Anti-Fraud System Design: Authenticating Magnetic Fingerprint Signal

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Abstract

The objective was to design an anti-fraud system to discriminate between magnetic prints of cards swiped in real time, or saved as data files. The signals obtained from the card swipes will be resampled and cross correlated with all other cards, allowing the generation of two distributions: an accept and a reject distribution. These distributions allow for deciding on a threshold that would, with a small error, reject fraudulent cards and be forgiving of sloppy swipes.

Problem Formulation

Magnetic cards are widely used in various applications but counterfeiting remains an issue. Thus being able to authenticate a magnetic card or swipe is crucial to minimize fraud. This anti-fraud system is possible because the cards possess unique magnetic characteristics that can be repeatedly sensed. In addition to data, these cards have noise like characteristics, which allow for authentication. They are known as magnetic fingerprint. Extracting this magnetic fingerprint is the aim of this project. Filtering and resampling were used to process the swipes. Each cards used has 2 tracks; track 2 peaks were used as landmarks to locate the Magneprint signal in track 1. In addition, two modes of operation were used: file mode (the swipes are saved to be investigated later) and live mode (the swipes are investigated as they are collected). The following figure illustrates the VI used to specify the mode of operation (live or file).

Design Implementation

The design was implemented through the following steps:

- Collect swipes LIVE mode or FILE mode
- Resample to obtain 267 samples per bit at 1 inch per SEC
- Choose the Magneprint™ starting with the first zero bit following the first one bit
- Cross correlate Magneprints™ to obtain ACCEPT and REJECT distribution histograms
- Calculate S (Separation) which reflects the system performance

MAGNEPRINTER VI

•Inputs

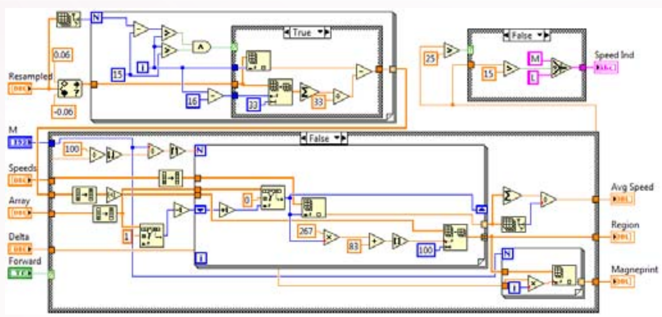
- Swipes (resampled)
- Number of samples (M=1024)
- Delta (spacing between samples chosen to be 20)
- Direction of the swipe (Forward/Reverse)
- Array of bits

•The resampled swipes are processed to extract the Magneprint™ and get rid of the slope by taking a running average of the data.

•The backward swipes are reversed and negated

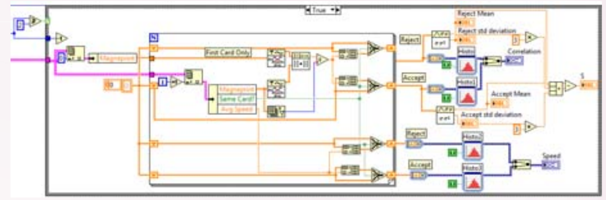
•The average speed is calculated with each swipe and indicated as HIGH, MEDIUM or LOW

•Output is the Magneprint™, every Delta-th sample in the zero bits starting after the first one if it's forward and before the last one if it's reverse

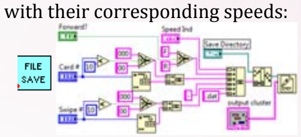


LIVE MODE

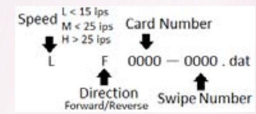
The following is a case statement from Live Swipe VI, that processes the swipes and cross correlates them as they are manually collected in real time. This case statements checks that we have more than 1 swipe before starting the correlation process. It also keeps track of whether we have the same card or a different one and plots the reject and accept distributions and speed histograms.



This VI saves the LIVE MODE swipes with their corresponding speeds:

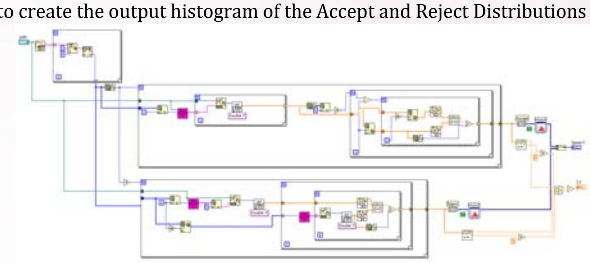


All directories have file names specified as follows:

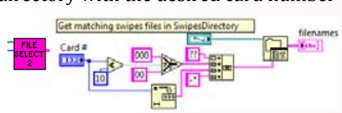


FILE MODE

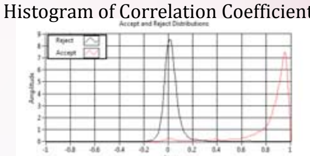
File Mode uses File Select VI that calls the saved Magneprints™ and cross correlates them to create the output histogram of the Accept and Reject Distributions



This VI obtains all the files from a specified directory with the desired card number



Histogram of Correlation Coefficients



Project Specification and Analysis

The cards account numbers are encoded as binary data where "1" has two 2 peaks in the bit time and "0" has one peak. There are trailing zeroes in both ends of the magnetic stripe. Start and end sentinels bracket the card account number which is encoded in groups of five bits.

Hardware and Software

•Grey Magtek Readers: 2 track read head with gain of 100

•Test cards have magstripes with 75 BPI

•Swipes are generated with Collect 16 bit

•LabView

Requirements

•Different cards should have low correlation even when the data encoded is the same

•Different swipes of the same card should have high correlation regardless of speed or direction

•Delta (sample spacing) and M (number of samples) should be chosen to maximize S (separation between Accept and Reject Distributions)

Speed Specifications

•Slow: <15 IPS

•Medium: 15-25 IPS

•Fast: >25 IPS

Source: ESE103 – Card reader signal

Failure Analysis

Several VI were implemented to make sure that the system works accurately. For instance LRC check VI was written to make sure that the bits were read properly for each swipe and that we were distinguishing between forward and backward swipes. The next VI was Binary Reader VI that outputs the account number for each card and a serial number. For same swipes the account number remained the same, as well as for forward and reverse swipes of the same cards. We generate graphs at different stage within each VI to make sure that the data correlated is similar for different swipes of the same card. We also insert a button to indicate whether we are swiping the same card or a different one. As part of the design implementation we checked the parity bits to ensure the accuracy of the account number.

Conclusions

- Running average filter allows for the extraction of Magneprints™ from the encoded bits
- The means of the Reject and Accept distributions have significant separations
- Standard deviations are lower and the distributions are more consistent when the cards are swiped faster
- System appears to be functional and ready for shipment

References

1. Magnetic Stripe Reader. ESE 103, Washington University, St Louis <http://classes.engineering.wustl.edu/ese103/images/3/38/Magnetic_Card_Reader_Instructions.pdf>
2. Morley, Jr. et al. Unites States Patent, Patent NO.: US 7,478,751 B2. *Methods and Apparatus for Authenticating a magnetic Fingerprint Signal Using a Filter Capable of Isolating a Remanent Noise Related Signal Component. Jan. 20, 2009*
3. Morley, Robert. ESE 498 <http://www.ese.wustl.edu/~rem/ese498/>