# Research Report

DataHiding for Automobile Insurance Claim Process, FOAK
Accomplishment Report

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- 1 -

# DataHiding for Automobile Insurance Claim Process
# FOAK Accomplishment

(SIMON : Secured Image Management on Notes)

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# 1. Executive Summary of Offered Solution

A prototype of secured image filing system with data management features (SIMON : **S**ecured **I**mage **M**anagement System **O**n Lotus **N**otes) is developed as a FOAK (First Of A Kind) project for the solution to be adopted to insurance claim process. It is offered as the first brilliant step of centralized and auditable electronic claim process with advanced security features to protect digital images such as evidence photos from an unauthorized alteration.

SIMON is an image filing system built on Lotus Notes database with easy-to-use interface specially designed for automobile insurance claim process. The system offers an advanced security features to protect digital image files such as evidence photos from being modified or tampered by an unauthorized personnel. These advanced features are enabled by using IBM DataHiding technology developed at TRL.

The key features offered by SIMON are; (1) Embed a photo ID in to the image as an invisible and robust watermark. (2) Detect the presence of the alteration applied to the image. (3) Identify the location of the alteration in the image. One of the major enhancements from the previous still image DataHiding is to add the capability to apply this technology directly to the compressed JPEG image files.

With this advanced image filing system, the insurance company can now, enjoy the advantage of using digital photos instead of chemical photos to save the money of film development and shorter the time of photograph submission in claim process. More importantly, the insurance company can prove the fairness to their customers who submit the claims, and audit adjusters and contracted repair shop for adequate loss evaluation.

### Background
Among many insurance companies, one of the most paper-intensive operations is the claim process, where damage estimation report, damaged car photos and accident report are created in paper forms and passed around, and often sent by mail or fax. For higher efficiency and lower process cost, it is highly desirable to convert all those processed into electronic domain. As of the photos, the emergence of inexpensive digital cameras can eliminate the development/printing cost of chemical photos, leading to a significant cost reduction of the handling cost involve in the claim processes.

### Problem
One of the serious obstacles is the fact that digital photos are much easier to retouch or alter than the chemical photos, and usually it does not leave any trace on the image data itself. And the fear of the potential risk of increasing fraud claims becomes a big obstacle for those insurance companies to move into a fully digitized claim process.

### Value of the proposed solution
The objective of this project is to develop a solution prototype of a secured photo filing system by using TRL DataHiding technology. This system, that offers additional function of authentication and detection of illegal alteration or tampering will provide our customers a secure infrastructure to use, exchange and store the important digital images and the photo would also be capable for the use as a evidence.

# 2. System Overview

## 2.1 System Architecture

**S**ecured **I**mage **M**anagement System **O**n Lotus **N**otes (SIMON) is a prototype system that consists of two systems;

(1) A secure image filing system built along with Lotus Notes. This filing system has advanced features to embed and retrieve image ID and detect the alteration applied to the images by using IBM DataHiding technology developed at TRL.

