MCU-based Unmanned Photo Booth Prototype with PIC16F877A Microcontroller and OpenCV API Integration

Prepared for: **Alvin Joseph Macapagal,** Instructor
Prepared by: **Jhaycee Anthony Acain, Thomas Lee Castro** & **Danica Marie Dumalagan**, (10:30-01:30 TUE THURS)

April 20, 2023

Department of Computer Engineering University of San Carlos Talamban Campus Cebu City, Cebu 6000 T (32) 2300100 loc 263 F (32) 3460351

Executive Summary

Rationale

Photo Booths have become a popular addition to weddings, parties, and other social gatherings, as they offer guests a fun way to capture memories, treasure moments, and take home a personalized souvenir. In recent years, the advancements in technology have led to the development of digital photo booths that allow users to automatically capture and share photos instantly. The use of microcontrollers in these photo booths has made it possible to incorporate various features and functions, such as filters, animations, and social media integration [1].

The PIC16F877A microcontroller is a popular choice for developing embedded systems due to its high processing speed, low power consumption, and ease of programming. The real-time processing capability of the PIC16F877A enables quick and efficient handling of user requests within microseconds, and its connectivity options allow for easy integration of Photo Booth and Timer modules and other peripherals, such as UART, SPI, and I2C. By using this microcontroller, it is possible to create a Photo Booth Machine Prototype that is efficient, reliable, and cost-effective. The Photo Booth Machine Prototype will feature a user-friendly interface that allows users to select different photo capture modes, add filters and effects, and share their photos on social media platforms. The prototype will also include various sensors and actuators that can detect and respond to user input, such as motion sensors, touch sensors, and LED lights.

Overall, the development of an MCU-based Unmanned Photo Booth Prototype with PIC16F877A Microcontroller and OpenCV API Integration has significant potential to provide a portable, unique and engaging experience for users in social events and public places. This technology can also be extended to commercial applications, such as in amusement parks, malls, and tourist attractions, to generate revenue and enhance customer engagement.

Problem

How to implement a Photo Booth with an automated timer and capture based on the number of shots equivalent to the amount of the bill inserted using a laptop with a working camera and various peripherals interfaced to the PIC16F877A microcontroller?

Goals and Objectives

The goal of this project is to develop an MCU-based Unmanned Photo Booth Prototype with PIC16F877A Microcontroller and OpenCV Python API Integration capable of providing affordable and portable Photo Booth Machine for occasions like birthdays, weddings, parties and other social gatherings. Furthermore, the following objectives are to be met:

- study of the PIC16F877A and its capabilities towards an MCU-based Photo Booth Machine Prototype;
- interfacing of various input and output peripherals to the PIC16F877A microcontroller
- exploring different protocols and software tools to enhance functionalities of the project using its interfaced peripherals

