Automated Tool Monitoring System (AToMS)

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Advisor :
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Client:
ISU Electrical & Computer Engineering

Task Responsibility

- Edward | Team Leader
  - Manage project deadlines
  - Implement the Main Control Unit and Image Processing Unit
- Wan Zulsarhan | Webmaster
  - Implement the Main Control Unit and the Web Application
- Asyraf | Key concept holder
  - Design sensor circuit connection for each drawer
  - Design the mechanical lock mechanism for the system
- Ibtisam | Communication
  - Implement the Image Processing Unit
  - Write weekly reports

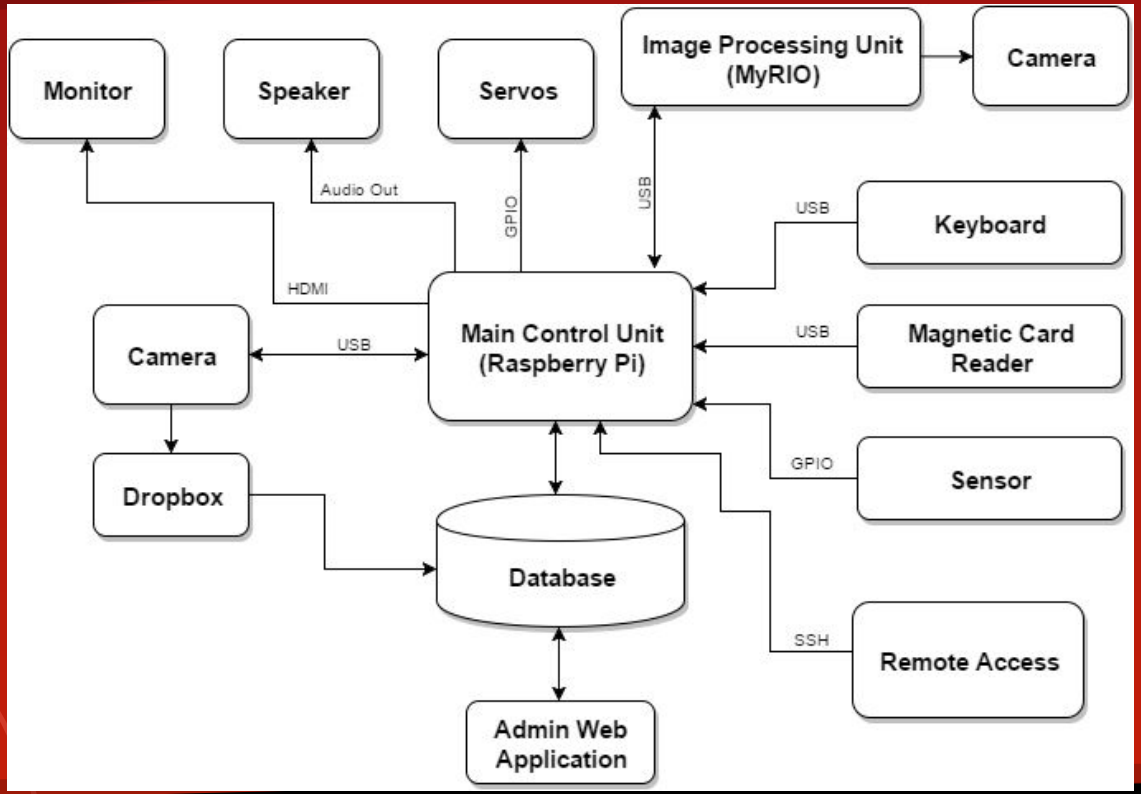
Problem Statement

- No accountability in place for tools
- Lack of tracking system
- Tools ‘checked-out’ on an honesty-based system
- Increased setup time required to track down necessary equipment for projects

Solution

- Create a system that will automatically track all equipment transactions
  - Keep the video feeds of every activity
  - Detect the tools taken or return automatically
  - Implement an admin web application to monitor the transaction logs
  - Introduce ability to restrict and/or deny tool access

Conceptual Sketch



System Requirements

- Users should able to open the tool machine using their card or by entering their ID number with numpad.
- The camera for Main Control Unit should able to record 480p video for more than 3 minutes
- The camera for Image Processing Unit should able to capture 1080p image for image analysis
- The Image Processing Unit able to detect which tool is taken or returned at more than 80% accuracy.
- The Dropbox have enough storage to store videos for 1 week worth of videos (assuming the number of tool transaction per day is at most 20)
  - which is 21 GB
- The validation process from MySQL database take less than 2 second.
- The tool box must be physically locked.