(2) An associated data management system built along with Lotus Notes. This manages the authentication keys of authorized digital camera in accordance with the names of repair shop, adjusters, and local claim service centers.
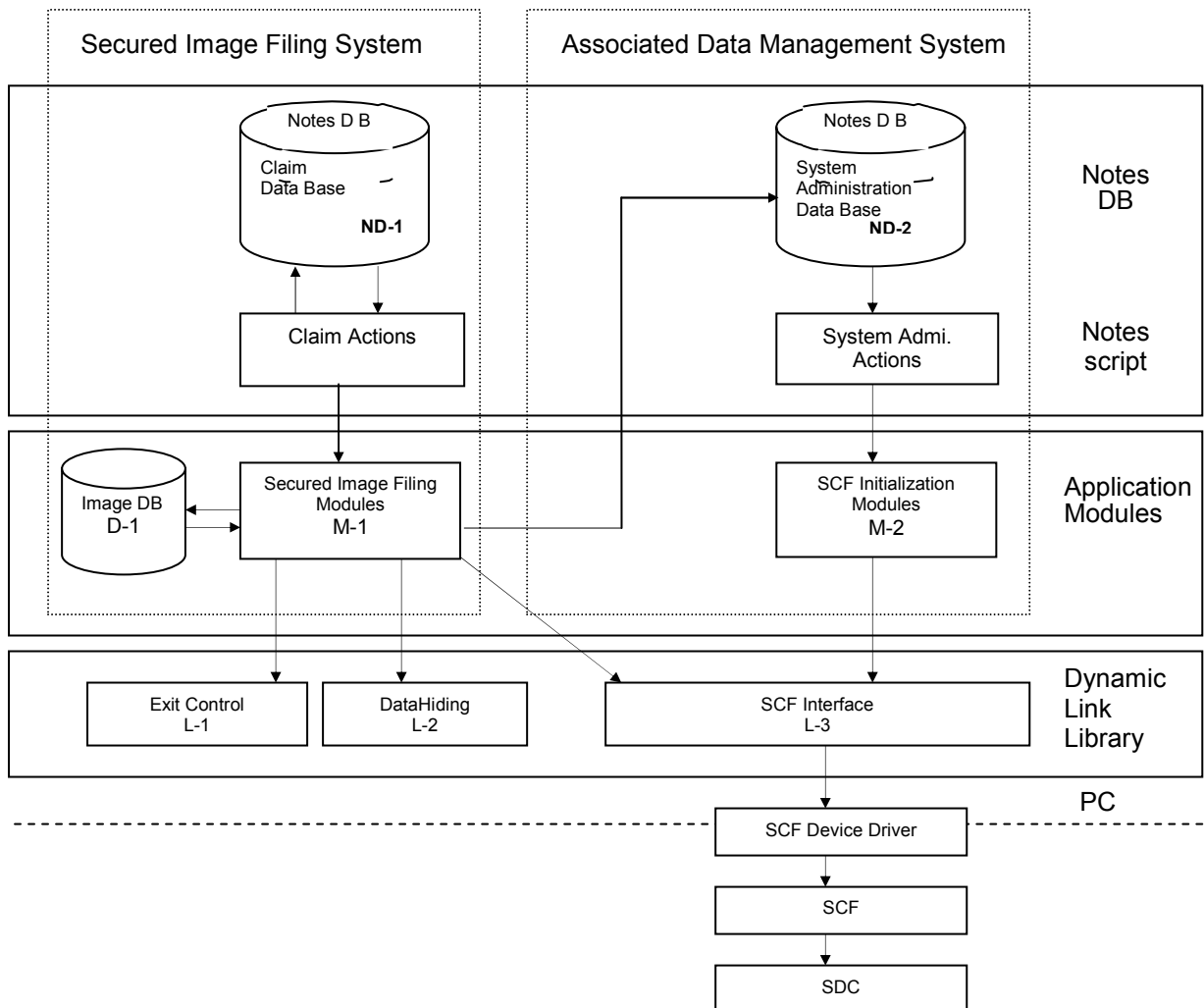


Figure 1    Block Diagram of System Architecture

Each system consists of application layer and system layer. Application layer is further divided into the GUI layer (this is language dependent and stick to Lotus Notes) and the Executable C-Program layer (image filing, display, and transmission, which are not limited on use of Lotus Notes).
The system layer consists of a set of DLL and drivers. The architecture of SIMON is illustrated in the Figure 1. Detail function of each block is described in the section 3.

## 2.2 Workflow and Supported Functions

In this section, the workflow of the automobile insurance claim process is explained, and the function to support the system will be described.

*Workflow of Automobile Insurance Claim Process*

1. When accident occur, the damaged automobile will be taken to the repair shop, and the claim will be filed according to the claim file by the repair shop. In many cases, an adjuster conducts on-site estimation and takes evidence photos at the repair shop. In the proposed solution, secured digital camera (SDC) with secured compact flash (SCF) are used to take the photos to ensure the originality and prevent illegal alteration of the evidence photos. (see section 6)

2. The adjuster reports damage estimation by registering all digital photos into a single folder of an in-branch database (D-1) that is an entry point of the secured image filing system. This is handled by photo filing modules (M-1). The originality of the photo loading from SDC is verified through the SCF interface (L-3) and the digital signature of the adjuster is automatically generated and embedded into the photo to prevent unauthorized alteration from then on. At the same time, data such as claim ID, date, name of the adjuster, are also embedded into the photos to ensure the integrity of the photos. These functions are handled by DataHiding Dynamic Link Library (L-2)

