

Control Systems: Introduction and History

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Vikram Sarabhai: Father of Indian Space Science: 1919-1971

Outline

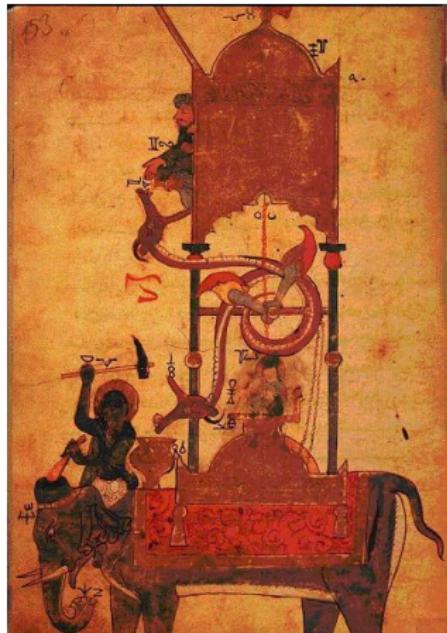
- 1 Brief History
- 2 Journals & Conferences: Publish Your New Theory, Applications, Findings
- 3 Scientists/Mathematicians in Area of Control
- 4 Recent Applications in Main Stream News

Brief History of Control Systems

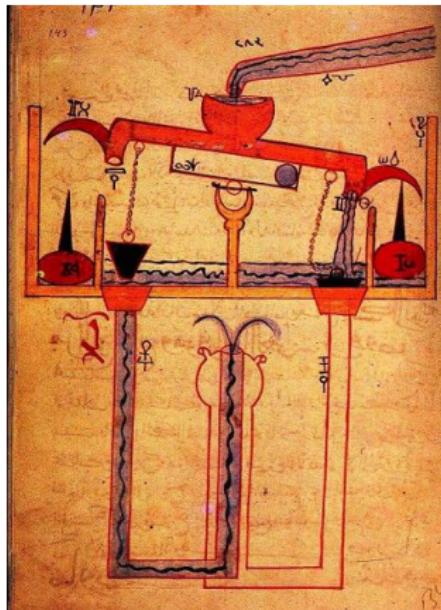


Figure: Jafar, Ahmad, Al-Hasan: Famous Musa Brothers: 800AD

Musa Brothers inventions



(a) Elephant Clock



(b) Fountain using balance

Machine in Indian Civilization

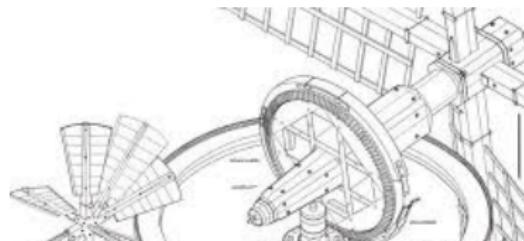
"samarangana sutradhara" by rajabhoja 11th century text besides discussing elaborately on architecture and town planning, in Chapter 31 discusses concept of 'yantra'..

The work treats of the construction of cities, palaces, and mansions with greater clearness of expression and wealth of details than any other available work of Śilpa Śāstra. The 31st chapter contains descriptions of various kinds of machines that are not found in other Śilpa works, such as the elephant machine (गजयन्त्र), wooden bird-machine travelling in the sky (ब्योमचारिविहङ्गयन्त्र), wooden vimāna machine flying in the air (आकाशगामिदारुमयविमानयन्त्र), door-keeper machine (द्वारपालयन्त्र), soldier machine (योधयन्त्र) etc.