Market Survey

- **Snap On Level 5 ATC Tool Control System** is the best example of product existed in the market.

- Using the Level 5 ATC as an example, we will be creating a same functioning system for our project. The goal is to provide a same functioning system that could be afford by the department to implement on campus.

Risk & Mitigation

Risk	Mitigation Strategy
User might try to cover their face while taking the tools and claiming that their card got stolen to steal tools from the drawer .	We have second camera installed for tools detection. Even if they covered their face, we have his ID number and all the tools he taken out.
Sensor and servo might draws a lot of current from Raspberry Pi and thus damaging the system	Servo is powered by external source to avoid current spikes that could happen and harm the Raspberry Pi
System will not work when the ISU internet is not working as the Raspberry Pi will be connected to the database using WiFi.	Have a backup database stored locally in Raspberry Pi
The Image Processing Unit might not be able to detect the tool that the users take or returned	Admin can always refer to the recorded video stored in Dropbox

Resource/Cost

Component	Price Per Unit ($)	Unit	Total ($)
Raspberry Pi	44.99	1	44.99
Raspberry Pi Camera	25.99	1	25.99
USB Hub	6.99	1	6.99
Magnetic Card Reader	14.45	1	14.45
Numpad Keyboard	10.99	1	10.99
Display Monitor + Audio	59.30	1	59.30
SD Card	7.95	1	7.95
Parallax Standard Servo	12.99	2	25.98
Reed Switch Magnetic Sensor	3.56	20	71.20
National Instrument MyRIO	250.00	1	250.00
Logitech B910 HD Webcam	29.99	1	29.99
TOTAL			**$488.53**

Project Milestones

Functional Decomposition

Authorization
- Read ID from the user
- Validate the ID with database

Record Video
- Activate the camera
- Record video
- Upload to Dropbox

Unlock Tool Box
- Signal the servo
- Unlock the key

Detect Missing Tools
- Capture Images
- Run images through vision program in MyRIO
- Send data back to RPi

Functional Decomposition…cont'd

Web Application

- Monitor users activity
- Add new user
- Remove user
- Monitor transaction history
- See tools availability

Detailed Design

The system is divided into three main parts

- Main Control Unit (MCU)
- Image Processing Unit (IPU)
- Web Application

Main Control Unit

- Main.py
  - Handle User Input
  - Interface with the webcam
  - Upload video to dropbox
  - Create new record in database
- Servo.py
  - Interface with servos
- Sensor.py
  - Interface with sensors

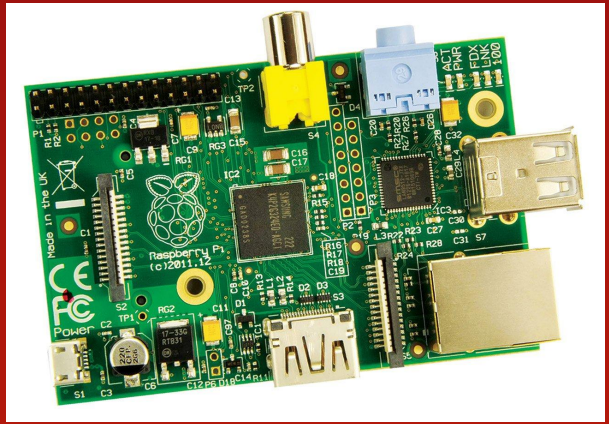


Image Processing Unit

- Used to implement the Tools Detection functionality
- This is achieved by creating a image analysis program using Vision Assistant script and LabView

