International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

DEVICE DESIGNED FOR METAL DETECTION AND STUDYING THE PATTERNS OF THE METALS THUS VERIFYING THE MODEL

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ABSTRACT

To find undesirable metal objects in processed food, Metal detectors are extensively used. In today's world, it is very important to see that the food products we consume are free from contamination. To ensure this, the need for metal detector is on rise. This paper focusses on hardware and software for metal detection. Hardware signifies the concept of detection. And software will analyse different data patterns of different metals through detector coil considering its amplitude and phase.

Keywords* - *Metal detector*, *Electromagnetic induction

I. INTRODUCTION

The progress of technology has taken metal detectors from valves to transistors, to integrated circuits and more recently, into microprocessors. Naturally this has increased their performance giving greater sensitivity, stability and flexibility, as well as widening the range of output signals and information they provide.

A metal detector detects the presence of metal. It is an electronic instrument. Metal inclusion hidden within objects or metal objects which are buried underground can also be found out using metal detectors. They can be used in landmines, food industry, etc. Metal detectors can work on different technologies such as balanced coil, pulse induction, very low frequency, etc.

Metal detectors has wide range of applications in pharmaceutical, textiles, plastics, lumber, food[1], mining, beverage, chemicals and packaging industries. Metal detectors are integrated in production line for major safety issue in the food industry due to contamination of food by metal shards from broken machinery during manufacturing process.

One of the most common foreign materials found in the food is metal. It can be a safety hazard to consumers although it is unintentionally introduced to the food products.

II. DESIGN OF DEVICE

Metal Detector has been designed in the same way as in [2]. The three coils are coaxially arranged at a uniform distance from each other and each coil is a one –turn loop antenna. A sinusoidal signal is provided to the transmitting coil from the PLL synthesizer. The receiving loops are connected to a differential amplifier. When no metal objects are detected, the output voltage at both receiving coils are the same and thus the output at the differential amplifier becomes zero.

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When a metal piece exists around these three coils, an eddy current is induced in the metal piece due to the magnetic field generated by the transmitting loop. The magnetic field generated by this eddy current induces a different voltage between the two receiving loops, mainly due to the different distance between the metal object and each loop, generating a differential output voltage. The detection of metal objects with this method utilizes the Difference in the phases between the outputs from each transmitting loop and the differential amplifier, in addition to the amplitude at the amplifier. The effects of the Electromagnetic properties and the size of the metal piece are detected as changes in the amplitude and phase [3],[4] in the differential output voltage in addition to the effects of the location of each of the three loops.

a) How Amplitude and Phase have been calculated?

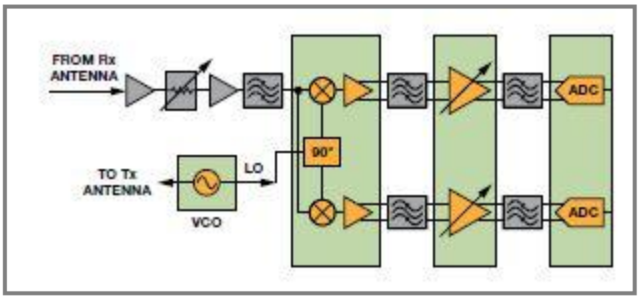

Fig.1.Internal Structure of Metal detector to calculate Amplitude and Phase through Real and Imaginary Data from ADC

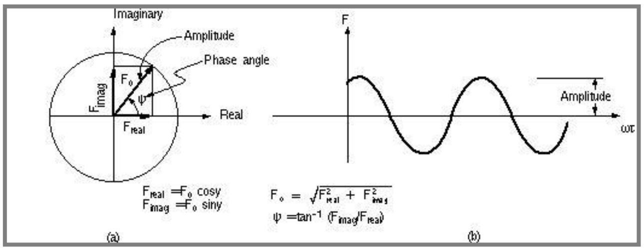

Fig.2. Calculation of Amplitude and Phase

III. RESULTS

A. Signal Testing

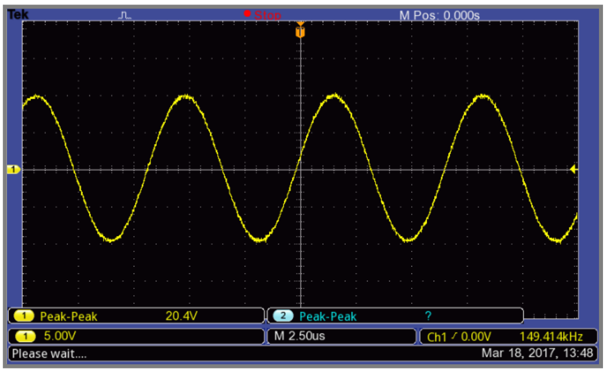

Fig.3.Spectrum captured of the Transmitted Signal

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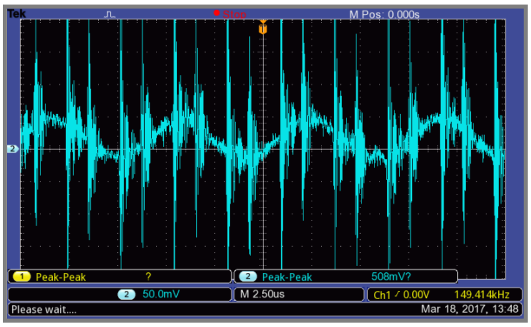