“ यन्त्रेण कल्पितो हस्ती न तद् गच्छत् प्रतीयते ।
शुकाद्याः पश्चिणः कलृप्सास्तालस्यानुगमान्मुहुः ॥
जनस्य विस्मयकृतो नृत्यन्ति च पठन्ति च ।
पुत्रिका वा गजेन्द्रो वा तुरगो मर्कटोऽपि वा ॥
बलनैवर्तनैर्नृत्यंस्तालेन हरते मनः । ”

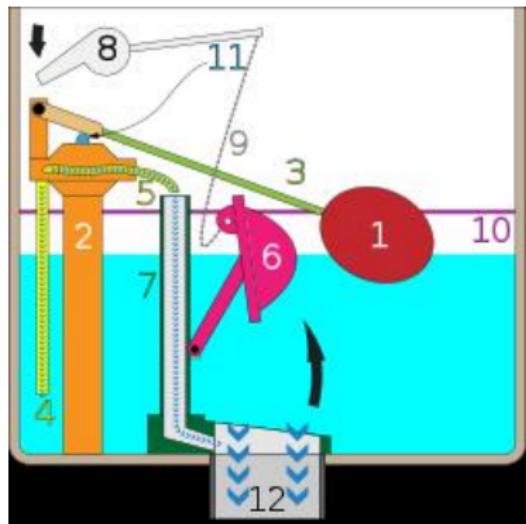
Industrial Revolution

Industrial Revolution 17th and 18th Century AD
Windmill; Fantail 1745 ; Turns the main sails to point in the direction of wind.



History

Float Governor for household plumbing (1749);



(e) Valve



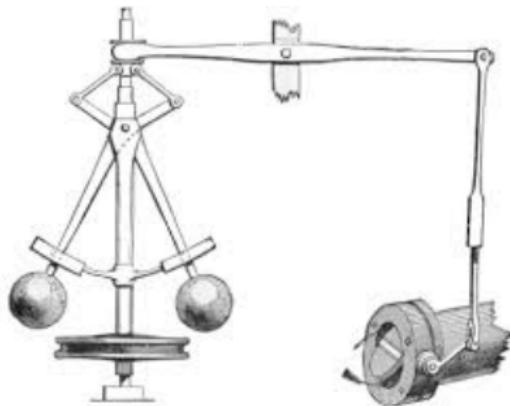
(f) Float

History Continued...

Steam Engine - 1769, Technology of float valve was later also adopted for steam engines Flyball Governor to control steam - 1788-89.



(g)



(h)

Tipu's Rockets (1780-1795)



(i)



(j)

<http://www.nal.res.in/pdf/pdfrocket.pdf>

Tipu's Rockets(1780-1795)

Mysore rockets of this period were much more advanced than what the British had seen or known, chiefly because of the use of iron tubes for holding the propellant; this enabled higher bursting pressures in the combustion chamber and hence higher thrust and longer range for the missile. The rockets consisted of a tube (about 60 mm diameter and 200 mm long), fastened to a sword or 3 m bamboo pole, and had a range of 1-2 km. In the famous battle of Pollilur (1780) in which the British were defeated - a scene celebrated on the walls of Darya Daulat Bagh in Srirangapatna - a strong contributory cause is thought to have been the explosion of Colo Baillies ammunition tumbrils, touched off by Mysore rockets. -Prof. Roddam Narasimha

History

In 1840, the British Astronomer Royal at Greenwich, G.B. Airy, developed a feedback device for pointing a telescope. His device was a speed control system which turned the telescope automatically to compensate for the earth's rotation.

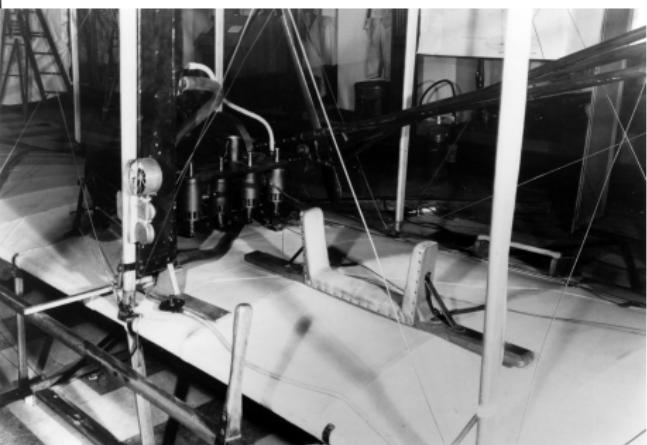


On May 30, 1899, Wilbur Wright wrote a letter to Smithsonian Institute, expressing desire to join the aeronautical community, stating,
"Dear Sirs: I am an enthusiast, but not a crank in the sense that I have some pet theories as to the proper construction of a flying machine. I wish to avail myself of all that is already known and then if possible add my mite to help on the future worker who will attain final success.

