A COMBINED RELUCTANCE-HALL EFFECT BASED ANGLE SENSOR

IITM Technology Available for Licensing

Problem Statement

- Existing angle sensors face limitations such as short lifespan, sensitivity to harsh environments, and complexity in installation, especially for through-shaft applications like brake wear sensors or steering wheel angle sensors.
- Current solutions combining Hall-Effect and variable reluctance techniques are either complex, inaccurate, or require special signal conditioning, indicating a need for a simpler and more efficient angle sensing solution.
- The objective is to develop **an angle sensor that combines the benefits of Hall-Effect and variable reluctance technologies**, particularly for through-shaft angle sensing applications.

Intellectual Property

- IITM IDF Ref. **1021**
- **IN 393904 - Patent Granted**

Technology Category/ Market

Category - Sensor Technology
Applications - Automotive Steering Systems, Industrial Robotics, Renewable Energy
Industry - Automotive, Industrial Automation

Market - Global automotive steering system market was valued at USD 36.33 billion in 2023 and is expected to grow at a **CAGR of 2.4%.**

TRL (Technology Readiness Level)

TRL - 3, Proof of concept stage.

Research Lab

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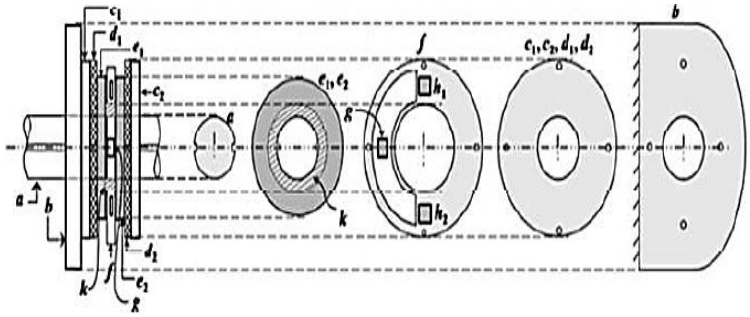

a-rotating part (of automotive), b-guiding part (of automotive), c_1, c_2-magnetic shields, d_1, d_2-non-magnetic spacer layers, e_1, e_2- moving circular plates of the sensor, f- spacer layer embedded with Hall Effect sensors (h_1, h_2), g-permanent magnet, k-Non-magnetic layer.

FIG.1. illustrates a diagram of a sensor assembly fitted on a rotating target.

Technology

1

- **The invention introduces an angle sensor combining Hall-Effect sensing and variable reluctance techniques, consisting of ring-shaped magnetic sensor parts fixed to a non-magnetic ring attached to the rotating target. Hall-Effect sensors and a permanent magnet may be incorporated between these parts for enhanced sensitivity.**

2

- **A linearizing digital converter (LDC) circuit is proposed to achieve a linear direct-digital output from the angle sensor, employing a dual-slope ADC technique with single pole double throw (SPDT) switches, an op-amp configured as an integrator, and a comparator connected to a control and logic unit (CLU).**

3

- **The method for measuring angle involves positioning magnetic sensor parts relative to the rotating target, using fixed magnetic field sensing devices between them and a magnetic flux source to impose flux. The control unit measures the output signal from the sensing devices to derive a linear direct-digital output, providing accurate angle measurements.**

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Key Features / Value Proposition

1. Enhanced Sensing Accuracy: Combining identical ring-shaped magnetic sensor parts and linear Hall-Effect sensors ensures precise angle detection with finite reluctance and minimal error.

2. Robust Mechanical Integration: Non-magnetic ring mechanically locked to the rotating target ensures stable and reliable sensor placement, ideal for harsh industrial environments.

3. Expanded Angular Range Options: Detection capabilities ranging from 150 to 360 degrees cater to diverse application needs, providing flexibility and versatility.

4. Linear Direct-Digital Output: The Linearizing Digital Converter (LDC) circuit with third-order-polynomial transfer characteristics delivers a linear direct-digital output for straightforward data interpretation and integration.

5. Efficient Signal Processing: Utilizing Single Pole, Double Throw (SPDT) switches, an integrator op-amp, and a comparator in the LDC circuit ensures efficient signal processing, enhancing system performance.

6. Streamlined Measurement Process: The method's systematic approach involving fixed magnetic field sensing devices, magnetic flux sources, and a control unit facilitates straightforward and accurate angle measurement, optimizing operational efficiency.

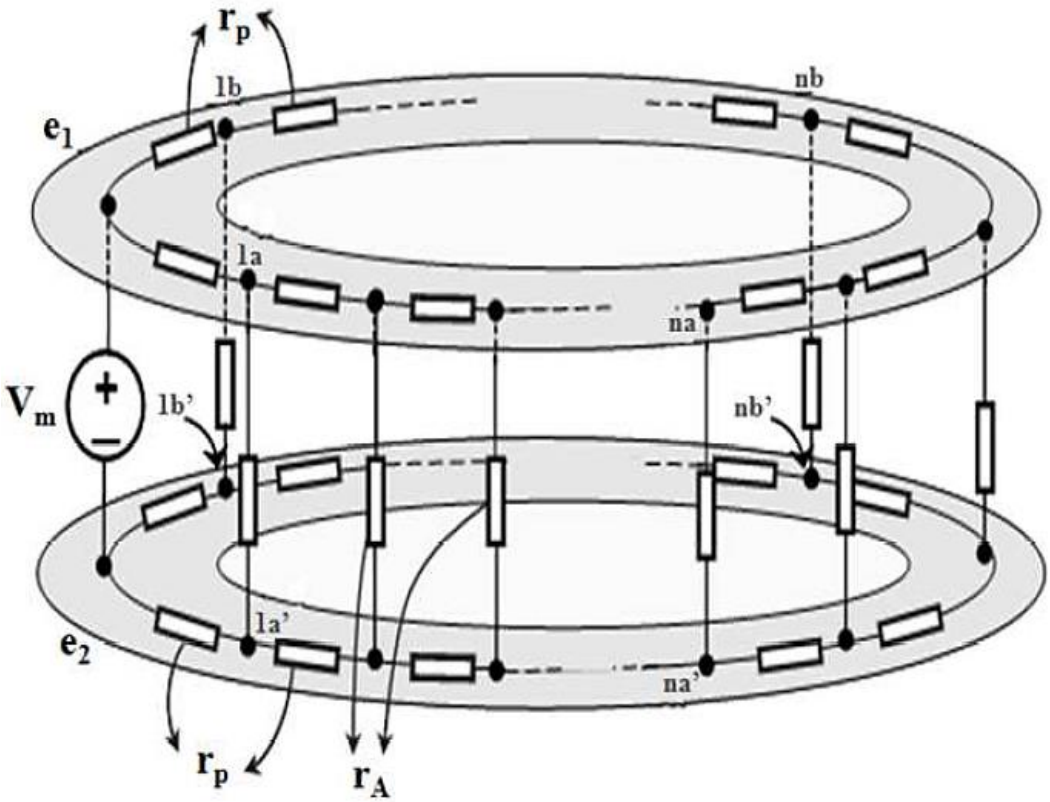

FIG.2. illustrates a simplified equivalent circuit of the sensor assembly.

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