :

The first Artificial intelligence method used in the lower extremity as Intelligence prosthesis which is a knee joint that replace the hydraulic mechanism by combination of microprocessor controlled and hydraulic or pneumatic actuator.

The microprocessor as name suggests process the signal received by the first sensor known as knee angle sensor provides information about the knee's angle of flexion and extension and velocity of lateral and angular movement, unlike the human body, the sensor determines the direction of movement because of a magnetic implant and second sensor gathers information about weight placement.

Microprocessor receives the data or signals by the motion employed by the amputee and that data are analyzed and interpret to get the closer approximation to natural gait. This data provides information to the microprocessor about the device's position and the extent of its motion, which are essentially proprioceptive sensations. The data are stored in the memory of the microprocessor for the future use like a recurrent neural network (RNN). A series of wire networks which are similar in function to the body's nervous system. That is, it enables the sensors, microprocessor, servo motors, and hydraulic cylinder to communicate with each other. These networks connect the two sensors to the microprocessor, which transmits sensory data much like the ascending sensory pathways send information to the brain. The wires exiting the microprocessor leading to the servo motors carry "motion commands," mimicking the descending motor pathways which instruct muscles to contract and produce a desired movement.

As in the human nervous system, these wires are dedicated to specific communication circuits between the sensors, microprocessor, servo motors, and hydraulics. This computed data are used to control the resistance generated by the hydraulic cylinders through the small valve passes into and out of the cylinder which regulate extension and flexion of the knee joint in different sub phases of gait cycle. It controls knee joint motion from 0° to maximum 60-700. This mechanism helps the amputee to do various activities like stair climbing, jogging, running and walking in uneven terrain.

The microprocessor knee joint uses various algorithms to achieve gait symmetry, motion analysis, stumble control and comfort. These algorithm are control logic, Intent detection algorithm, Genetic algorithm, Fuzzy logic based classifier, Expectation maximization algorithm and Impedance control algorithm . The Prosthetic knee joints uses this microprocessor control mechanism with machine learning Artificial Intelligence are Otto Bock's C leg (1997), OssurRheo knee

(2005), Power knee by Ossur (2006), Self-learning knee by DAW Industries, Plie knee from freedom Innovation, Intelligent Prosthesis (IP) (Blatchford, United Kingdom), Linx (Endolite, Blatchford Inc. United Kingdom), Orion 2 (Endolite, Blatchford Inc. United Kingdom), X2 prostheses (Otto Bock Orthopedic Industry, Minneapolis, MN), X3 prostheses (Otto Bock Orthopedic Industry, Minneapolis, MN) etc.The volitional EMG control robotics Transtibial prosthesis was developed in 2014 by Baojun Chen et al., which adapt the amputee to walk on slope with different angles. The combination of myoelectric and intrinsic controller reduces the fatigue of muscle and attention during walking . The prototype design of prosthesis. Apart from EMG Control lower extremity prosthesis can be controlled by EEG signal using BCI, the example of EEG based control prosthesis is BiOM.

Lower Extremity Orthosis is a supportive device to the patients those have lost their function due to traumatic, neurologic and congenital abnormalities. The working principle of the Orthosis for the patient like hemiplegia, paraplegia and traumatic brain injury is changed vigorously with the implementation of artificial intelligence like functional electrical stimulation, Brain computer Interface and myoelectric controller. The concept of machine learning implemented in some sensor embedded stance control Orthosis which help the paraplegic to achieve near to normal gait with some limitations. The concept of functional electrical stimulation (FES) started in the year of 1960. This is used in case of damage of brain or spinal cord, stroke, Multiple Sclerosis (MS) and cerebral palsy.

The Functional electrical stimulation (FES) is the application of electrical stimulus to a paralyzed nerve or muscle to restore or achieve function. FES is most often used in neuro rehabilitation and is routinely paired with task-specific practice. Neuroprosthesis is a common example in orthotic substitution. Control system can be open loop or Feed forward control, closed-loop or Feed backward control and adaptive control can be applied to both Feed forward and Feed backward controller. In open-loop controlled FES, the electrical stimulator controls the output and closed-loop FES employs joint or muscle position sensors to facilitate greater responsiveness to muscle fatigue, or to irregularities in the environment.