Wilbur along with his brother Orville eventually realized his vision in 1904 by designing and demonstrating a practical flight.



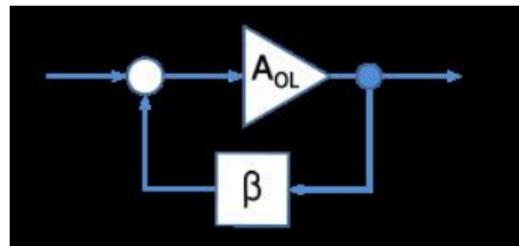
(k) Flight Transmission system



(l) Flight controller

History

Feedback Amplifier was invented by Herold Stefan Black at Bell Labs, 1927.



Later Inventions

- Process Industry
- Servo Mechanisms
- Ships
- Telephone and Feedback Amplifier
- Aircraft
- Radar Control
- Missile Control
- Process Control
- Power Systems
- Trains
- 2-D and 3-D Printers
- Satellites
- Robots
- Rovers
- Space Station

International Journals

- ① IEEE Transactions on Automatic Control
- ② IEEE Transactions on Control Systems Technology
- ③ Elsevier: Automatica
- ④ Taylor & Francis: International Journal on Control
- ⑤ Springer: Mathematics of Control Signals & Systems
- ⑥ Springer: Journal of Control, Automation & Systems
- ⑦ Wiley: Asian Journal of Control

International Conferences

- ① **IEEE International Conference on Decision and Control**
- ② **IEEE American Control Conference**
- ③ **IEEE European Control Conference**
- ④ **IEEE Indian Control Conference**

Scientists/Mathematicians in Area of Control



Simon Laplace: 1800

Scientists/Mathematicians in Area of Control

James Maxwell: wrote differential equations for flyball governor 1868



Scientists/Mathematicians in Area of Control

Alexander Lyapunov: studied stability of dynamical systems 1898.



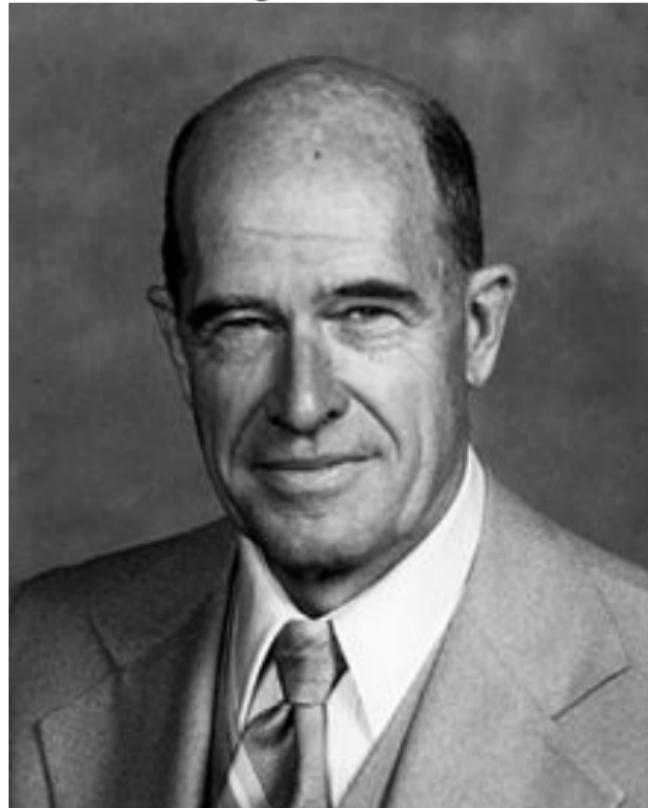
Scientists/Mathematicians in Area of Control

Edward John Routh, gave stability tests (1877).