3. The branch manager can use this system to monitor the status of the claim process. When the branch manager or supervisors review claim files, they can confirm the authenticity of the photos, check whether the alteration is applied to the photo or not, and detect alteration location in the case of modified photo . The alteration verification function provides a capability to treat digital photos as evidence. All the keys for the embedding and retrieval of the data, and for the alteration detection associated with the adjusters, branch-office, and repair shop are stored and managed by the Associated Data Management System.

4. The folder of damage estimation reports generated in one branch service center can be transferred to or shared by adjusters in other branch service center. Again the DataHiding Dynamic Link Library enables to verify the origin of photos attached on receiving the estimation report through an Intranet or the Internet. Automatic alteration verification can be done to each incoming outgoing photo.

5. The archive of the electrical claim files can be used by headquarters staff to review the claim process. For example tracking the due date, analyze and monitor the damage estimation process, or conduct an audit of the entire operation of each branch office to measure the performance and improve the speed and accuracy of the entire insurance process.

# 3. Software Assets

## 3.1 Notes Databases

SIMON consists of two systems; (1) Secure Image Filing System, and (2) Associated Data Management System. Each system has its own database built on Lotus Notes.
Refer to Figure1 Block Diagram of System Architecture.

## 3.1.1 Claim Database (ND-1)

Claim Database of Secure Image Filing System stores accident claim reports, and calls some executable programs that are registered photos to report, displayed photos, print-out reports and send/receive report to/from other service centers.

a) Notes Document
   Notes Document includes the following document-items. These items are controlled by Notes application.
   1) Case Number
   2) Case Registration Number
   3) Incident Date
   4) Inspection Date
   5) Car
   6) Car Registration Number
   7) Repair Shop
   8) Adjuster-ID
   9) Service Center Name
   10) Photo Alteration Status flag
   11) Report Transmission flag
   12) Report Received Date
   13) Report Receive Time
   14) Sender Service Center Name

b) Notes Views
   Notes View displays the list of values that is set at Notes Document . Notes view has the following value-list.
   1) Case Number -list
   2) Incident Date-list
   3) Adjuster-ID-list
   4) Transmission Status-list

c) Notes Items
   Each Notes View has the following Notes Items.
   1) Case Number
   2) Incident Date
   3) Adjuster-ID
   4) Inspection Date
   5) Transmission Status
   6) Sender Service Center Name
   7) Receive Report Date
   8) Receive Report Time
   9) Alteration Status
   5) Received Report-list

d) Claim Actions
   Notes document and Views call executable program (*mark) and controlled document by Notes Actions.

Claim Actions is programmed by Notes Script.
1) Create Report
2) Receive Report   (*)
3) Edit Report
4) Delete Report
5) Register Photos (*)
6) Verify Photos (*)
7) Display Photos (*)
*-marked actions kick additional Visual Basic programs.

## 3.1.2 System Administration Database(ND-2)

System Administration Database of Associated data management system manages Adjuster-ID, Service Center data, and Keys for Datahiding, and calls an executable program that are initialized SCF. This action is kicked by Notes script.

a)   Notes Document
Notes Document includes the following document-items. These items are controlled by Notes application.
1) Adjuster ID
2) Service Center Name
3) Service Center Telephone Number
4) Alteration Key seed
5) SCF Key seed

b)   Notes Views
Notes View displays the list of values that is set at Notes Document . Notes view has the following value-list.
1) Service Center
2) Adjuster-ID
3) Service Center List

c) Notes Items
Each Notes View has the following Notes Items.
1) Service Center Name
2) Adjuster-ID
3) Telephone Number

d)   System Administration Actions
Notes document and Views call executable program (*mark) and controlled document by Notes Actions.
System Administration Actions is programmed by Notes Script.
1) Create New Service Center
2) Create New Adjuster-ID
3) Edit Adjuster List
4) SCF initialization (*)
5) Key Database Creation
*-marked actions kick additional C-language programs.