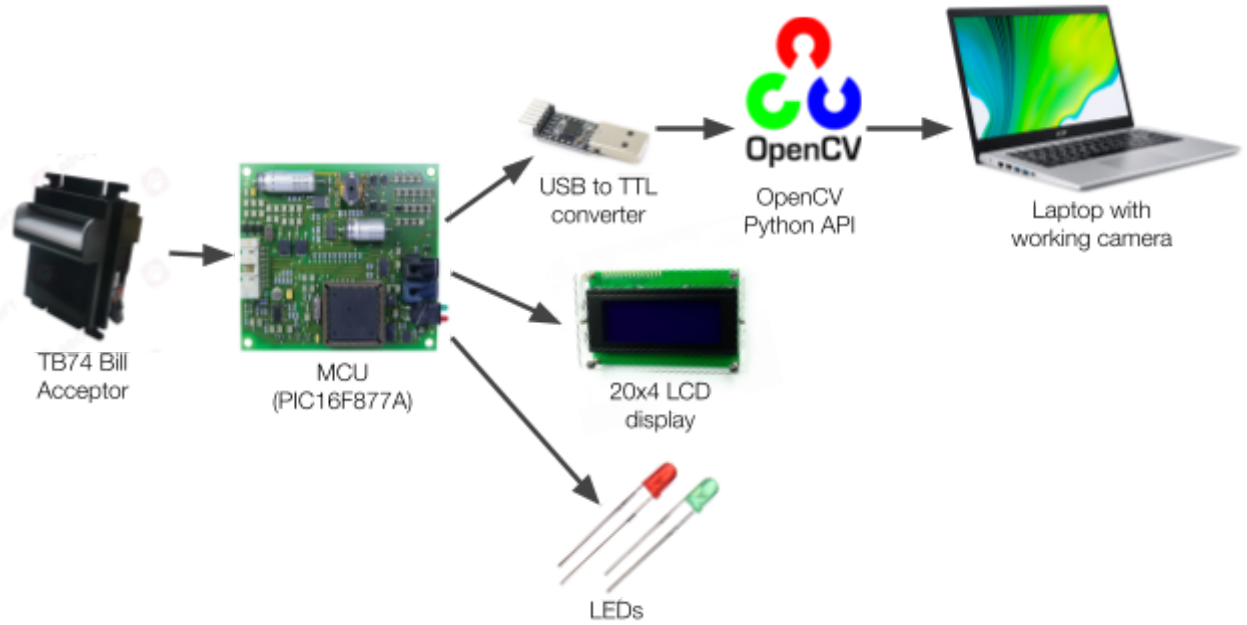
Scope & Limitation

The project scope includes the construction of a bill-accepting photobooth prototype using a PIC16F877A microcontroller and a laptop with a working camera. This includes implementing a system that utilizes a TB74 bill acceptor that accepts Philippines peso bills and communicates the amount of the inserted bill. This bill amount is converted into the number of shots available for the customer to take in the booth within a pre-programmed time interval per shot. Moreover, the bill acceptor machine states are echoed on a 20x4 LCD screen and LED indicators, all of which are interfaced to the PIC16F877A microcontroller using C programming language. For image capture, Open Source Computer Vision (OpenCV) Library will be used to control the Camera application of the laptop and display the camera timer from the PIC16F877A timer module to the laptop screen using OpenCV Python Application Programming Interface (API).

The limitations include accepting Philippine peso bills only, and in the context of this project, specifically limited to accepting P20, P50, P100, P200, P500, and P1000. Also, only a maximum total of P1000-worth of shots are allowed. Moreover, the prototype converts the whole bill amount into shots, thus does not dispense change, and does not refund bills in case of cancellations. No additional transactions could be performed until the previous transaction is completed, in which, one bill insertion counts as one transaction. Photos captured using the photo booth machine are only stored in one folder in the laptop, thus only producing a softcopy output.

Conceptual Framework

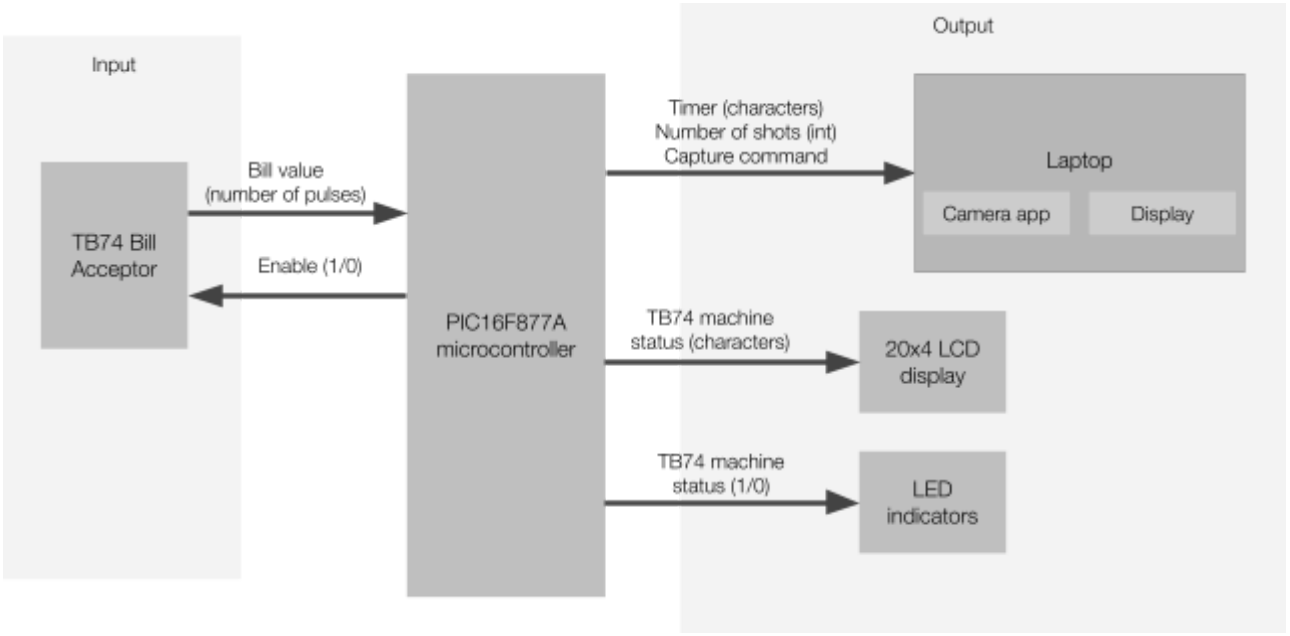
The following is the conceptual framework of the proposed project.



