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Editorial

Steady Trajectory Tracking Control

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EDITORIAL

Robust control or Steady control is a controller design technique that directly addresses uncertainty in control theory. Robust control methods are intended to work properly if unclear parameters or disturbances are encountered within some (usually small) set. Robust approaches strive for robust performance and/or stability in the face of bounded modelling flaws. The early approaches of Bode and others were generally robust; but, the state-space methods developed in the 1960s and 1970s were occasionally discovered to be lacking in robustness, motivating research to enhance them. This was the beginning of robust control theory, which emerged in the 1980s and 1990s and is still in use today. The Brachystochrone issue introduced trajectory optimization in 1697: find the geometry of a wire such that a bead sliding along it moves between two points in the shortest time. The intriguing aspect of this problem is that it optimises over a curve (the form of the wire) rather than a single integer. The most well-known solution was calculated using calculus of variations. Informally, a controller developed for one set of characteristics is said to be robust if it also functions well under another set of assumptions.

A simple example of a robust control system is high-gain feedback; with sufficiently high gain, the influence of any parameter variations is minimal. In the presence of system parameter uncertainty, large open-loop gain leads to significant disturbance rejection from the standpoint of the closed-loop transfer function. Sliding mode and terminal sliding mode control are two other types of resilient control. Robust control systems frequently employ complex topologies such as numerous feedback loops and feed-forward routes. The control laws may be expressed by high order transfer functions that are required to achieve desirable disturbance rejection performance while maintaining robust closed-loop operation.

Robust control theory originated in the late 1970s and early 1980s, and it quickly produced a number of approaches for dealing with limited system uncertainty. H-infinity loop-shaping, created by Duncan McFarlane and Keith Glover of Cambridge University, is arguably the most notable example of a robust control approach. Sliding Mode Control (SMC), a form of variable structure control, is a developing application field of robust control (VSC). SMC's resilience features in terms of matching uncertainty, as well as its simplicity in construction, drew a wide range of applications. While deterministic approaches have typically been used to deal with robust control, in the last two decades this approach has been criticised on the grounds that it is too rigid to reflect genuine uncertainty, and it frequently leads to too conservative solutions. Probabilistic robust control, which interprets robust control within the context of scenario optimization theory, has been introduced. The processes of constructing a trajectory that minimises (or maximises) some measure of performance while satisfying a set of restrictions is known as trajectory optimization. In general, trajectory optimization is a method for calculating an open-loop solution to an optimal control issue. It is frequently employed in systems where computing the complete closed-loop solution is unnecessary, inconvenient, or unattainable.

Although the concept of trajectory optimization has been known for hundreds of years (calculus of variations, brachystochrone problem), it was only with the arrival of the computer that it became feasible for real-world applications. Many of the first uses of trajectory optimization were in the aerospace industry, where rocket and missile launch trajectories were computed. Trajectory optimization has lately been applied in a wide range of industrial process and robotics applications. Within the topic of walking robotics, there are numerous applications for trajectory optimization. One paper, for example, employed trajectory optimization of bipedal gaits on a basic model to show that walking is energetically advantageous for travelling at a low speed and running is energetically advantageous for moving at a high speed.

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