Scientists/Mathematicians in Area of Control

Walter Evans gave us Root-Locus Tool.



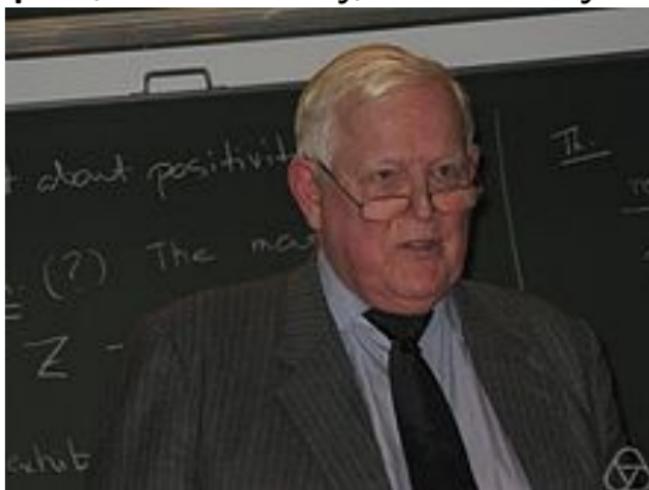
Scientists/Mathematicians in Area of Control



Bode and Nyquist.

Scientists/Mathematicians in Area of Control

Rudolf Kalman: State-space, Controllability, Observability concepts and



famous Kalman Filter.

Scientists/Mathematicians in Area of Control

Alberto Isidori: Non-Linear Control Systems



Scientists/Mathematicians in Area of Control



Jane Cullum
numerical algorithms for large-scale computations, systems and control



Irmgard Flugge-Lotz
aerospace dynamics, automatic control, and aircraft flight systems



Faina M. Kirillova
optimal control, extremal problems, optimization algorithms, and control stabilization



Violet Haas
control engineering research and education



Makiko Nisio
mathematical aspects of stochastic control



Huashu Qin
control research and education

Scientists/Mathematicians in Area of Control

ISRO Scientists celebrating success of Mangalyaan!



Scientists/Engineers in Area of Control

Ritu Karidhal: Mission Director of Chandrayan-2



Scientists/Engineers in Area of Control



Nandini Harinath
Project Manager, Mission Design
Deputy Operations Director
Mars Orbiter Mission

Link: [▶ Link](#)

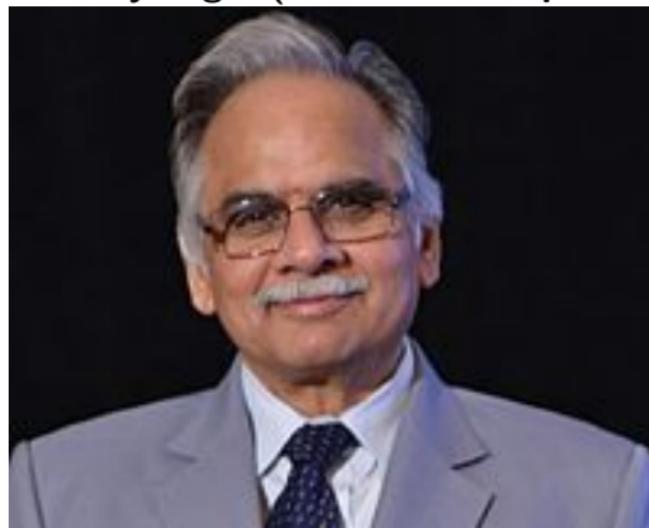
Indian Researchers in the Area of Control Systems