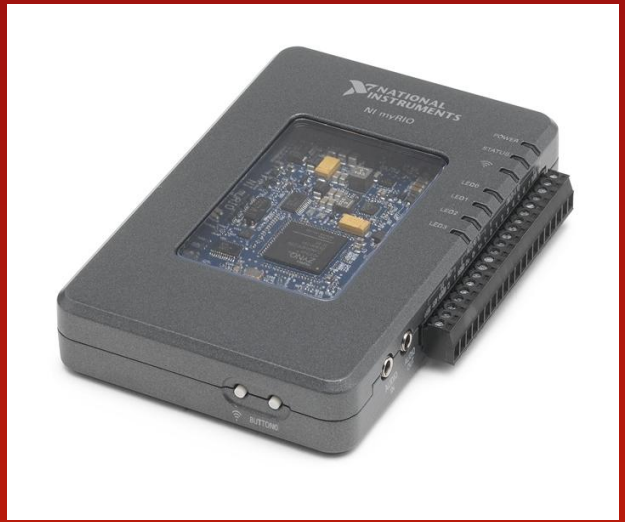
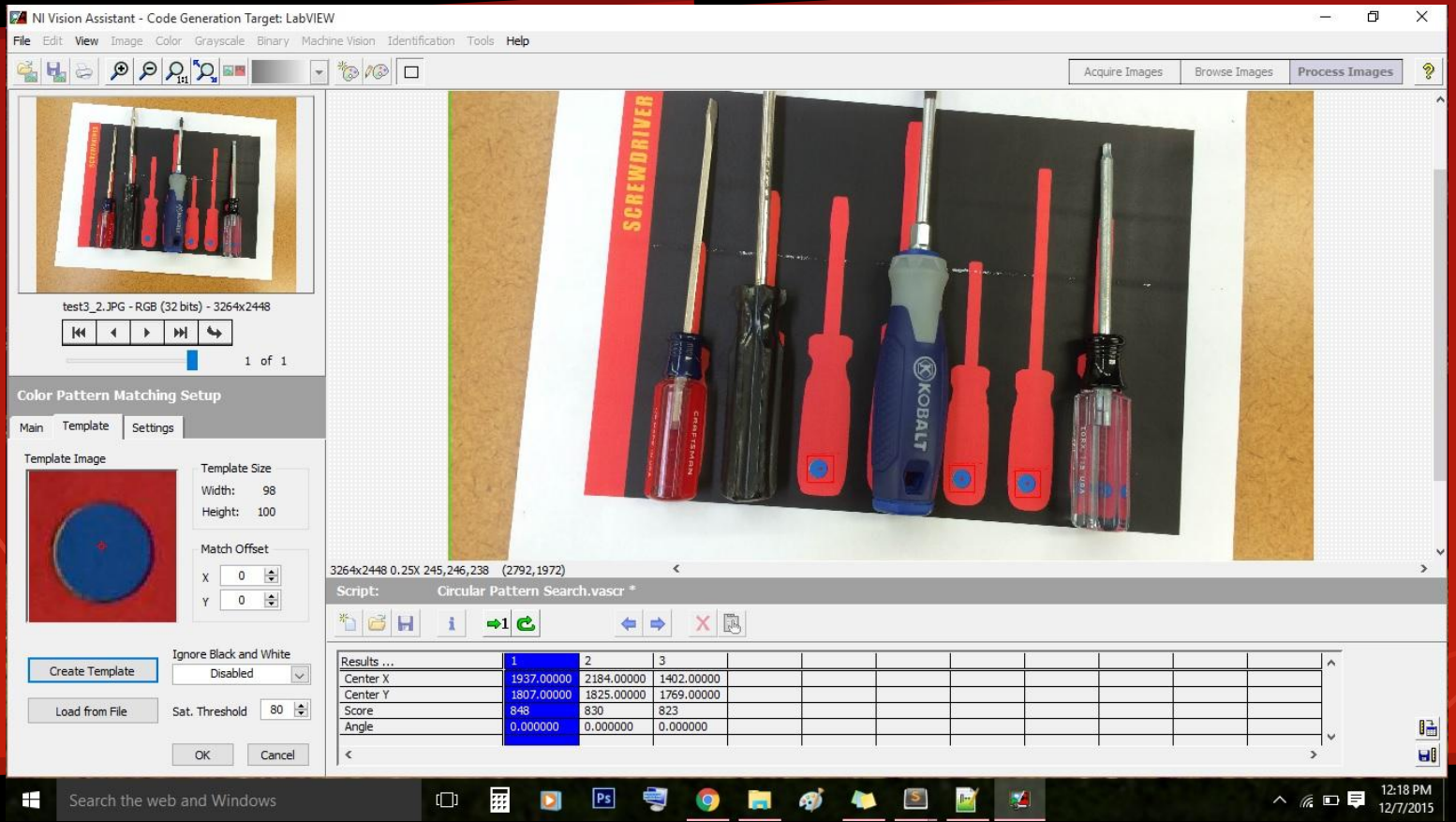