## 3.2 Application modules

Each Notes Database calls Application modules. These are written by Visual-Basic and C-language. Clime Database in Secure image filing system calls Secure Image Filing Modules, Key Management Database in Associated data management system has SCF Initialization Module.

Please refer to Figure1 Block Diagram of System Architecture.

### 3.2.1 Secure Image Filing Modules(M-1)

 Photo Filing Module is Visual-Basic program, consists of 4-executable programs named ImgReg.Exe, ImgDsp.Exe, ImgNoDH.Exe and RcvDoc.Exe. Each programs has the following functions.

a)  ImgReg.Exe
    1)  Photo Registration
    2)  Source Device Analysis
    3)  Exif / SCF Information
    4)  Enlarge Photo
b)  ImgDsp.Exe
    1)  Hiding Data Detection Alteration Checking
    2)  Photo Information
    3)  Alteration Area Detection
    4)  Enlarge Photo
    5)  Print Photo
    6)  Transfer Report
c)  ImgNoDH.Exe
    1)  Enlarge Photo
    2)  Print Photo
    3)  Transfer Report
d)  RcvDoc.Exe
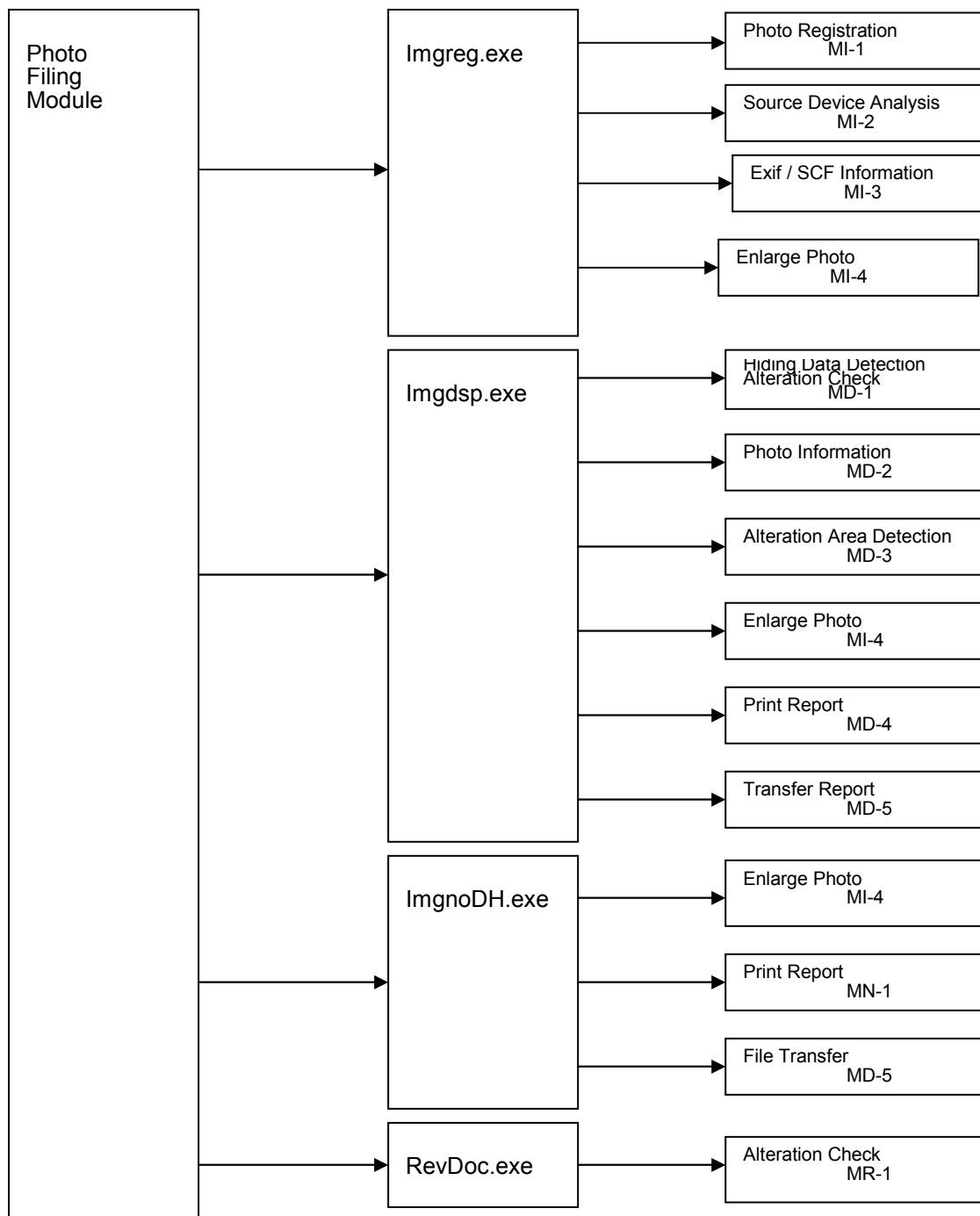    1)  Alteration Checking

