CONSIDERATION OF ULTRASONIC MOTOR

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Abstract: A motor is a machine that converts electrical energy to mechanical energy. hey it is an arrangement of coils and magnet that converts electrical energy into magnetic energy.
In 1831, a British physicist, Michael Faraday, discovered the law of electromagnetic induction that electric current flows when you move magnets in air core coil. The law of electromagnetic induction proved that electrical energy and mechanical energy are mutually convertible. It is said that this is the catalyst of invention of motors. In those days, Great Britain was in the period of the first Industrial Revolution and steam power was the driving force of the revolution. No one could recognize the importance of motors which worked with electricity in those days without power network.

1. INTRODUCTION

An ultrasonic motor is a type of electric motor formed from the ultrasonic vibration of a component, the stator, placed against another, the rotor or slider depending on the scheme of operation. Ultrasonic motors differ from piezoelectric actuators in several ways, though both typically use some form of piezoelectric material, and most often lead zirconate titanate and occasionally lithium niobate or other single-crystal materials. The most obvious difference is the use of resonance to amplify the vibration of the stator in contact with the rotor in ultrasonic motors. Ultrasonic motors also offer arbitrarily large rotation or sliding distances, while piezoelectric actuators are limited by the static strain that may well be induced in the piezoelectric element.

2. WHY ELECTROMAGNETIC MOTORS SHOULD NOT BE CONSIDERED?

Many large electric motors are not easily portable, and consideration must be made for the correct electrical supply and voltage. Sometimes expensive line extensions are necessary in remote locations where existing electrical power is not available. Also, if you are using a high-horsepower motor and a low load factor, you might have a high cost per hour of operation.

3. Electromagnetic Motors rely on the attraction and repulsion of magnetic field for their operation. Without good noise separation circuitry turn noisy electrical operation will affect the electronic components inside. Surges and spikes from these Motors can cause destructing or even damage in nonmotor related items such as CRTs and various types of receiving and transmitting equipment. Also, electromagnetic Motors are notorious for consuming high amount of power and creating high ambient motor temperatures. Both are undesirable from the efficiency point of view excessive heat energy is wasted as losses. Even efficiently rated electromagnetic motor has high input to output energy loss ratios.

4. Replacing the electromagnetic magnets by ultrasonic Motors would virtually eliminate the above mentioned undesirable effects. Electromagnetic Motors produce strong magnetic field which in turns cause interference. Ultrasonic Motors are piezo electric use electric effect and hence cause no magnetic interference, which would be really appreciable.

3. ADVANTAGES OF ULTRASONIC MOTOR OVERLECTROMAGNETIC MOTOR

A. Noisy operation.
B. Surge currents and spikes.
C. Electromagnetic interference.
D. Magnetic losses (Eddy currents & Hysteresis).
E. High power consumption & high temperature.
F. Low power factor.
G. Comparatively lesser efficiency
H. Little influence by magnetic field
I. Compact size
J. High holding torques

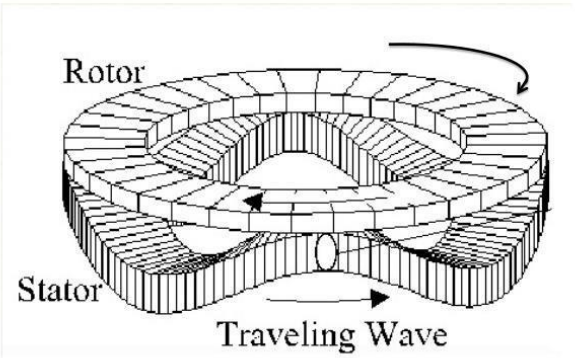
4. WORKING PRINCIPLE

The vibration is induced into the stator of the motor, and it is used for conveying the motion to the rotor and also to modulate the frictional forces. The amplification and micro deformations of active material are utilized for generation of

the mechanical motion. The macro-motion of the rotor can be achieved by the rectification of the micro-motion using the frictional interface between the stator and the rotor.

The ultrasonic motor consists of stator and rotor. The operation of the Ultrasonic Motor changes the rotor or linear translator. The stator of the Ultrasonic Motor consists of piezoelectric ceramics for generating vibration, a metal of the stator for amplifying the generated vibration and a friction material for making contact with the rotor.

