Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Engineering Research in Fluid Power: A Review

Hua-yong YANG, Min PAN

Cite this as: Hua-yong YANG, Min PAN, 2015. Engineering research in fluid power: a review. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 16(6):427-442. [doi:10.1631/jzus.A1500042]

Introduction

- In fluid power engineering, hydraulics is used for the generation, control, and transmission of power by the use of pressurized liquids. Fluid mechanics provides the theoretical foundation for hydraulics. Hydraulic topics range through some areas of science and most engineering modules

- It covers concepts such as pipe flow, fluidics, fluid power motion control,pumps,valves,actuators,turbines,hydropower, computational fluid dynamics, and flow measurement.

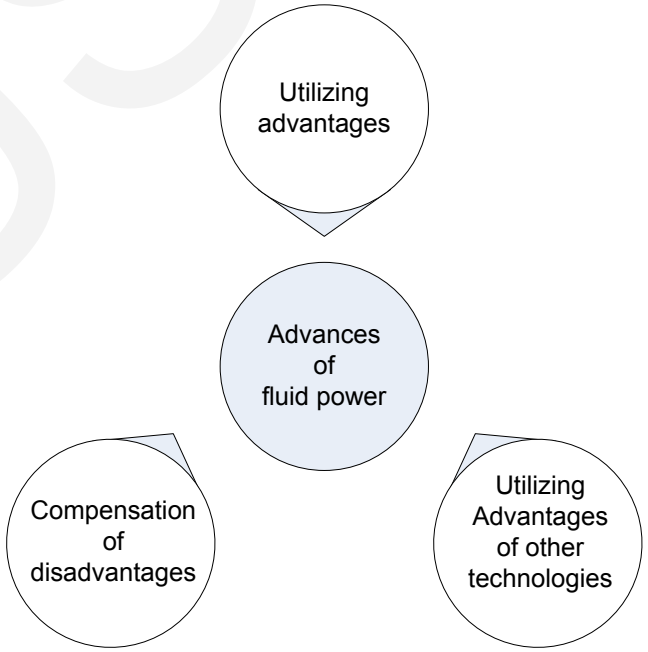


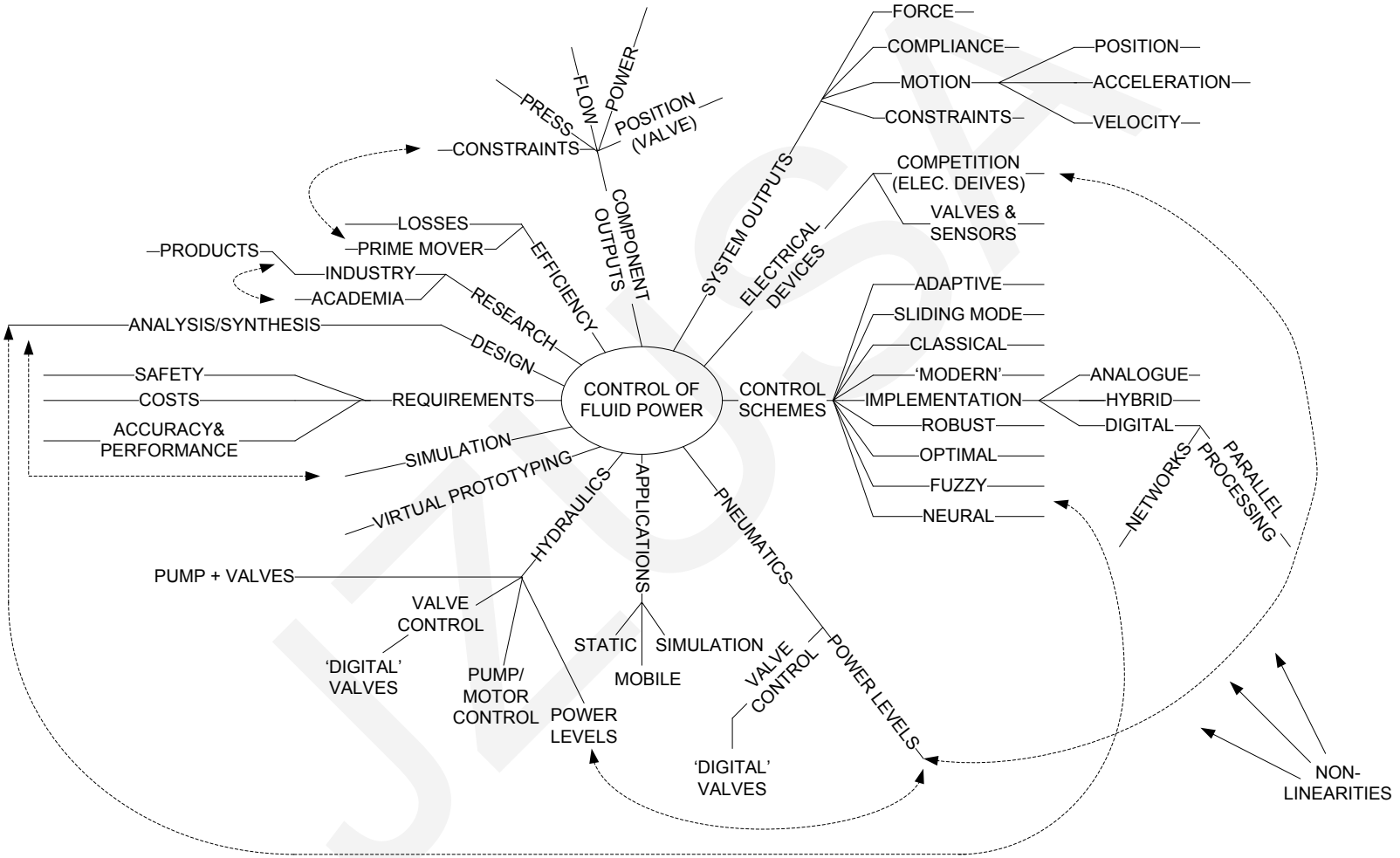
Fig. 1 Development of fluid power (Backé, 1993)

