EE/SE/CPRE 491
MAY 1631
PROJECT PLAN VERSION 2

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Client
ISU Electrical & Computer Engineering

Project Title
Automated Tool Monitoring System

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Project Statement

Due to the tools used in the ECPE machine shop often get missing or do not get returned, our group will try to solve the problem by creating a system called Automated Tool Monitoring System to secure and track down those tools borrowed by students. The system will allow access to the toolbox by the swipe of a student, staff or faculty member's ID card. Once opened, the system will keep video records of tools removed and returned. The system will also need to interface with the lock system of the existing toolbox.

Ideally our system will utilize a single board computer called Raspberry Pi to handle the workload. As Raspberry Pi is capable of doing everything like a desktop computer do, we will connect a camera and user input components, which are magnetic card reader and keyboard, through USB port. User input components will allow the user to swipe their card or enter their ID card number. High resolution camera will be used to record a 1080p video. Servo will be used to unlock the tool drawer while the sensor will be used to detect which drawer is opened. All the videos recorded will be sent to dropbox for image analysis and comparison before go to the database. Also, the system will use a 7’ monitor as user interface.

System Requirement

System Requirement

The system created for this project will meet the following requirements:

- The user with valid access should able to open the tool machine by using their ISU card or by entering their ID number using 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 should able to detect which tool is taken or returned at more than **80% accuracy.**
- The Dropbox should have enough storage to store videos for 1 week assuming the number of tool transaction per day is less than 20.
    - 20 transaction * 7 days = 140 transaction

    - Each transaction take at most 3 minutes of video = 420 minute worth of 480p video.
    - 1 minute 480p video requires approximately 50 MB storage
    - 420 minute * 50 MB = **21 GB of video storage**
- The sensors on each drawer should able to detect if a drawer is open at **100% accuracy.**
- Warning alarm should be activated when more than one drawer is opened at the same time
- The validation process from MySQL database should take **less than 2 second.**
- The Raspberry Pi should able to be accessed remotely from any computer using SSH for configuration and troubleshooting.
- The tool box must be physically locked.

Assessment of Proposed Solution

Strengths

- Raspberry Pi is a cheap single-board computer that can operate all the functionality that we needed for the system.
- Every component of the system is easily integrated with each other.
- A large community of Raspberry Pi user make it easier to find solution for troubleshooting

Weaknesses

- There is a risk that the image analysis and comparing server is down anytime.
- The result of tools detection using image analysis and comparing are not 100% accurate.
- Storing 1080p videos required a lot of space in Dropbox.
- Uploading and downloading the video to and from the cloud storage could take some times.

Validation Test and Acceptance Test

- Different ID cards will be used to test the functionality of magnetic card reader after integrated with the system.

- Camera testing to capture and record video will be made to ensure it achieves the desired resolution, efficiency, functionality and automatically stored in the Dropbox.

- Create unit testing for image analysis and comparing functionality.
- Make sure that Dropbox has at least 64 GB storage
- Do stress testing to magnetic sensor to test its limit before its failed.
- Test the speed of each MySQL query that is used to validate the user from database.
- Test the SSH connection to Raspberry Pi using PuTTY.

System Description

Design Component

- Raspberry Pi
- Magnetic Card Reader
- Keyboard
- Monitor
- Speaker
- Camera
- Servo (Lock)
- Drawer Sensor
- Dropbox
- Image Processing Unit
- Database
- Web Application for Admin

Design Specification

- ### Raspberry Pi

  Raspberry Pi plays an important role in this system. Raspberry Pi is a credit card sized single board computer that basically can do anything that a normal computer can do. In this system, Raspberry Pi acts as a central processing unit

that handles all the input from Magnetic Card Reader and Keyboard, run the main program and handle interaction with Dropbox and MySQL database. It will also will interact other output component like monitor, speaker, camera and servo.

- ### User Input

  The two input component for this system are the magnetic card reader and keyboard. The magnetic card reader should able to read the card number for validation. In case of card read failed, user can enter their card number manually using keyboard.

- ### Camera

  The camera is used to record activity for every transaction of taking tools or returning tools. It also used to capture image for further image processing and comparing to detect which tool is taken or returned. Camera that will going to be used for this project Logitech Webcam.

- ### Lock Mechanism

  Servo is the main component for the tool box lock mechanism. Since there are two lock for each compartment of the tool box, there will be two servo used in the system. Each drawer of the tool box will be installed with sensor to detect whether it is opened or not. If more than one drawer is opened in the same time, the system will sound the alarm to give warning to the user.

- ### Image Processing Unit

  The system will be able to detect which tool is taken or returned by user. For that purpose, a few images will be captured by the camera and sent to the MyRio for processing and analysis. The result then will be sent to the main control unit.

- ### Admin Web Application

  Admin will be able to see all the transaction records through this web application. It also enable admin to add new user to the system, remove user from the system, contact user and update database.