T. Kailath (Infinite Dimensional Systems, 1970)



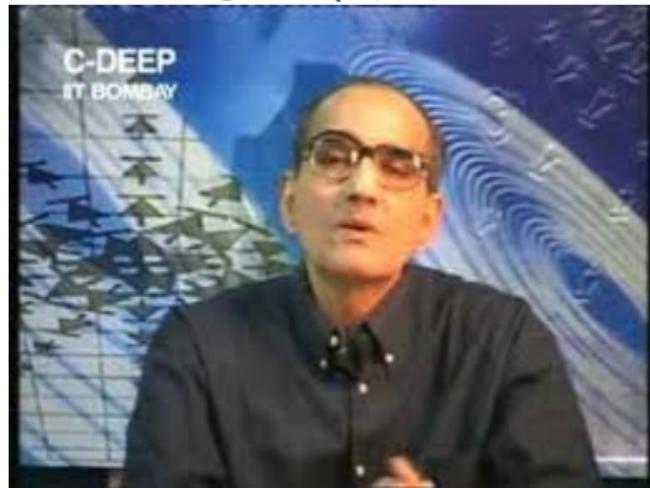
Indian Researchers in the Area of Control Systems

M. Vidyasagar (Multivariable optimal control, 1980).



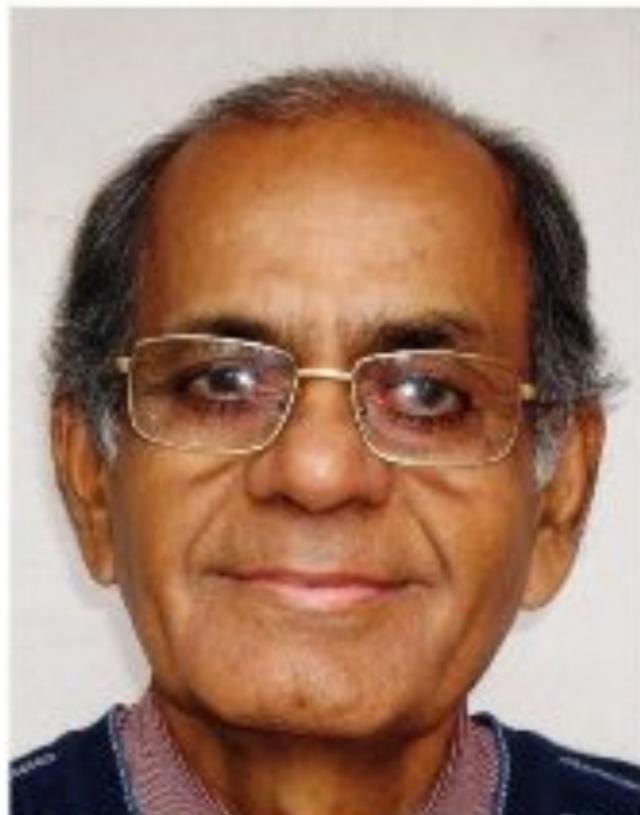
Indian Researchers in the Area of Control Systems

Sadanand Agashe (Optimal Control Theory)



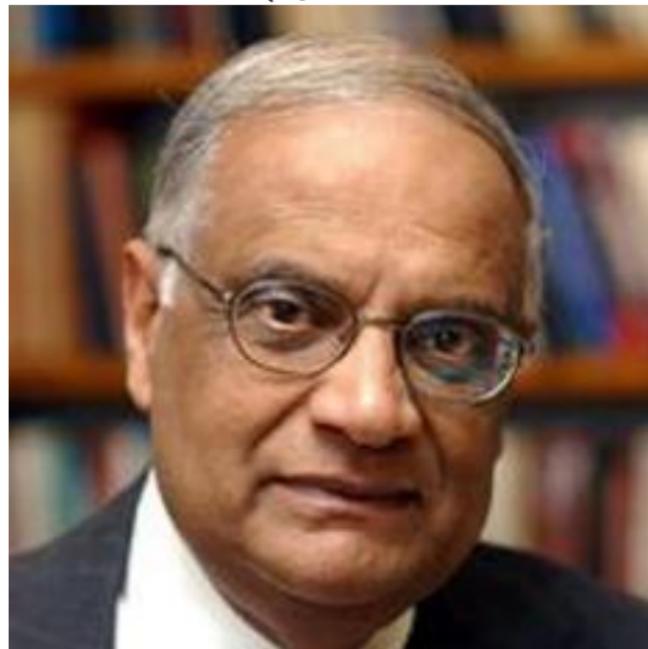
Indian Researchers in the Area of Control Systems

M. Gopal (Modern Control Systems).



Indian Researchers in the Area of Control Systems

K S Narendra (System Identification, Geometric Control Theory, 1980).



