Demonstration of a Ferrimagnetic Ceramic Application for Position Sensor Using a Visual Basic-based Measurement System

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Abstract

In the present paper, we present an induction coil with an antenna coil's core for proximity sensing. The sample was an inductor with an antenna coil's core. The antenna coil's core was placed inside the induction coil, then voltage from a signal generator flowed through this coil and the voltage frequency was set at a fixed value. Voltage drop across the inductor was sent to a computer. The computer controls the stepping motor movement for displacement of this ferrite core. This induction coil with antenna coil's core operates as a position sensor. The details of this paper are to introduce a system developed for measuring voltage drop across the induction coil using a procedure based on virtual instrumentation. The measurements and processing of the data were made using an analog to digital converter (ADC0809), buffer (74LS244), a ET-PCI8255V3 data acquisition card and Visual Basic program. The system was able to store and display the data. In addition, this prepared system can be used for controlling the movement of a stepping motor. The antenna coil's core was used as position sensor. So, a demonstration of the ferrimagnetic ceramic application for position sensor using the Visual Basic-based measurement system was successfully tested. This system can be used in position sensing at a distance of 0 to 4 cm. The system has been in operation this year and all its units have functioned well.

Keyword: ferrimagnetic ceramics, position sensor , Visual Basic.

1. Introduction

Inductors are a type of passive electrical devices that are used to store energy from magnetic fields and release it when needed. The inductor has a coil of copper conductor wound around a central core. When a current is passed through the coil, magnetic flux is created around the coil due to the properties of electromotive force. The resistance increases when a core is placed in the coil and this increases the inductance by hundreds of times. The core can be made of different materials, but cores made of ferrite produce the maximum inductance. Ni-Zn ferrites are soft ferri-magnetic materials having low magnetic co-ercivity and high resistivity values and little eddy current loss in high-frequency operations (10-500 MHz) [1]. Its high electrical resistivity and good magnetic properties make this ferrite an excellent core material for power transformers in electronics, recording heads, antenna rods, loading coils, microwave devices and telecommunication applications.

A proximity sensor can detect objects without physical contact [2,3]. A proximity sensor often emits an electromagnetic field or beam and measures changes in the field. The object being sensed is often refered to as the proximity sensor's target. Proximity sensors can be used to detect the distance from the sensor to the target. A position sensor creates an output that is proportional to the position of some object along a given axis. Perhaps the most common form of displacement sensor is the potentiometer. For applications tolerant of error, almost any ordinary linear-taper potentiometer can be pressed into service. The output voltage V_o is a function of the displacement x, as measured by the position of the potentiometer wiper along its element.