 This module is illustrated in Figure 2.

**Figure 2. Secure Image Filing Modules**

MI-1: Photo Registration
1) Hiding data creation
2) Embedding hiding data
3) Embedding alteration detection mark
4) Store operated file to Image Database

MI-2: Source Device Analysis
1) Check of CF in PCMCIA card reader(Whether CF in PCMCIA card reader is SCF)
2) Check Drive location (Whether selected Drive/Folder is in SCF device)
3) Check Adjuster-ID in SCF(Whether SCF is initialized by system administration database)
4) Authentication between SCF and SCF driver
5) Authentication between SCF driver and SIMON
6) Check whether there is any modification exist of   image file in SCF
7) Display a list of photos in selected device in multi-window with alteration check mark

MI-3: Exif/SCF information
1) Investigation/Display Exif Header
2) Display SCF information
3) Display result of source device analysis

MI-4: Enlarge Photo
1) Contrast change
2) Brightness change
3) Rotation (-90, 0, +90)
4) Enlarge/Reduction
5) Reset to original photo condition
6) Input comment to Exif header of photo
7) Save photo condition

MD-1: Hiding Data Detection & Alteration check
1) Hiding data detection of registered photos
2) Analysis of detected data
3) Check whether there is any alteration in registered photos
4) Display a list of photos in selected device in multi-window with alteration check mark

MD-2: Photo Information
1) Inspection date
2) Registration date
3) Adjuster-ID
4) Source Device Analysis result
5) Alteration Check result

MD-3: Alteration Area Detection
1) Alteration Area Detection
2) Alteration Area Frame color selection
3) Display Alteration Area with colored frame
8) Contrast change
9) Brightness change
10) Rotation (-90, 0, +90)
11) Enlarge/Reduction
12) Reset to Original Photo Condition
13) Input Comment to Exif header of Photo
14) Save Photo Condition

MD-4: Print Report
1) Print accident clime report with registered photos, Hiding information and Alteration status (A4

Lengthwise)
   2) Photo selection for print out
   3) Print a list of registered photos with alteration location frame
   4) Color selection for alteration location frame

MD-5: Transfer Report
   1) File Transfer Accident Report with registered photos by Dial-Up Networking
   2) Photo Selection for Transmission
   3) Display Receive Service Center Name List
   4) Dial-up networking Connection

MN-1: Print Report
   1) Print Accident Report with registered photos (A4 Lengthwise)
   2) Photo selection for print out
   3) Print a list of registered photos

MR-1: Alteration Check
   1) Check whether there is any alteration in registered photos
   2) Display alteration check result

## 3.2.1 SCF Initialization Module(M-2)

SCF Initialization Module is C program, consists of one executable program named InitSCF.Exe.
InitSCF.Exe is SCF initialization program, created SCF-key, input it to SCF memory, labeled Adjuster-ID and delete all files in SCF.
SCF key is used for the authentication between SCF and SCF-Driver, and set by each Adjuster.

## 3.3 Image Database(D-1)

Secure Image Filing Modules is stored registered images to Windows Folder named Image Database.
This database includes all registered images and registered image condition.
Secure Image Filing Modules displays/checks image in this database.

Please refer to Figure1 Block Diagram of System Architecture.