JZUSA

Prognosis of the possible future development of fluid power (Backé, 1993)

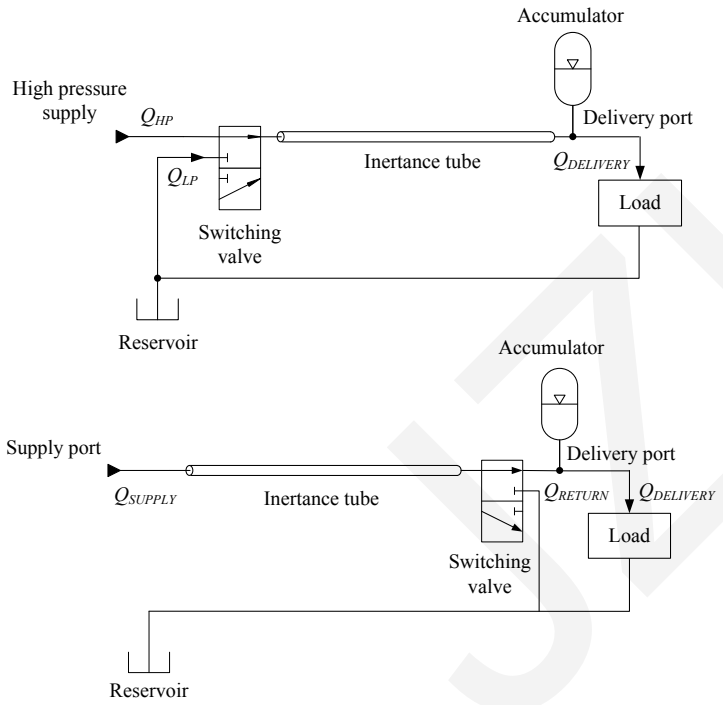
1	Intensified application of computer programs to optimize motion, flow, noise and mechanical properties
2	Application of new materials: coatings, ceramics, plastics to improve wear resistance and tribological properties
3	Application of energy-saving components and systems: (a) Intelligent pressure supply adapting pressure and flow to the demand of the consumers (e.g. load sensing) (b) Intensified use of variable displacement units with high efficiency
4	Further development of sealing and joint techniques to minimize leakage
5	Development and use of biological degradable pressure fluids
6	Use of oil-free compressed air in pneumatics
7	Separation of fluid power circuit and electronic signal circuit for high-quality applications
8	Tendency to fully digitized signal circuit with digital interfaces for signal input and output
9	Intensified application of modern control concept with adaption to changes of open-loop properties
10	Integration of component-related electronics and sensors into devices, e.g. variable displacement units, cylinders, proportional valves
11	Tendency to self-sufficient electrohydraulic or electropneumatic axis drives with bus interface