Industry Research Opportunities

- ① Indian Space Research Organization
- ② National Aeronautics Laboratory
- ③ Defence Research Laboratory (DRDO)
- ④ Automotive Industry: GM, GE, Honeywell, Mahindra

Recent Applications in Main Stream News

Under the bonnet

How a self-driving car works

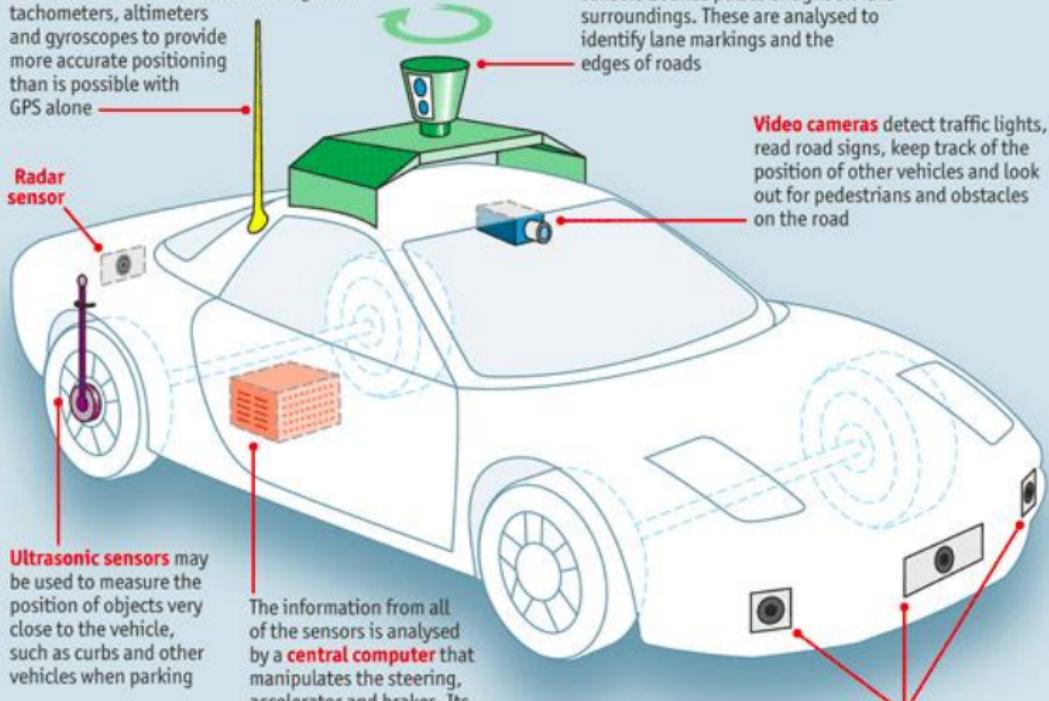
Signals from **GPS (global positioning system)** satellites are combined with readings from tachometers, altimeters and gyroscopes to provide more accurate positioning than is possible with GPS alone

Radar sensor

Ultrasonic sensors may be used to measure the position of objects very close to the vehicle, such as curbs and other vehicles when parking

Lidar (light detection and ranging) sensors bounce pulses of light off the surroundings. These are analysed to identify lane markings and the edges of roads

Video cameras detect traffic lights, read road signs, keep track of the position of other vehicles and look out for pedestrians and obstacles on the road



Recent Applications in News

Curiosity Rover Landing <https://www.youtube.com/watch?v=oNviFQpRvwQ>





▶ Link