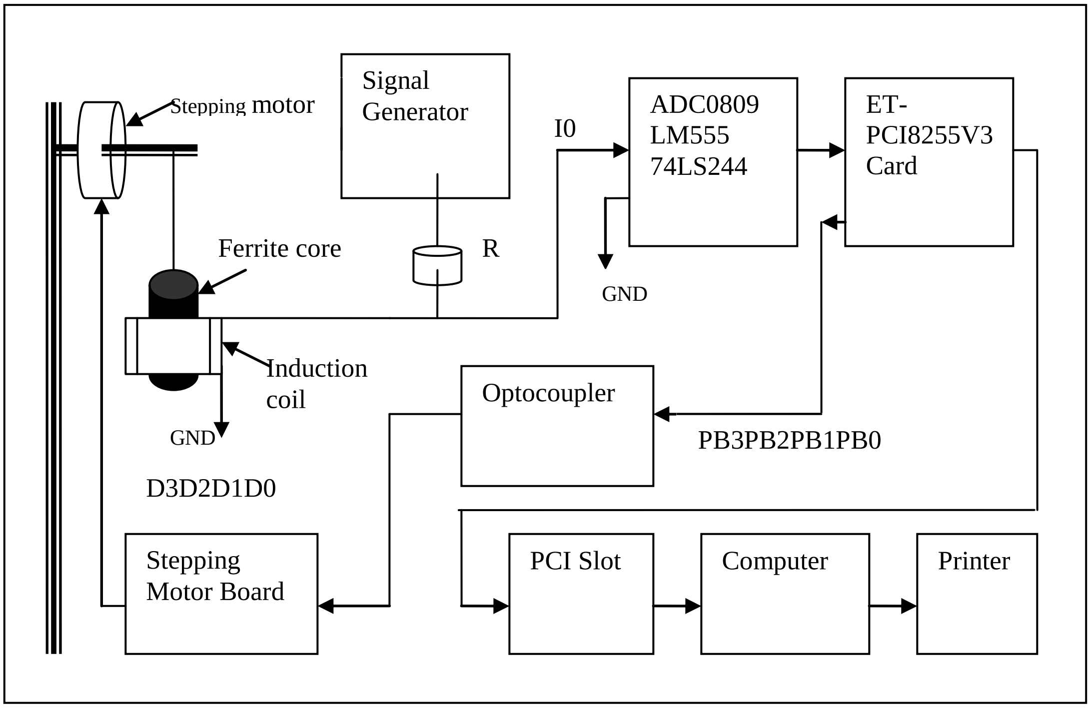
A common characteristic of the mentioned data acquisition systems is the use of data loggers or microcontrollers for measuring and acquiring the signals and transmitting them to a PC through a serial RS-232 port [4,5]. However, descriptions of ferrimagnetic ceramic applications for position sensor using a Visual Basic-based measurement system has not been found in the literature.

In this paper, we present a sensor for proximity sensing. The functioning of the equipment was based on the so-called virtual instrumentation and the program was developed using Visual Basic. The data are transmitted and stored in a computer through a data acquisition board. The monitoring variables were processed and displayed on the computer screen by using virtual instruments developed with Visual Basic.