Fig.4.Spectrum Captured of the received signal

The above two figures shows the transmitted signal and the received signal .The Received signal is captured when there is nothing passed through the coil. We get a signal due to the noise which is present in the hardware circuitry due to op-amps and other internal circuitry. There will be some amount of noise present always. The Transmitted signal will always be the same whereas the received signal will change depending on what goes through the metal detector.

B. Data Patterns for Various Objects

The Metal Detector was tested on various objects to prove its stability. The Transmitted and received signals were captured and verified. The different data patterns for every object were observed. The objects taken into consideration were mainly metals, and pickle to see the different variations in their data patterns. The data pattern will remain in the same quadrant for every metal detector designed thus verifying the model. The ferrous material will always be the 2nd and 4th quadrant whereas the non-ferrous materials will be in the remaining two quadrants.

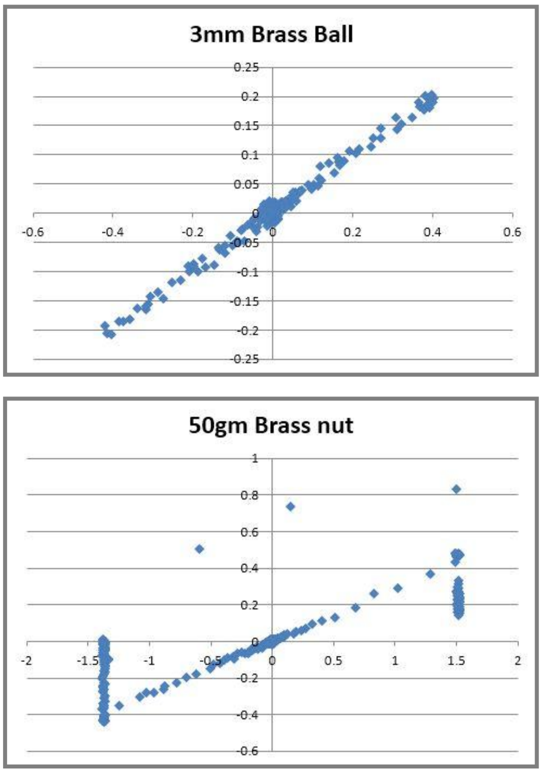

Fig.5. Brass Material Showing the Pattern in 1st and 3rd Quadrant

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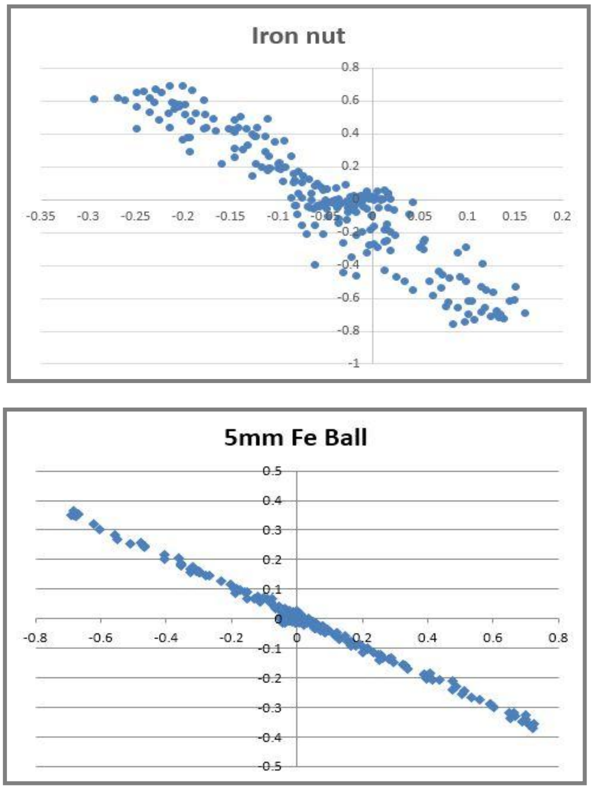