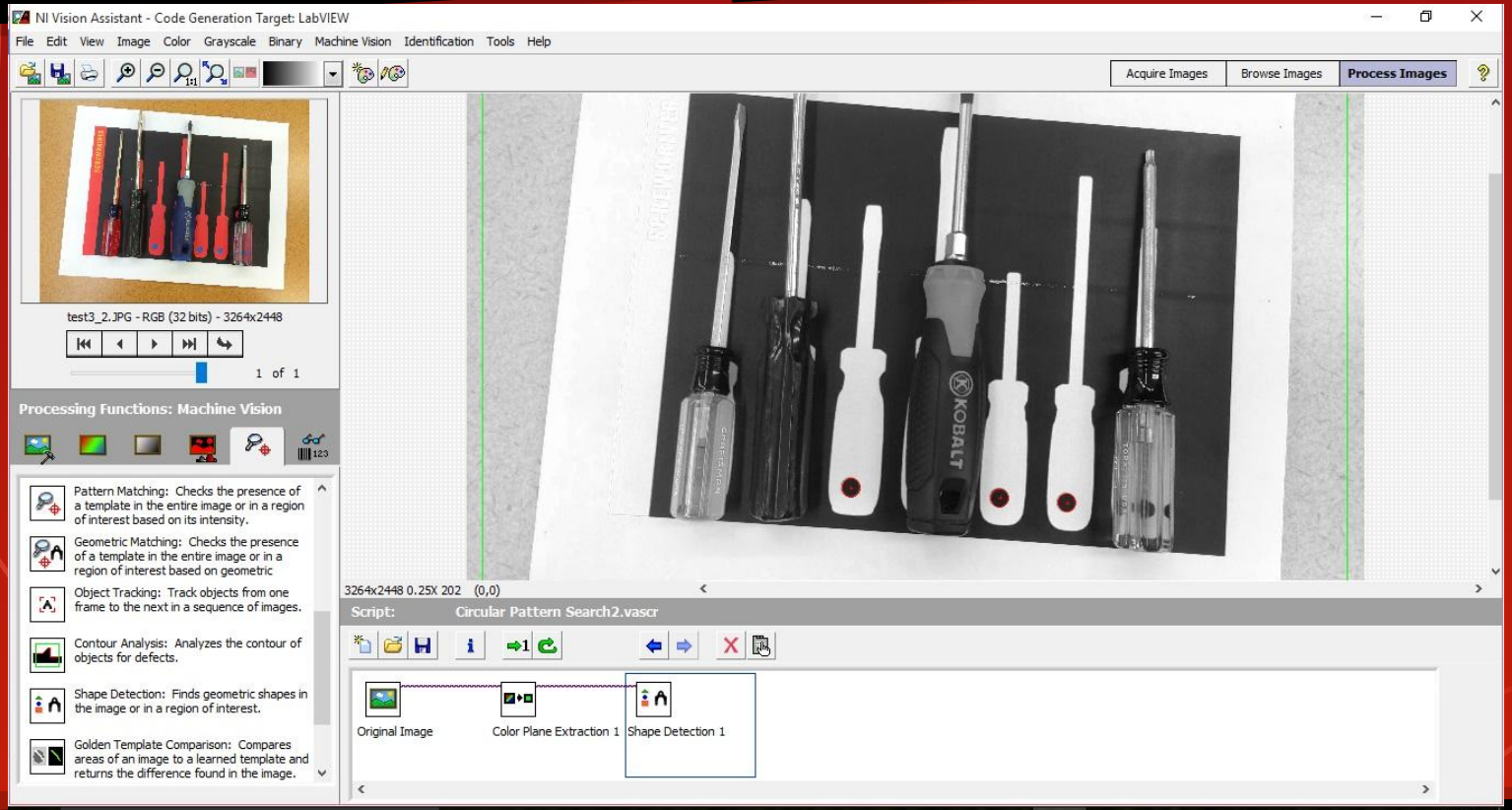
Image Processing Unit… cont’d

- Vision Assistant
  - Color Pattern Matching
  - Circular Pattern Search

Color Pattern Matching



Circular Pattern Search



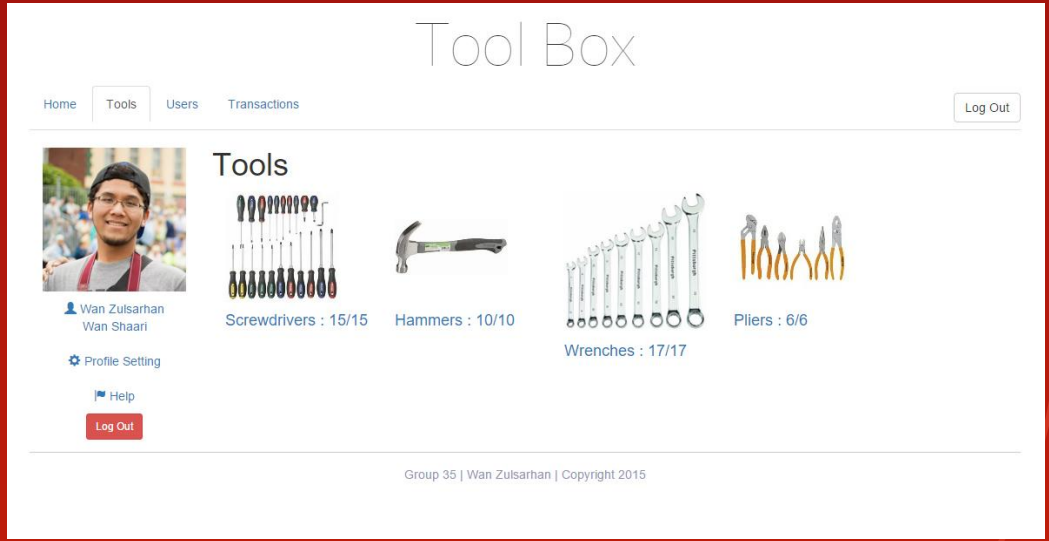
Web Application

Admin Privilege

- Monitor all users
- Monitor transaction history
- See tools availability

Regular User

- See tools availability



Web Application

Client Side

- Using Laravel 5 framework
  - HTML, CSS and Blade Templating Engine

Server Side

- PHP scripting language
- MySQL database
- Dropbox (to store video)

Platform Used

- HARDWARE
  - Raspberry Pi
  - NI MyRIO
- SOFTWARE
  - Python
  - PHP
  - Laravel Framework
  - LabView
  - Vision Assistant

Testing Plan

- Hardware
  - Rigorously test to verify Raspberry Pi, servo, camera, magnetic card reader and keyboard can perform under modest stress condition
- Electronics
  - Simulate sensor and servo circuit
- Software
  - Test all edge cases in the Main program
  - Conduct a usability testing for web application with our client

Prototype Implementation

First Prototype Demonstration

Current Project Status

- Main Control Unit ✔
- Admin Web Application ✔
- Image Processing Unit (On Going)
- Lock Mechanism (Next Semester)
- Tool Box Setup (Next Semester)

Plan for Next Semester

- Work on the lock mechanism
- Set up the tool box
- Continue to work on the Image Processing Unit
- Add more functionality to the Web Application
  - Add and Remove User
  - Send notification to User
- Work on the sensors circuit design for the drawers
- Testing and Improvement

Questions?

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