

Robot and Its engineering field applications

A robot is a programmable, multi-function manipulator designed to move material parts, tools, or special devices through variable programmed motions for the performance of a variety of tasks. In present-day robots, the most obvious anthropomorphic characteristic is the robots mechanical arm, which is used for performing various industrial tasks. Less obvious humanlike characteristics are the robot's capability to make decisions, respond to sensory inputs, and communicate with other machines. These capabilities permit robots to perform a variety of useful tasks in industry. This paper discusses the various capabilities and applications of robots.

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Work Characteristics of Robot Applications

The general characteristics of an industrial work situation which have tended to promote the substitution of a robot for human labor are the following:

- Hazardous work environment for human beings: when the work environment is unsafe, unhealthful, hazardous, uncomfortable, or otherwise unpleasant for people, this is a reason to consider a robot for the work.
- Repetitive work cycle: if the sequence elements in the cycle is the same and the elements consist of relatively simple motions, a robot is usually capable of performing the work cycle with greater consistency and repeatability than a human worker.

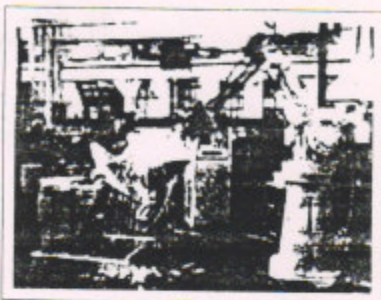


Fig. 1 Arc Welding

- Difficult handling for human beings: if the task involves the handling of parts or tools that are heavy or otherwise difficult to manipulate, it is likely that a robot is available that can perform the operation.
- Multishift operation, in manual operations requiring second and third shifts, substitution of a robot will provide a much faster financial payback than a single-shift operation.
- Infrequent changeovers: most batch or job operations require a change over of the physical workplace between one job and the next. The time required to make the changeover is non-productive time since parts are not being made. Robots have been easier to justify for relatively long production runs where changeovers are infrequent.

Some important Robot Applications

At least some of the work characteristics must be present in any of the following application categories in order to make the installation of a robot technically and economically feasible.

Material Transfer

The primary purpose of the robot is to pick up parts at one location and place them at a new location. Transferring parts from one conveyor to another is an example.

Machine Loading and Unloading

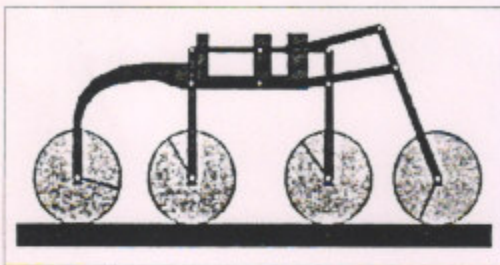


Fig. 2 Schematic representation of mobile robot

This case involves both loading of the raw workpart and unloading of the finished part by the robot. The primary applications are in die casting,

plastic moulding, transfer moulding, metal machining, forging, pressworking, heat treating.

Welding: The applications logically divide into basic categories: spot welding and arc welding. The robot accomplishes a spot weld by means of the following sequence:

- Position the welding gun in the desired location against the two pieces.
- Squeezing the two electrodes against the mating pieces.
- Weld and hold, when the current is applied to cause heating and fusion of the two surfaces in contact.
- Release and cool the electrodes for next spot-weld.

This is a sequence, which has become an ideal task for a point-to-point robot. A typical arc welding station (fig.1) would consist of the following components:

- A robot, capable of continuous path control
- A welding unit, consisting of the welding tool, power source, and the wire feed system

A workpart manipulator, which fixtures the components and positions them for welding

Assembling

Assembly operations are seen as an area with big potential for robot applications.

Batch-type assembly operations seem to offer the most promise for using robots. The reason for this is based economics and the technological capabilities of the robot.

Spray Coating: Many large consumer products (e.g. automobiles, and appliances) and most industrial products require the application of some form of paint. Spray painting requires a robot capable of executing a smooth motion pattern, which will apply the paint or the fluid evenly and avoid runs.