## 3.4 Dynamic Link Library

SIMON has the following 3-Dynamic Link Library, these are written by C-language.
a) Exif Control library
b) Datahiding Library
c) SCF interface library

Please refer to Figure1 Block Diagram of System Architecture.

## 3.4.1 Exif Control Library(L-1)

JPEG image file that is shot by Digital camera has header information named Exif（Digital Still Camera Image File Format Standard）. Exif includes Digital Camera name, Camera Maker name, Inspection date, Comment etc…This library(ExifInfo.dll) read/write these information from/to Exif as follows;
   1) ExifRead() : Read Exif information(Digital Camera name, Camera Maker name, Inspection date) from JPEG file

2) ExifReadComment() : Read Exif Information(Comment) from JPEG file
3) ExifWriteComment() : Write Comment to JPEG file used of Exif format.

## 3.4.2 DataHiding Library(L-2)

DataHiding library is a core function of SIMONJPEG. The following advanced features will be offered by using DataHiding technology.

● Embed unique image ID and alteration detection mark directly into JPEG image file invisibly
● Detect embedded image ID from JPEG image file
● Verify whether there is an alteration be applied to the image or not
● Identify altered location(s) in JPEG image and display the region(s) by surrounding lines.

This library (dhJPEG.dll) included in the following functions.

1) EmbedJPEGHash() : Embed hiding data and Alteration detection mark to JPEG image directly by Datahiding technology.
2) RetrieveJPEGHash() : Detect hiding data, Alteration detection mark (Check whether there is any modification in operated JPEG file) and Altered location from operated JPEG image by Datahiding technology.
3) DisplayAlteredArea() : Create JPEG file that is pointed altered location by colored
4) ZipHidingData() : Create hiding data

## 3.4.3 SCF interface Library(L-3)

SIMON includes SCF driver for access SCF device. This laibrary(SCFio.dll) has interface of　SCF driver.

1) GetDriveLetter() : Get Drive letter of SCF device
2) QuerySCF( ) : Query SCF status
3) AuthenticateDriver() : Authentication between SCF and SCF Driver
4) CheckImageInSCF() : Investigation whether there is any modification Image in SCF
5) WriteKpcToSCF() : Input SCF key to SCF memory, label Adjuster-ID and　delete all files in SCF
6) ReleaseDriver() : Release SCF driver

# 3.5 SCF Device Driver

The device driver to control the SCF interface is written by ASPI (Advanced SCSI Programming Interface). Technical specification is available upon request at TRL.

# 4. Intellectual Assets

## 4.1 Application Know-How

Through the joint activity with our partner company from insurance industry, we have accumulated knowledge and experiences regarding the workflow of the claim process, user interface requirement, priority and the surrounding environment of the insurance claim processes. Those knowledge were reflected to the system configuration as well as the prototype development. In the following section, we listed up some of the major user interface requirement that was co-developed with our partner company.

## 4.2 User Interface Requirements

| Process | Function Requirement | Description |
|---|---|---|
| Incident Registration | Input of information to incident information sheet | Incident claim number, date of incident automobile registration number, name of repair shop, free comment |
| | Free comment per each photo | Exif header |
| Incident file database | Search files by keyword and items | Use sorting function of Lotus Notes |
| | Indicate sent out files by flag | First time only |
| | Indicate incoming files by flag | |
| | Indicate files that may include altered images | After first verify process |
| | Perform receiving inspection for the check of the photo alteration | Automatic verification performed at the background of file receiving |
| Photo registration | Display photos by thumbnails | Display all photos in the SCF |
| | Indicate altered images by color | Indicate by background color of file name |
| | Display of extra photo information | Use date and camera type information obtained from Exif header |
| | Display of SCF information | Display information registered by user at the SCF initialization |
| | Carry individual comments by each photo | Use Exif header to carry Maximum 100 characters of comment |
| Display photos | Display photos by thumbnails | Display all registered photos from the SCF |
| | Distinguish photos by alteration or no alteration | Change color of background of file name |
| | Display alteration location | Display boarder(s) of identified area of alteration |
| | Distinguish photos by authentication or no authentication | Change color of background of file name |
| | Retrieve embedded photo ID | Display of ID is optional |
| Review photos | Image editing for display | Rotation, enlarge, luminance/contrast adjustment |
| | Luminance/contrast adjustment | |
| | Store the display options | |
| | Display individual comments by each photo | |
| Print photos | Distinguish photos by alteration or no alteration | Change color of background of file name |
| | Display alteration location | Display boarder(s) of identified area of alteration |
| | Distinguish photos by authentication or no authentication | Change color of background of file name |