Fig.6. Ferrous Material Showing the Pattern in 2nd and 4th Quadrant

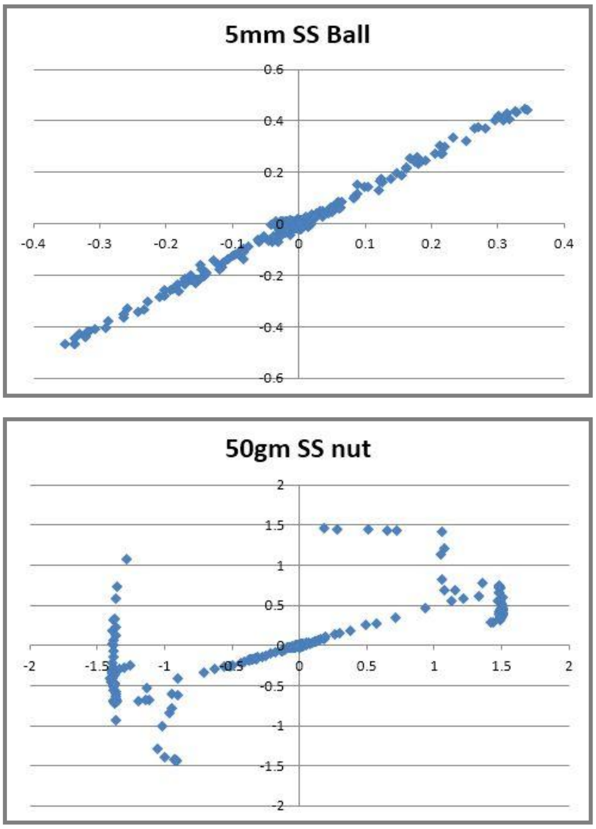

Fig.7. SS Material Showing the Pattern in 1st and 3rd Quadrant

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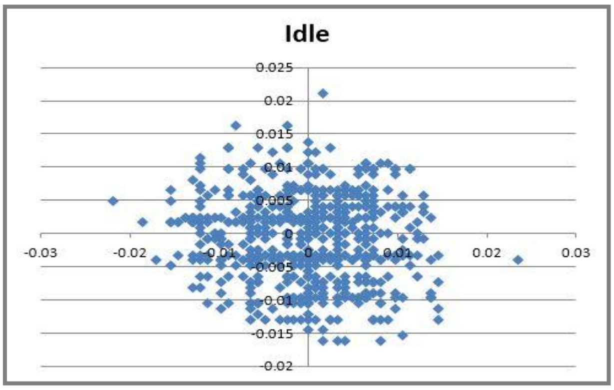

Fig.8. Showing the scattered plot when there is nothing through Metal detector showing the noise

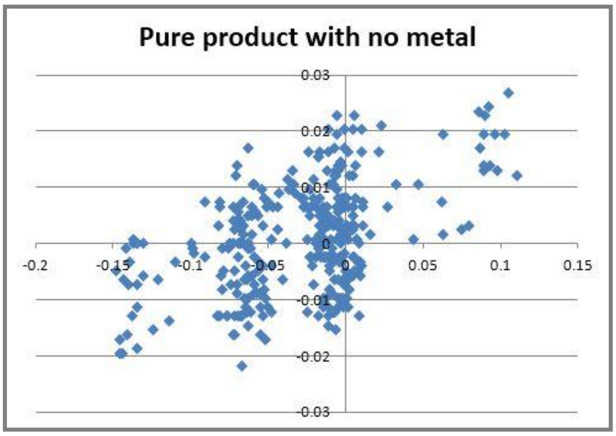

Fig.9. Showing the scattered plot when the pure product is passed through the metal detector.

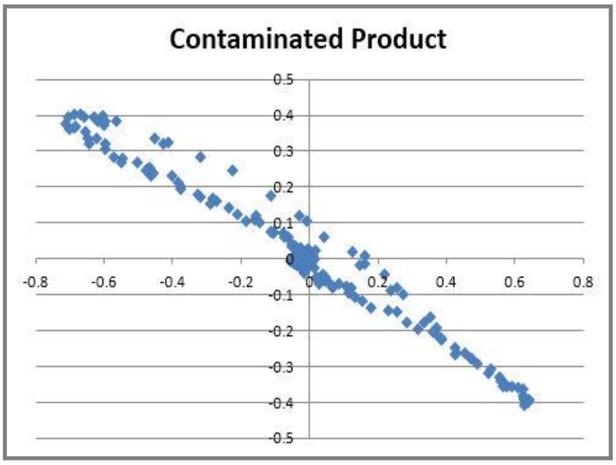

Fig.10. Showing the scattered plot when the contaminated product is passed through the metal detector

The objects tested on the metal detector were Stainless Steel, Brass, Iron and pickle of different sizes and weights.

IV.CONCLUSION

The metal detector was studied and designed. Features such amplitude and phase were extracted through the real and imaginary values from the ADC of the microcontroller. Hence, through these values we have studied different data patterns of different objects showing and validating the model of metal detector.

V. ACKNOWLEDGMENT

I am deeply indebted to my guide, Dr.Nitesh Guinde for allowing me to carry out this project under his supervision. I express my gratitude to my company guide, Mr. Abhijit Tamba, at EME Automation Goa who exhorted me to pursue the challenges posed by the project. I also thank my parents, family members and friends along with the almighty without whom this work would not have seen the light of the day.

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