The domain of fluid power control (Edge, 1997)



Fluid power components and systems

- Typical hydraulic components: pump, valve and actuator
- Examples: fluid power systems



Switched inertance hydraulic system

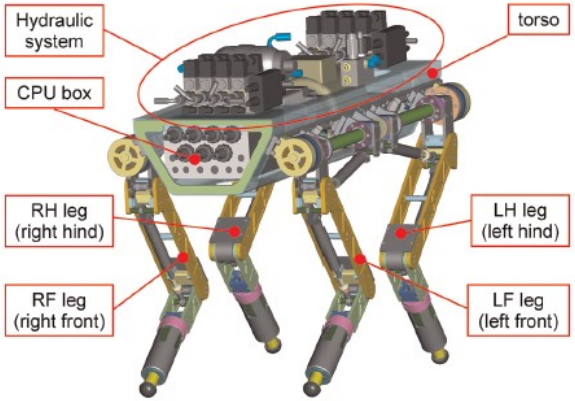


Marc Raibert's 3-D biped



BigDog – Boston Dynamics

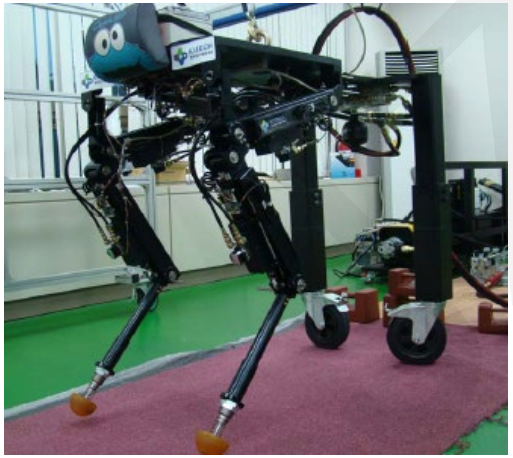
Fluid power components and systems



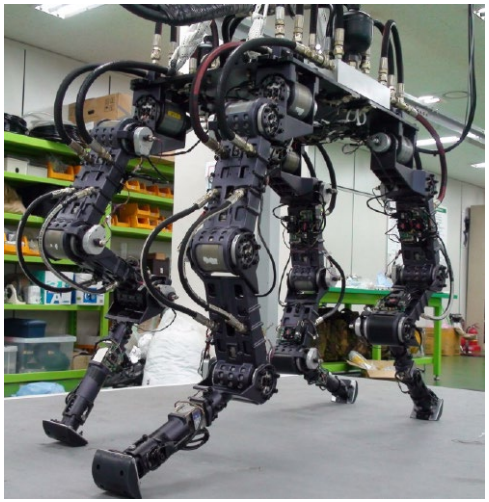
Hydraulic Quadruped (HyQ) developed in Italian Institute of Technology, Italy