Technical Approach / Concept Sketch

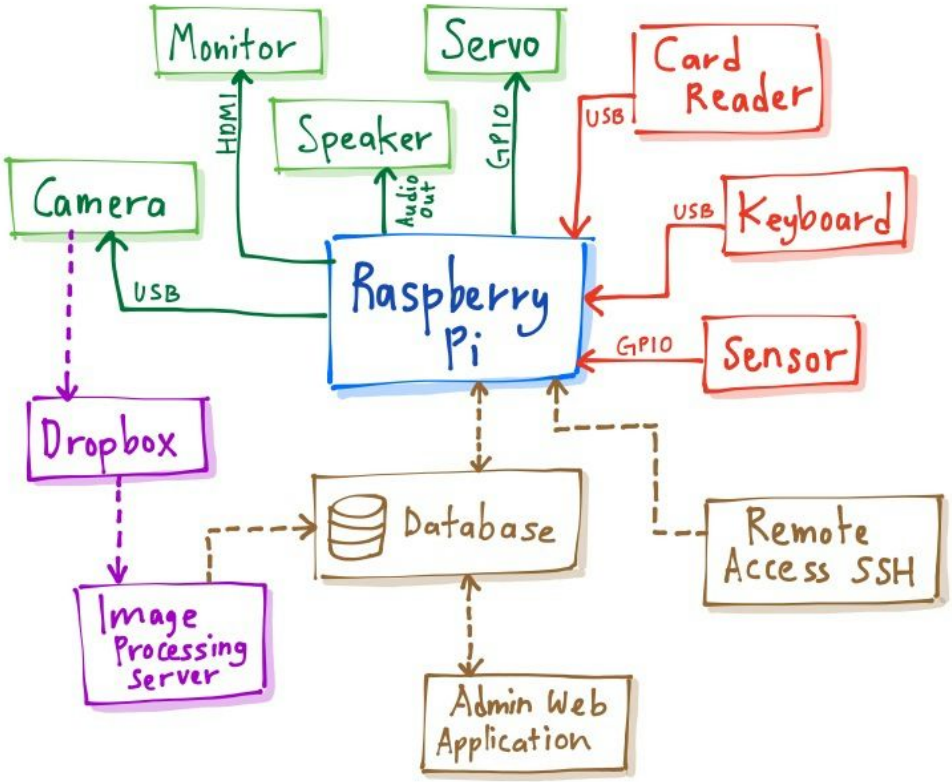

Figure 1 : Concept Sketch

Deliverables

Present Version (First Semester)

- Project Plan Draft
- Design Document Draft
- Project Website Draft
- First Prototype
    - A working system with minimum requirement (without tools detection and admin web application)

Final Version (Second Semester)

- Final Project Plan
- Final Document Design
- Completed Project Website

- Final Prototype
    - A working system with tools detection functionality
    - A functional admin web application
- Locking Mechanism integrated with Servo
- Tool's foam container for each drawer

Testing

Testing plan for the present version of the project is by using our own student cards as test case. We will insert our own information in the database and see if the system able to validate our card by making a MySQL query to the database. Besides, we will also can test if the video of our activity is recorded or not by checking the directory in Dropbox storage associated with the system. We also will create a separate test case to test the functionality and reliability of the servo and drawer sensor.

Work Structure

Work Breakdown Structure

Edward Droesch | Team Leader

- Manage project deadlines
- Implement Main Control Unit and Image Processing Unit

Wan Zulsarhan Wan Shaari | Team Webmaster

- Implement the server and client code for database interaction with the system
- Implement the main program to read input from magnetic card reader and numpad keyboard.
- Write the functions to interact with other component of the system such as camera, monitor and speaker.

Ibtisam Ostham | Team Communication Leader

- Write the weekly report
- Implement the Image Processing Unit

Mohamad Asyraf Samsudin | Team Key Concept Holder

- Design the mechanical lock mechanism for the system
- Design sensor circuit connection for each drawer

