iSanta

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Background

NSWC Crane:

- Needs to be able to analyze targets in the field.
- Want to increase the accuracy of analysis.
  - By hand is not accurate enough because of the methods that are used.
- Want an iOS app for ease of use and availability of hardware.
- We will use image recognition to identify bullet holes in the large target.
- The app will normalize the image and approximate bullet holes.
- The user can manually adjust impact placement after recognition.

Client Overview

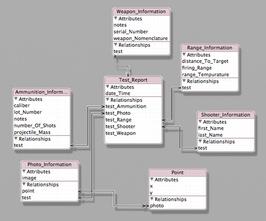
- Clients:
  - Charles Zeller, Techincal Warrant Holder, Small Arms & Weapons Crane Division
  - David Long, Air, Land, Sea, and Expeditionary Systems Small Arms Project Manager Crane Division
- Their Role:
  - Handle small arms testing division at NSWC Crane.
  - Manage the technicians who will be using our product to perform analysis on targets.

Current System

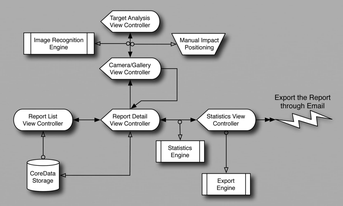
- By hand or with a desktop system designed by Rose Senior Design Team (Can no longer be used).
  - The Rose system, SANTA used Visual C++ and OpenCV to accomplish the image recognition and report generation.
- Negatives of the Current System:
  - Technicians don't like being required to go back to the office to perform analysis on the test targets.
  - Using Rulers and by hand calculations doesn't yield results that are as accurate as desired.
  - The analysis method used in the by hand calculations uses a statistics method that is inferrior to those which can be done efficiently with computers.
- New Restriction required a new system.
  - Cannot use USB devices (Cameras, SD card readers) any longer because of new security regulations.

Design & Architecture

CoreData Model

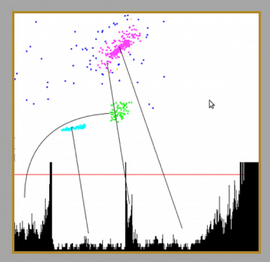


Application Flow



Engines & Image Recognition

- Statistics Engine
  - Takes the impact points and calculates:
    - » Extreme Spread in the X & Y.
    - » Extreme Spread of the group.
    - » Mean Radius of the group.
    - » Sigma values in the X & Y.
    - » The furthest a round is left, right, above and below the centroid of the group.
    - » The circular error probable (CEP) radius.
- Export Engine
  - Uses CSV to produce a file that is readable by Excel.
  - Attaches the file by converting the CSV to NSData.
  - Parses the statistics table to produce the CSV.
  - Accesses CoreData to pull the basic report data.
- Image Recognition Engine
  - Performs image normalization with a matrix transform.
  - Planning on using Laplacian of Gaussian to find the impact points.
    - » Uses a grayscale image to allow for easy identification of dark regions before checking for a round shape.
  - Considering using Lindberg's algorithm to allow for better blob recognition.



- Chi-squared analysis of points
  - Gives a good description of the shooter's proficiency.
- The OPTICS system may allow for the identification of multiple spreads.

The App

Reports View
- The main app view.
- Shows a list of reports.
- Reports are stored with Core Data.
- Editing is allowed, but not reordering.

Report Detail View
- Shows the details of a stored or new report.
- Every field is editable.
- Saving is done a single field is edited to prevent data loss.

Picker View Example
- When the user taps a field the appropriate input mode is selected.

Email View
- When the user is done tweaking the report & taps the button on the statistics view the file is added to an email and the user can email it anywhere.

Statistics View
- Displays the calculated values along with the report information.
- This is a way for the user to check that the report is correct before emailing it.

Target Analysis
- After the image is processed the impacts are show to the user overlayed on the image.
- The user can add, edit & remove points that are wrong.

Technologies Used

- iOS 5 & Objective-C: To build the application including the user interface and data storage.
  - CoreData: A CoreData schema was used to store the reports generated in the application.
- C++ & OpenCV: To process the target images and perform image recognition to find the bullet impacts.
- CSV: To allow the application to transfer reports and results from the iOS device to a computer through email..