## 4.3 Invention Disclosures

*Invention Disclosures submitted by TRL related to DataHiding FOAK project*

- JA9-96-087   A method for identifying digital camera & detecting alteration on digital images (filed)
  Original patent describes use of DataHiding technology in digital camera and secured memory for image authentication and alteration detection.

- JA9-98-173   A system that controls access to data in memory devices (filed)
  Description of device authentication protocol using secured compact flash (SCF) and secured digital camera (SDC) for secure image transmission.

Other patent applications in process.

# 5. Demonstration Package

## 5.1 Deliverble Hardware and Software

### Software Packages [need more information here!]
- Notes Databases
- Executable files / Dynamic Link Library
- SCF Device driver
- Automatic demonstration program for Lotus ScreenCam

### Digital Camera and Compact Flash Memory
- Secured Digital Camera : Rework based on Konica GK
- Secured CompactFlash : Rework based on IBM TurboFlash

Both devices required special order with detail specification available at TRL, which are currently only disclosed under appropriate NDA. Please contact TRL for the availability and the ordering information.

## 5.2 Required System Environment

### PC (recommended configuration)
- CPU : Pentium 350MHz or higher
- Memory : 64MB memory or more
- Screen Size : XGA and higher
- PCMCIA card reader : IODATA (recommended)
- PC card adapter for Compact Flash
- Printer : Optional
- ISDN connection : Optional for file exchange with other PC

### Operating System and Software
- Windows95 with Plus
- Lotus Notes Version 4.5 or higher
- Photo retouching software (Adobe PhotoShopVer4 or equivalent)

## 5.3 Demonstration Scenario

The demonstration package delivered with the instruction is capable to perform all of the functions described in this document, including ID embedding, alteration detection, and so on. Device authentication can also be demonstrated with optional secured digital camera, secured compact flash and PCMCIA card reader with CF adapter.

Suggested demonstration scenario will be shown in the attached ScreenCam presentation. This presentation video was presented at the IBM Global Insurance Symposium in Monte-Carlo at November 1998. Following is the outline of the suggested presentation of the demonstration system. The step (1) through (3) can be skipped if Secured Digital Camera and Secured Compact Flash Memory are not available.

(1) Shooting photos by Secured Digital Camera
(2) Read photos from Secured Compact Flash to the PC
(3) Confirm authentication of the photos
(4) Create a sample incident report information sheet for photo registration
(5) Register photos and verify the authenticity of the photos as well as the embedded data
(6) Exit the system and perform alteration by using conventional photo retouching tool
(7) Re-open the incident database to verify the same sample photos by warning message
(8) Display the photo to show the indication of the alteration location

# 6. Accompanied Project

A secured photo transmission mechanism between digital camera and PC uses secured compact flash and secured digital camera which implement device authentication protocol by hardware, the hardware implementation of device authentication protocols. The hardware and the drivers were developed by an accompanied joint-project with ESBU (Embedding System Business Unit) and TRL, which was funded by ESBU.

# 7. Conclusion

We have proved the technical feasibility of using DataHiding technology for the world first advanced image filing systems through the prototype development of SIMON and a joint on-site testing with our partner company. The advanced features provided This system offers the first time in the world, advanced. And we also accept gained experience and valuable input from the working environment. The next step is to move forward with some real application with the established know how and technology.

# 8. Acknowledgment

This project was made successful with supported by number of TRL researchers and ESBU engineers. Kohichi Kamijoh, Akio Koide, Kazuharu Toyokawa from TRL and Satoko Tonegawa from ESBU contributed for architecture design, technology development and enhancement. Technology implementation. As a member from the accompanied project, Tohru Sakakura, Ikushi Tominaga, Seita Shiga from ESBU provides hardware and device driver software for SDC and SCF.

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