Patent: Anti-Freeze Lubricant Delivery System for Robot Joints

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ABSTRACT

A system and method for delivering temperature-resistant lubricant to robotic joint assemblies operating in sub-zero environments. The invention comprises an integrated network of microchannels, thermal sensors, and electronically controlled lubricant dispensers that maintain optimal joint lubrication across operating temperatures from -40 C to +50 C. The system utilizes proprietary nano-engineered lubricant compounds and predictive delivery algorithms to prevent joint seizure and ensure continuous operation in extreme cold conditions.

BACKGROUND OF INVENTION

[0001] Autonomous mobile robots operating in cold storage and industrial freezer environments face significant challenges related to joint lubrication and mechanical movement. Traditional lubricants become viscous or freeze at low temperatures, leading to increased friction, mechanical wear, and potential system failure.

[0002] Existing solutions typically rely on heating elements or specialized lubricants, but these approaches consume excessive power or provide inadequate protection at extreme temperatures. There remains a need for an efficient, reliable system for maintaining proper joint lubrication in cold-environment robotics.

SUMMARY OF INVENTION

[0003] The present invention provides a novel solution for maintaining optimal joint lubrication in cold-environment robotic systems through:

a) A network of temperature-monitored microchannels integrated into robot joint assemblies

b) Electronically controlled lubricant dispensers with predictive delivery capabilities

c) Proprietary nano-engineered lubricant compounds resistant to freezing

d) Smart sensors that continuously monitor joint temperature and friction coefficients

e) Adaptive control algorithms that optimize lubricant delivery based on operating conditions

DETAILED DESCRIPTION

Microchannel Network

[0004] The invention's primary component is a network of precision-engineered microchannels (diameter 0.5mm - 2.0mm) integrated directly into robot joint assemblies. These channels are fabricated using advanced metal 3D printing techniques and are arranged in a redundant mesh pattern to ensure consistent lubricant distribution.

Lubricant Composition

[0005] The system utilizes a proprietary lubricant compound comprising:

- Base oil: Modified synthetic hydrocarbon (40-60% by volume)
- Viscosity modifiers: Engineered polymer chains (15-25%)
- Anti-freeze additives: Proprietary nanoparticle suspension (10-20%)
- Friction modifiers: Advanced organic compounds (5-10%)
- Corrosion inhibitors: Specialized chemical package (2-5%)

Control System

[0006] The electronic control system includes:

- Temperature sensors (accuracy 0.1 C) at critical joint locations
- Pressure transducers monitoring lubricant flow
- Microprocessor running proprietary IceNav(TM) algorithms
- Network interface for system monitoring and adjustment
- Redundant power supply with cold-resistant battery backup

CLAIMS

A system for delivering lubricant to robot joints comprising:

a) A network of integrated microchannels

b) Electronic lubricant dispensers

c) Temperature and pressure sensors

d) Control algorithms for predictive delivery

e) Cold-resistant lubricant composition

The system of claim 1, wherein the lubricant maintains operational viscosity between -40 C and +50 C.

The system of claim 1, wherein the control algorithms utilize machine learning to optimize lubricant delivery based on historical performance data.

DRAWINGS

[Figure 1: Microchannel Network Schematic]

[Figure 2: Lubricant Dispenser Assembly]

[Figure 3: Control System Architecture]

[Figure 4: Temperature Response Curves]

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GOVERNMENT INTERESTS

[0007] This invention was made with government support under Contract No. NSF-SBIR-2145789 awarded by the National Science Foundation. The government has certain rights in the invention.

PRIOR ART REFERENCES

US Patent 10,234,567 - "Cold Environment Lubrication System"

US Patent 10,876,543 - "Adaptive Joint Lubrication Method"

EP Patent 3,456,789 - "Temperature-Controlled Robotic Assembly"

The foregoing description of various embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed.