actuators

Editorial

Updated Author Guidance for Papers to *Actuators*

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1. Original Actuator Technical Guidance

The potential authors for *Actuators* must consider a wide range of scientific, technical, application, and economic issues in creating a useful paper of interest to the widest population of readers and decision makers. The journal was established in 2012 based on a broad review of the actuator domain: "Overview of the Long Term Objectives of the Journal Actuators" [1]. This review remains valid today. It also refers to the foundation paper by the Editor-in-Chief: "Next Wave of Technology" [2].

2. Actuator Applications and Development Priorities

A careful review by the Editor in-Chief and Associate Editors recommends the following nine principal application and development categories to be invited for submission to the journal *Actuators*. It is further recommended that paper topics involve actuators which have a high benefit to cost ratio for a given field of use.

1. Land Transport	This involves the primary function of transforming on-board energy into commands to wheels for land transport (motorcycles, cars, buses, trucks, trains, etc.). These wheel drives must be very durable (20,000 h), very efficient (~85%), and independent to respond to command and to meet adverse operating conditions.
2. Aircraft	The dominant requirements are fault tolerance (no single point failures), torque/force density, and efficiency. Generally, distributed control with a minimum weight, volume, etc. and standardized interfaces for rapid repair and refreshment are essential.
3. Medical Instruments	Here, the question is reliability and miniaturization, especially in surgery or other invasive operations. It is useful also to have a high efficiency (low operating temperature and low noise), especially in rehabilitation systems.
4. Robotics	This has now become a very diverse field, from industrial manipulators to mobile platforms used to move packages in internet-based distribution centers. Durability and cost are the major measures of success.
5. Manufacturing	This involves two distinct application ranges. The first is the simple handling and preparation of product components for assembly (polishing, trimming, forming, painting, etc.). The other end of the spectrum involves high accuracy even under machining force disturbances. The first involves cost (system assembly, repair, and up-dates using standardized modules performed by a well-trained high school-level technician). The other end involves high value-added precision operations (machining, drilling, cutting, etc.), rejecting force disturbances using high-end sensor data and multi-criteria-based operating system software.

6. Materials	This involves a very wide range of choices. For transport, low weight/high stiffness could be an issue. In the medical field, the material must be lucent relative to measurement signals (MRI, x-ray) during surgery. Some material applications may require a high formability, high resistance to chemicals, low contact friction, etc.
7. Power/Torque Density	Increasingly, many high-level applications require a high output power or torque relative to the weight and volume. A prime mover may offer 1 ft-lb/lb. up to 6 ft-lb/lb. of torque. The prime mover may operate at a full range of speeds (say, from 1 to 50 k RPM) to offer a very wide range of power densities. All of this is affected by the basic actuator reality, that it must control positive/negative operations through cross overs in the minimum time in order to best manage the complex output functions under command.
8. Precision	A lot of applications are dominated by a need for precision response (position, velocity, acceleration, torque, etc.) to command. This is especially true of many medical, military, and manufacturing domains. Precision response depends first on having high-end sensors to measure the response quality to command, which informs the decision making software to respond to disturbances with the minimum latency. Unfortunately, most actuators are highly nonlinear, making this topic of special value to all future high-end actuator applications.
9. Miniaturization	Computer electronics based on the miniaturized chip are essential for advanced decision-making systems. The same is the case for actuators in the medical field, precision handling in small assemblies, product inspection, etc. Here, the piezo element likely becomes the principal prime mover fully integrated into a position/force/torque transformer to provide a wide range of very small physical operations under command.

3. Editorial Guidance on Paper Content

In general, each actuator is a combination of a motion reducer, prime mover, sensor, electronic controller, and control software. These, when unified into a valid driver of electro-mechanical systems (under human or machine command, or both), must meet a set of criteria to measure their relative merits for a given application (or a range of similar applications), as described in the 2012 journal overview [1]. Here, we list 10 such criteria to assist the prospective author in validating their proposed paper for review and for acceptance by future readers.

1. Torque/Force Density	Response to command means to physically move an output structure from position A to position B. The output may involve a resistance to this motion. A useful measure, then, is the amount of force or torque produced by the actuator relative to its overall weight (and, closely related, its volume/geometry).
2. Inertia Content	Another basic measure is the inertia content of the actuator, which is a combination of the mass content and the velocity of that mass inside the actuator. Some applications have low output velocity requirements (say, a rudder on a ship), while, for others, velocity and acceleration are critical (say, control fins on a rocket).
3. Stiffness/Ruggedness	A very stiff actuator means that it can hold a position relative to changing output forces. Ruggedness means that it can resist shock in multiple directions to maintain a six DOF position reference and not fail.
4. Accuracy/Precision	Some applications require the maintenance of a position (or velocity or acceleration) even under disturbances, as would be seen in machining operations using industrial robots. This requires exceptional sensing, decision-making software, a high stiffness, and minimal inertia.

5. Backlash/Lost Motion	Many mechanical reducers involve gear mesh backlash, lost motion due to bearing compliance, or inadequate sensing, resulting in inaccurate position data. Multiple sensors at the prime mover and reducer can dramatically improve precision even under disturbance based on very fast decision-making software.
6. Efficiency	Older hydraulic actuators were very inefficient, representing an 80% loss of the input energy. Increasingly, energy efficiency is critical where values of 85% or more are essential, especially in mobile transport systems depending on expensive batteries or hydrogen fuel cells. Systems with long duration operating cycles (industrial robotics, production machinery, construction machines, etc.) are increasingly required to be efficient.
7. Responsiveness	The key to actuator relevance to the customer is rapid response to command. This means that antique methods of PID control, lower power density, out-of-date controllers, etc., must be replaced by high-end decision making software. Real-time (msec.) sensor data, rapid-response prime movers, low inertia reducers, etc., must be combined into fully integrated actuators of the future.
8. Durability	The success of high end industrial robots is their 100,000 h of demonstrated durability. Trucks are now at 15,000 h, cars are at 5,000 h, aircraft are at 20,000 h. Hence, to be fully useful and integrated, actuators in general must reach 20,000 h and in many cases get to 100,000 h of expected operation, with a minimum downtime for maintenance.
9. Scalability	Most actuators will have to be fully scalable from, say, 1 ft-lb. output torque up to 1,000,000 ft-lb. Many applications do not require this range of scalability (say, in miniaturized applications, as found in surgery or human rehabilitation, where the human scale is the relevant reference).
10. Cost	All applications are dependent on the overall cost of the actuator. Very high-end applications can tolerate a high cost because of the real potential benefit. On the other hand, where human utilization is involved (say, in transport, entertainment, human rehabilitation, etc.), then cost can be the critical measure of success.

It is recommended that each author identify a range of applications to which their actuator concept is relevant and list a ranking of 1 (low rank) up to 10 (highest rank) for each of the above measures relative to their application spectrum.

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References

1. Tesar, D. Overview of the Long Term Objectives of the Journal Actuators. *Actuators* **2012**, *1*, 1–11. [CrossRef]
2. Tesar, D. Next Wave of Technology. *Intell. Autom. Soft Comput.* **2016**, *22*, 211–225. [CrossRef]