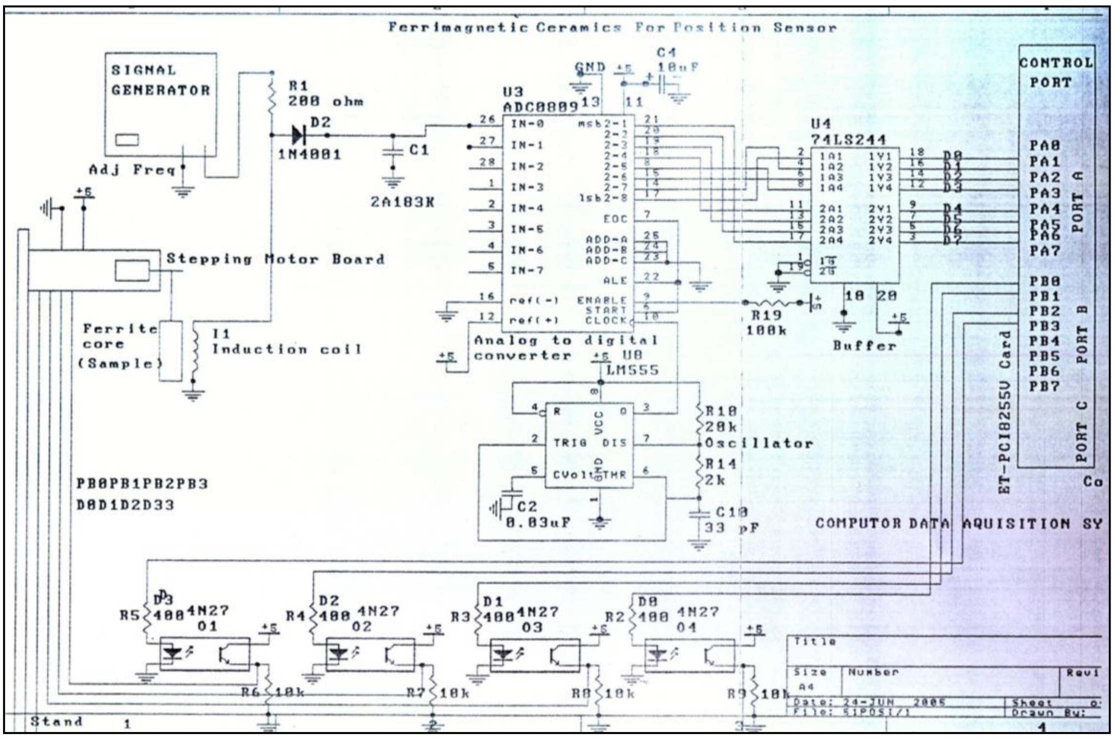
2. Materials and methods

The core of the induction coil was made of soft ferrite. The devices were tested at a frequency of 2.4 kHz. The accurate positioning of the induction coil in the vertical direction was enabled by stepping motors. The setup of the software can be obtained from ETT, Co., LTD [6]. The experimental setup for ferrimagnetic ceramic application for a position sensor using the Visual Basic-based measurement system is shown in Figure 1. The data acquisition board was developed using ADC0809, 74LS244, ET-PCI8255V3 card and a computer. This card was commercially supplied by ETT Co., LTD [6]. The output control board was developed using a computer, ET-PCI8255V3 card, optocoupler, stepping motor board and stepping motor. The form of the system in Visual Basic, for a ferrimagnetic ceramic application, for a position sensor using the Visual Basic-based measurement system, is shown in Figure 2. The code was written and the Properties Windows was set for controlling this experiment. The sample was the core of an antenna coil. The stepping motor was used as position controller. Initially, the core of the antenna coil was at the upper position. The electronic load (R_L=200 Ω) was connected in series with the sample (R_s) as a voltage divider. This voltage divider was used to supply a voltage to the input of ADC0809. The current from this +5V pin of card flowed through the load resistor (R_L) and sample (R_s) and the Voltage drop across R_s was V. A rectifier diode was used for its unidirectional electric current property. The computer reads the program name using the instruction: "Ferrimagnetic ceramics for Position Sensor." The computer executes output-input instruction using the instruction: The Private Declare Sub Out Lib "inpout32.dll" Alias "Out32" (ByVal PortAddress As Integer, ByVal Value As Integer) and Private Declare Function Inp Lib "inpout32.dll" Alias "Inp32" (ByVal PortAddress As Integer) As Integer. The computer can time-delay using the instruct-tion: Private Declare Sub Sleep Lib "kernel32" (ByVal dwMilliseconds As Long). Variables were defined using the instruct-tion: dwMilliseconds As Long) and Public t

As Integer. The position for Form appearance was defined using the instruction: Left = (Screen.Width - Width) / 2 and Top = (Screen.Height - Height) / 2. The direction of entrance and exit of voltage for port A: input port and port B: output port was defined using the instruction: Out &H14CC, &H90. The computer screen was cleared using the instruction of Picture1.Cls. The computer operated cycles repeatedly using the instruction of For i = 20 To 3500 Step 50; Next i. Time was delayed using the instruction: DoEvents. When the command button was clicked, the computer transmitted the voltage of D3D2D1D0=1000, 3D2D1D0=0100, D3D2D1D0=0010 and D3D2D1D0=0001 using the instruction: Out &H14C4, &H8, Out &H14C4, &H4, Out &H14C4, &H2, Out &H14C4, &H1, respectively. The stepping motor moves clockwise to displace the position sensor (the core of the coil). Time was delayed using the instruction: Sleep (t). The vol-tage V from diode was transmitted to analog input 0 (I0) of ADC0809 for analog to digital conversion (AV to DV), then transmitted to buffer (74LS244) and passed to computer via ET-PCI8255V3 card. Inpout32.dll is a file which provide the input and output instruction using the Visual Basic program. Out &H14CC, &H90 was used for setting the control word for the input-output operation of port A and port B. V=Inp(&H14C0) was used for reading votages (V) from ADC0809 and 74LS244 into the computer. Voltage V was transformed to be Vs using V_s = (5 / 255)*V. The relation between distance of the ferrite core movement and voltage drop across the coil (d vs V_s) for position sensor test was determined (Figure 3). Voltage V_s was transformed to be the distance (d) using the expression d = 4.652 * V_s - 11.007. This equation was written into the program. So, this program can operate as a position sensor. Voltage drop across the sample was displayed on the computer screen using the instruction: LabelV_s.Caption = V_s. Coordinates x = i and y = 255 - (255 / 5) *d were defined for displaying the d vs. t curve on screen using the instruction Picture1.PSet (x, 10 * y), vbBlue. The delay time was defined using the instruction: t = HScroll1.Value. The scan of the d–t curve was automatically achieved through the virtual instrument, controlling the d-t measuring process. The program was RUN for displaying d vs. t curve on computer screen. Visual Basic enables users to save their Form, Codes and Properties Windows with the file extension of *.frm. Print Screen was used for transfering picture of d vs. t curve onto working area of Microsoft word and saved in a text file. All results were printed using a printer. This is done in order to control the position of the ferrite core.