Project Schedule

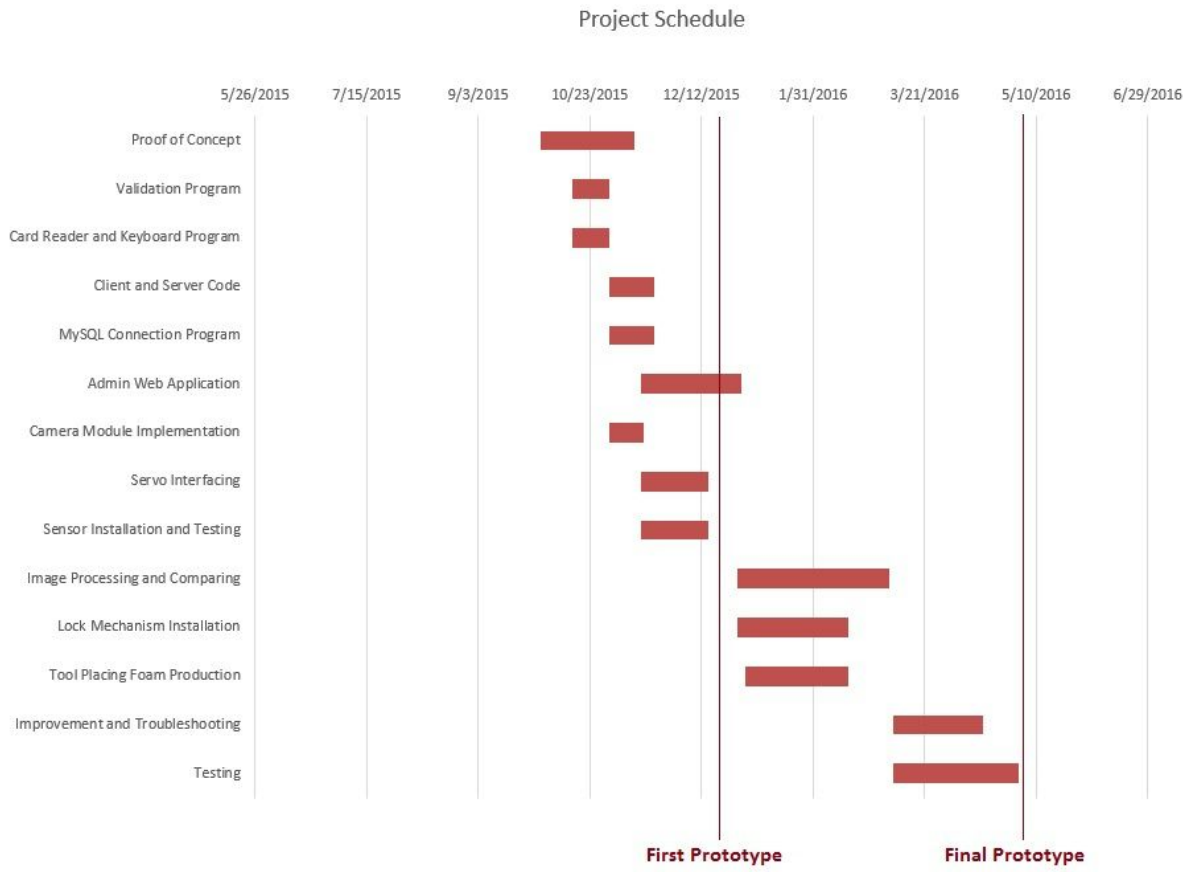

Figure 2 : Gantt Chart for Project Schedule

Risk and 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

Cost Consideration

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
Pro HD Webcam 1080P	29.99	1	29.99
TOTAL			**$488.53**

Market Survey

Snap On Level 5 ATC Tool Control System is the best example of product existed in the market. This company might be the only company that produced an automated tool control system. The Level 5 ATC comes with a base dimension of 36" and 54" retailed at a price of $21,000 and $26,000 respectively. The Level 5 ATC uses RFID scanner as their input. User will scan their ID's to lock and unlock the system. A light will flash to indicate the system is unlocked. A hidden camera will then capture photo of the drawer for image processing. The image captured will be analysed and then whatever tools be taken out, or misplaced will be detected. An audio output will inform the user and also

the activities will be recorded into the supervisor logbook file. This system is necessarily to be very accurate as it was intended to be used by the aviation industry. As we all know, when tools were left behind in an aircraft, it may cause the airplane to crash and that would include loss of lives. So the system uses a very high quality products as well as experienced workers to make this system works.

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. However, we will be delivering a similar functioning system with highest precision as possible that we could at a lower price.

Conclusion

This project is a two semester length project. Our goal is to create a system that would benefit others. The purpose of this project is to ensure that anyone who take tools from the department`s tools drawers to feel responsible and return the tools so that it could be used again by others. Our work will be focusing on creating a security for the tools. We will be creating a system to monitor who took what and when. Also, we will record a video of them taking the tools out from the drawer. By using the camera provided, we will also try to make an image comparing software to detect what tools were taken out so that we could record and store all the necessary information in our database. For the first semester, we will be focusing on the design aspect and creating a first prototype of the system. For next semester, we will be focusing more on the improvement of the system. Also, we will be focusing on delivering a working final product that meet the required specification given. We hope that we could make as much improvement from the first prototype before the end of the second semester.

We do noticed that the system is already existed in the market. However, we hope that we could create a working product that function the same as the one in the market at a lower price. Thus, the product usage that we will be making could be expanded more throughout the campuses as it requires lower cost to be implemented. With all the knowledge we learn at the Iowa State University, we are looking forward to make this project a success.