Whenever voltage is applied, a travelling wave is generated on the surface of the stator metal which causes the rotor to rotate. As the rotor is in contact with the stator metal, as mentioned above – but only at each peak of the travelling wave – which causes the elliptical movement – and, with this elliptical movement, the rotor rotates in the direction conversely to the direction of the travelling wave



5. FEATURES OF ULTRASONIC MOTOR

- These are small in size and are excellent in response.
- These have low speed of ten to several hundred rpm and high torque, and hence reduction gears are not required.
- These consist of high-holding power, and even if the power is turned off, they don't need brake and clutch.
- They are small, thin and have less weight compared to other electromagnetic motors.
- These motors don't contain any electromagnetic material and they do not generate electromagnetic waves. So, these can be used even in high magnetic field areas as these are unaffected by the magnetic field.
- These motors don't have any gears, and an inaudible frequency vibration is used for driving these motors. So, they do not generate any noise and their operation is very quiet.
- Accurate speed and position control are possible with these motors.
- The mechanical time constant for these motors is less than 1ms and the speed control for these motors is step less.
- These motors have very high efficiency, and their efficiency is insensitive to their size

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7. APPLICATIONS OF ULTRASONIC MOTOR

- In the automobile industry the ultrasonic Motors are used for the operation of power steering, seat adjustment etc.
- In medicine
- In aerospace
- In the field of robotics
- Watch Motors
- compact paper handling
- Sensor scanning
- In microsurgery

8. ULTRASONIC MOTORS PROTOTYPES

1. Linear Ultrasonic Motors

a. DOF planar pin-type actuator

The objective of this project is to design and develop a piezo electric actuator based on the fundamental operating mechanism of ultrasonic Motors. two pin type prototype with piezo electric bimorph plate and contact pin for generating driving force in the x-y direction was designed and fabricated. A test rig was also constructed for the evaluation of the two proto types and basic characteristics of the activity activator investigated; The working principle of the actuator was verified and proven during the experiment. Basically, the optimal driving speed of an activator is dependent on the driving frequency, input voltage, the contact surface and friction coefficient between the stator and motor. An analytical study of prototype has been carried out by means

of the finite element analysis utilizing ANSYS5.4. With comparison to the experimental results it was proven that the optimal driving condition occurred at the specific resonant mode depending on the pin vibration. Maximum unloaded driving speed was obtained to be approximately 0.68 centimeters per second at a frequency of 14.8 Kilo Hertz anti optimum input voltage was found to be approximately 70 Vp-p.

b. Bi-directional linear standing wave ultrasonic Motor

Standing wave bidirectional linear ultrasonic motor has been fabricated. This linear ultrasonic motor has very simple structure and can be easily mounted onto any commercially available linear guide. a high precision positioning x-y table was built by mounting these individual movable linear guides together. The basic parameters of our linear ultrasonic motor are: moving range 220 mm, no-load speed 80 mms/s, ratings 23 millimeters per second at 3100 gf, stall force 700 gf, starting thrust 500gf, resolution less than 50 mm, response time of 12 ms from stationary status to constant velocity (80mm/s) with initial mass of 260 g.

2. Rotatory Ultrasonic Motor

The characteristics of the rotatory disc type motor will be investigated and theoretical model will be formed to relate the important components on the power of the motor. The scope includes designing different motor with various dimensions, form ulation of the analytical model, experimental testing and ultimately, setting standards for practical application of this particular type of ultrasonic motor. this project will lay the foundation of the characteristics and performance of the rotatory disc type ultrasonic Motors for future applications.

3. Spherical Ultrasonic Motor

Presently, a new type of spherical ultrasonic motor is under investigation. This particular ultrasonic motor consists of a thin square plate 30x30 milli meters in area. It can rotate in more than for individual directions. now we are trying to compile rotation in any directions by using a computer to control the 4 individual directions properly.

9. CONCLUSION

The above thesis has gone through approximately all the fundamental details of modern technology machine. Although these are not vastly used for heavy motoring activities, it is still unique in the miniature applications as discussed above. The main reason for USMs not being used in the heavy-duty activities is because of the requirement of a larger & expensive piezoelectric material that causes the production cost to shoot up double fold. However, many researches are in progress to improve the technology to meet the heavy industrial requirements and also to minimize the problems caused by ultrasonic noise. It is expected that the world will be replaced by proficient ultrasonic motors by the futile electromagnetic motors.

REFERENCES

[1] https://www.yaskawa-global.com/
[2] https://krazytech.com/
[3] https://connect2local.com/
[4] https://www.elprocus.com/
[5] https://www.slideshare.net/
[6] https://en.wikipedia.org/wiki/Main_Page