a) Block diagram



b) Circuit diagram

Fig. 1 The experiment setup for ferrimagnetic ceramic application for position sensor using the Visual Basic-based measurement system.

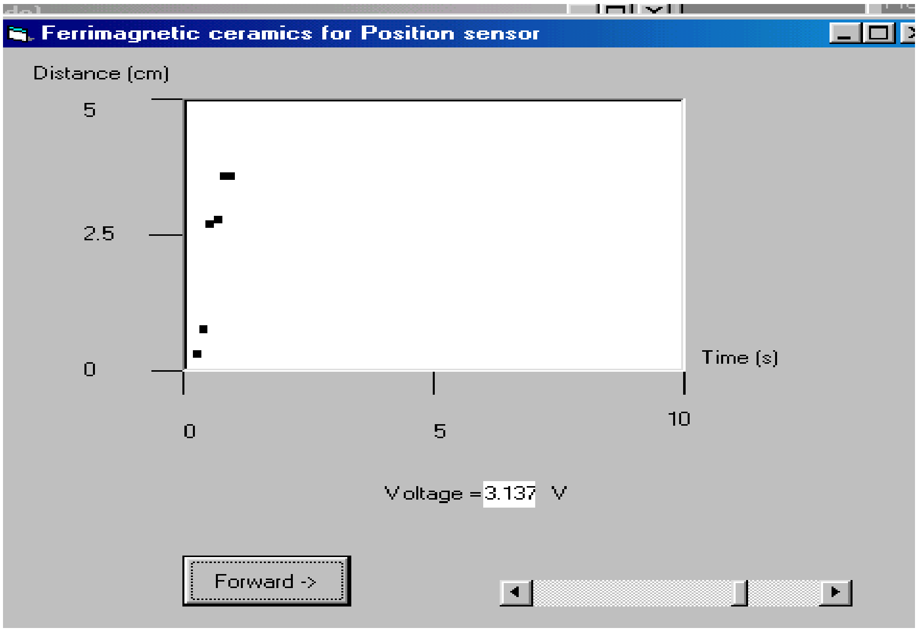


Fig. 2 Form of the system in Visual Basic for ferrimagnetic ceramic application for position sensor using the Visual Basic-based measurement system.

