

# Parallel Robots in Construction

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**Abstract**— Parallel robots have been in existence since the first half of the 20<sup>th</sup> century. Applications of parallel robots have ranged from tire testing machines to robots for performing surgery. The high load-to-weight ratio and high stiffness of parallel mechanisms sets them apart from more common serial robots. This presentation will discuss the relevant history of parallel robots and their kinematics, and presents past and current work on their application to construction.

**Index Terms**—Parallel robots, construction automation, Stewart/Gough platform

## I. WHAT ARE PARALLEL ROBOTS?

### A. Common synonyms

- Parallel link manipulator
- Stewart/Gough platform
- Parallel kinematic machine
- Parallel kinematic structure

### B. The structure of parallel robots and their serial cousins

- Closed loop vs. open loop kinematic chains
- Planar vs. spatial kinematic chains

### C. History

- 1931 – Gwinnett’s amusement device
- 1942 – Pollard’s position controlling apparatus
- 1957 – Gough’s tire testing machine
- 1965 – Stewart’s platform with 6 degrees of freedom
- 1965 to the present
- Examples of common/well-known parallel robots

### D. Advantages and Disadvantages of Parallel Robots

## II. KINEMATICS AND DYNAMICS OF PARALLEL ROBOTS

### A. Inverse kinematics

Simple to solve.

### B. Forward kinematics

- Still an open problem
- No general closed-form solution
- 40 real solutions
- How is the forward kinematics problem solved?
  - Extra sensors
  - Redundancy
  - Mathematical techniques
  - Interval analysis
  - Continuation techniques

### C. Dynamics

## III. COMMERCIAL EXAMPLES OF PARALLEL KINEMATIC MACHINES IN CONSTRUCTION

## IV. RESEARCH IN PARALLEL ROBOTS FOR CONSTRUCTION

### A. Research at NIST

- Robotic crane
- Automated welding, grinding, cutting, inspection, material handling, pipe fitting, oil-well fire fighting, ship building, bridge construction, air craft maintenance, ship-to-ship cargo handling, steel erection, etc.

### B. Other Research

- Quay cranes
- Space construction
- Robotic cranes
- Climbing robots
- Welding robots

## V. FUTURE DIRECTIONS