Walking Robot: A six-legged walking robot has the ability of walking over unknown terrain and obstacles. Inside the body are mounted micro controllers. They generate from global operator commands (move forward, backward, turn....) motion trajectories for each leg and leg corrections by means of force information (foot force distribution). The position control system enables tracking of commanded motion.

Technical data of the walking robot mechanics are:

- Aluminium construction
- Walking mechanism: a hexagonal body with 3 degrees of freedom per leg
- Number of legs: 6
- Active degrees of freedom of a leg: 3
- Active degrees of freedom : 18
- Height: 15 cm
- Length of edges: 17 cm
- Mass (without tools, camera...): 21 kg
- Length of a leg: 40.5cm
- Diameter of feet: 6 cm
- Mass of a leg: 2.8 kg
- Mass of the body (including microprocessors) 3.8 kg
- Drive DC-motors

Mobile Robot: A lot of outdoor tasks cannot yet be carried out by robots because of their poor mobility in rough terrain. Moreover, presence of stairs limits the indoor or urban use of mobile robotics. For planetary exploration, highly autonomous robots are necessary to perform long-range missions. Future missions will change from

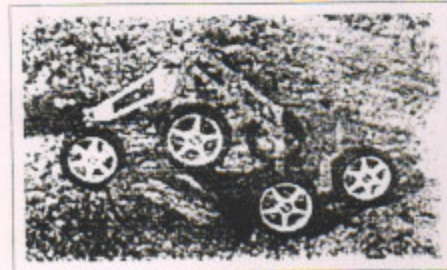


Fig. 3 Climbing of a rock



Fig. 4 Climbing of a step

pure exploration to real exploitation. This will drastically modify the environment of space rovers, that will not encounter only rocks or dunes but also trenches, pipelines, regular steps or even furrows (fig.2-4).

The Shrimp is a 6-wheeled rover. The total weight of this first prototype is 3.1 kg including 600 g of batteries and a 1.75 W DC motor powers each wheel. Dimensions are L 60 cm x W 35 cm x H 23 cm; the ground clearance is 15 cm.

- One wheel in front, mounted on an articulated fork.
- One wheel in rear directly connected to the body



Fig. 5 Tractor with a robot

Two wheels are mounted on two lateral bogies. The only actuators are the motorized wheels and the Shrimp adapts purely passively its structure during the motion to insure its stability. This allows a very simple control strategy as well as low power consumption. The secret of its high mobility lies in the

parallel architecture of the front fork and of the bogies Fig. 3 Climbing a rock.

Tractor Robot: Presently, land mines planted in rugged terrain require humanitarian de-mining efforts. This arduous and dangerous process of manually detecting a landmine with the equivalent of a metal-detector, places human lives in great risk and is time consuming. For effective and reliable mine detection, mine clearing robotics (fig.5) must position their sensors appropriately over "hills" and "holes" created concave and convex terrain surfaces.

Humanoid Robot: A humanoid robot is named Saika ("outstanding intelligence" in Japanese). The developed humanoid robot Saika has a two-DOF neck, dual five DOF upper arms, a torso and a head. Several types of hands and forearms are developed.

They are chosen depending upon the tasks to perform. The features of Saika are: Saika is modularized to reduce the developing cost and to make maintenance easy, the total weight of the head, the neck, the two upper arms and the torso is only eight kilograms and most of the motors are installed inside the arms and the torso. Three kinds of skillful manipulations are studied as examples of behavior based movement control:

- Hitting a bounding ball
- Grasping unknown objects by groping
- Catching a thrown ball.

Conclusion

Less obvious humanlike characteristics are the robot's capability to make decision, respond to sensory inputs and communicate with other machines. These capabilities permit robots to perform a variety of useful tasks in the industry. Some of the field applications discussed are the checklist of features to look for in a work situation in order to determine if robot application is feasible. **EA**