Code

```
'Ferrimagnetic ceramics for Position Sensor
Private Declare Sub Out Lib "inpout32.dll" Alias "Out32" (ByVal PortAddress As Integer, ByVal Value As Integer)
Private Declare Function Inp Lib "inpout32.dll" Alias "Inp32" (ByVal PortAddress As Integer) As Integer
Private Declare Sub Sleep Lib "kernel32" (ByVal dwMilliseconds As Long)
Public t As Integer
Private Sub Form_Load()
   Left = (Screen.Width - Width) / 2
   Top = (Screen.Height - Height) / 2
   Out &H14CC, &H90
   Command1.Caption = "Forward ->"
End Sub

Private Sub Command1_Click()
   Picture1.Cls
   For i = 20 To 3500 Step 50
      DoEvents
      Out &H14C4, &H8
'D3D2D1D0=1000
      Sleep (t)
      Out &H14C4, &H4
'D3D2D1D0=0100
      Sleep (t)
      Out &H14C4, &H2
'D3D2D1D0=0010
      Sleep (t)
      Out &H14C4, &H1
'D3D2D1D0=0001
      Sleep (t)
      V = Inp(&H14C0)
      X = i
      Vs = (5 / 255) * V
      d = 4.652 * Vs - 11.007
      Y = 10 * (255 - (255 / 5) * d)
      Picture1.PSet (X, Y), vbBlack
      LabelVs.Caption = (5 / 255) * Vs
      t = HScroll1.Value
   Next i
End Sub
```

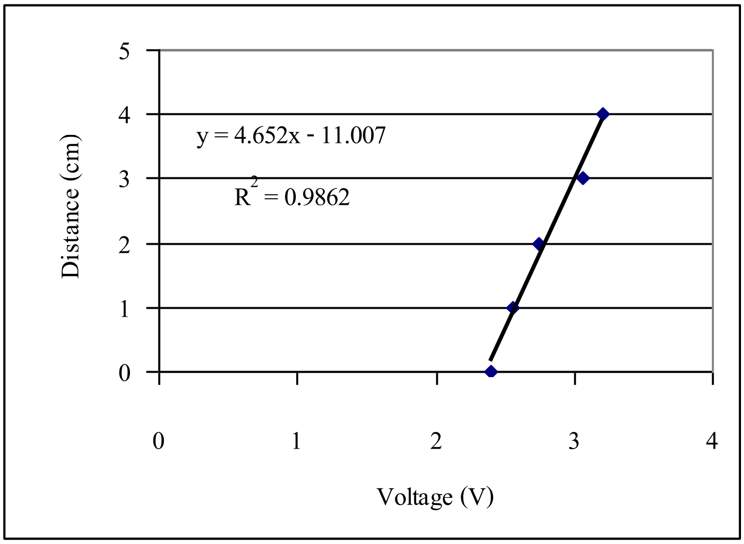


Fig. 3 The relation between distance for ferrite core movement and voltage drop across the coil (d vs V_s) for position sensor test.

3. Results and discussion

The experimental setup for ferrimagnetic ceramic application for position sensor using the Visual Basic-based measurement system is shown in Figure 1. The form of the system in Visual Basic for ferrimagnetic ceramic application for position sensor using the Visual Basic-based measurement system is shown in Figure 2. The relation between distance of ferrite core movement and voltage drop across the coil (d vs V_s) for position sensor test is shown in Figure 3. The computer reads the position of the sensor using the instruction: d = 4.652 * V_s - 11.007 and displays the position value using the core of the antenna coil as the position sensor. In the future, this position sensor will be used for measuring the position for other experiments such as thermal and optical properties of materials.

4. Conclusions

1) In this work, a sensor for proximity testing has been designed, and tested. These initial results are very promising and show that these devices have great potential for use as low-cost, highly sensitive proximity sensors.

2) The low cost position control system was made up of a stepping motor board, stepping motor, position sensor (the core of an antenna coil), A/D converter (ADC0809, LM555), buffer (74LS244), ET-PCI8255V3 Card and a computer. This system has been developed using a procedure based on virtual instrumentation. This system can be used for measuring and displaying the graphics of the results. The proposed equipment was based on the Visual Basic program, for processing, displaying and storing the collected data.

3) This test conducted since April 2008 has indicated that the developed equipment is suitable for controlling the position of the sensor. This experimental work was carried out at the Physics department, Faculty of Science, Prince of Songkla University, Thailand. The work presented is part of a research project, and in the near future, we will use it in other tests.

5. References

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