John Deere walking machine

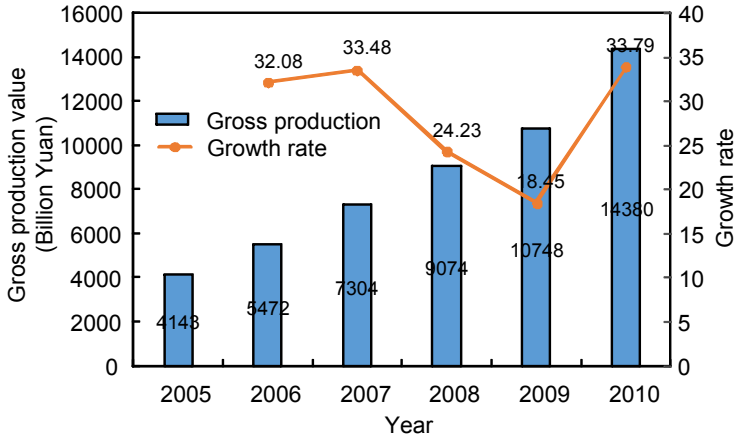


A quadruped walking robot, qRT-2

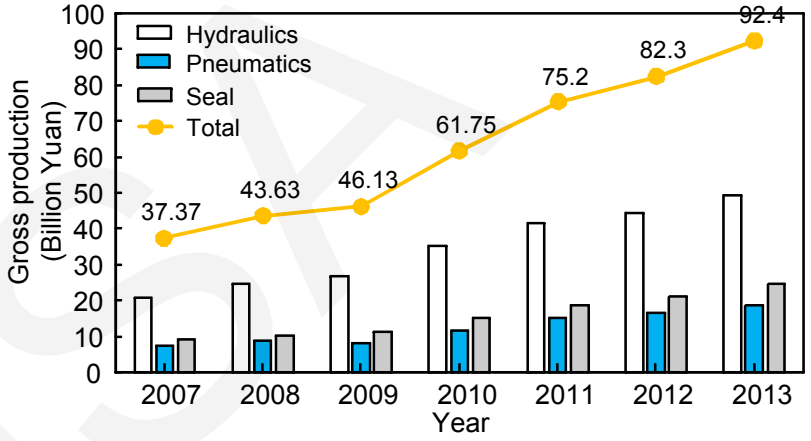


A quadruped walking robot, p2

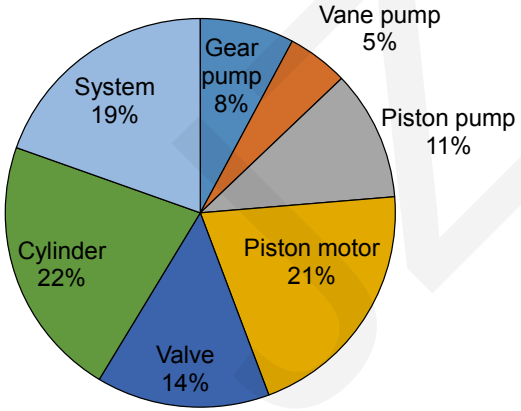
Development of fluid power in China



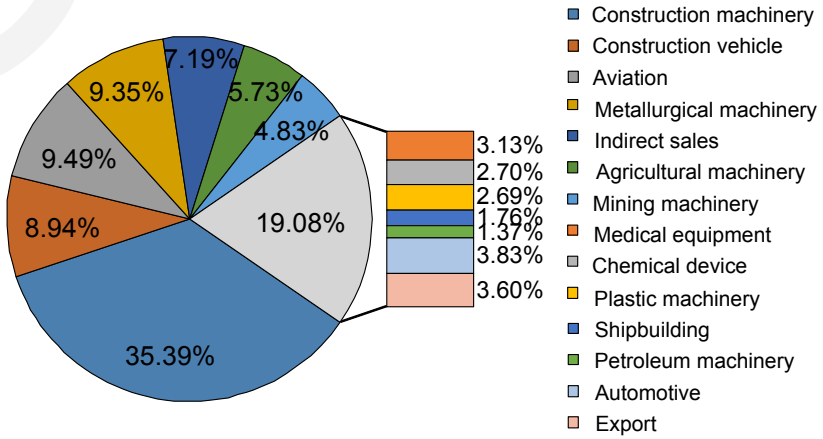
Gross production value of domestic mechanical industry and its growth rate



Gross production value of the fluid power areas



Distribution of products in hydraulics in China in 2010



Distribution of application areas of hydraulic machines in China in 2010

Challenges and recommendations

Energy efficiency

Quiet and clean

Compactness, integration, and weight

Fluid power education

Conclusions

- The domain of fluid power control can be expanded to a wider multi-disciplinary range, which can include efficiency, components design and optimisation, integration and compactness, environmental impact, and user friendly and energy-efficient applications.

- Although we are facing challenges and competition from other areas such as mechanics or electricity, we still believe there is a very promising future as fluid power has its particular and significant advantages of high power density, high power-to-weight ratio of actuators, system responsiveness, controllability, and versatility.

JZUSA