The TB74 bill acceptor, laptop with a working camera, 20x4 LCD display, and LED indicators are interfaced to the PIC16F877A microcontroller. The TB74 bill acceptor accepts peso bills, reads the amount of the bill inserted and communicates the data to the MCU via number of pulses transmitted over a specified period of time. Once a bill is inserted, one transaction is initiated. The TB74 bill acceptor would then not accept bills until the current transaction finishes. The bill

acceptor status is echoed using the 20x4 LCD display and LED indicators. The amount of bill inserted is converted into a number of camera shots based on the number of pulses configured, and is then communicated to the laptop via UART protocol. Using OpenCV Python API, the Camera application will be programmed to automatically capture photos according to the number of camera shots communicated by the MCU, including a 10-second countdown timer interval between shots. The timer is controlled using the timer modules of the PIC16F877A. The camera and countdown timer interfaces will utilize the laptop screen for a simpler user-friendly experience.

System Block Diagram



Hardware Design

The hardware consists of the (input device) TB74 bill acceptor, (output devices) laptop with working camera, 20x4 LCD display, and LEDs. The TB74 bill acceptor accepts Philippines peso bills and communicates the amount of the inserted bill via the number of pulses transmitted over a specified period of time. A 20x4 LCD display and LED indicators will be used to echo the bill acceptor's machine status for enhanced user experience. The laptop with a working camera is interfaced to the PIC16F877A using UART USB to TTL converter module. The laptop will be utilized as: a camera to capture photos, and a display interface for the Camera application and camera timer countdown.

Software Design

This system has six (6) main functions: Read bill amount, Convert bill amount to number of shots, Calculate countdown timer, Control camera capture, Display bill acceptor status, and Display remaining time. The Control camera capture function uses the Windows 10/11 laptop's Camera application to capture photos for the photobooth, controlled by a countdown timer to be displayed on the laptop screen. All these functions are to be implemented using I/O interfacing, interrupt service routine, OpenCV API, and timer functions of the PIC16F877A microcontroller, programmed in C and Python programming language.

Project Management

Team Composition

Danica Marie Dumalagan (Team Leader/System Design Lead/All-around) - is responsible for the management of the project, development of the overall system design. As a team leader, represents the team to the instructor and actively participates in both hardware and software development.

Jhaycee Anthony Acain (Member/OpenCV & UART Lead) - Assists the team leader, is mainly in-charge of the implementation of the desired functionalities via software programming for the OpenCV Python API and UART applications in the project.

Thomas Lee Castro (Member/PIC16 Interfacing Lead/Hardware Lead) - Assists the team leader and is mainly in-charge of the procurement of materials and development of the hardware circuitry and programming necessary for the peripherals to be properly interfaced to the PIC16F877A.

Task Assignment

1. Procuring of necessary hardware materials - Castro
2. Studying of the TB74 datasheet - Castro
3. Initial test interfacing of the TB74 bill acceptor to the PIC16F877A - All members
4. Initial test interfacing of the remaining peripherals to to the PIC16F877A - Castro & Dumalagan
5. Initial breadboarding of circuit components - Castro & Dumalagan
6. Development of the foreground process for the PIC16F877A - Castro & Dumalagan
7. Development of the interrupt service routine for the PIC16F877A - Castro
8. Initial test interfacing of PIC16F877A to laptop using UART and OpenCV - Acain & Dumalagan
9. Development of OpenCV Python API implementation - Acain
10. Finalizing the layout of MCU and peripheral devices - Dumalagan
11. Integration testing and design validation - All members

Development Timeline

Task	April			May				June	
	2nd Week	3rd week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week
Project Proposal Approval									
Submission of Revised Project Proposal									
Procuring of necessary hardware materials									
Studying of the TB74 datasheet									

Initial test interfacing of the TB74 bill acceptor to the PIC16F877A									
Initial test interfacing of the remaining peripherals to to the PIC16F877A									
Initial breadboarding of circuit components									
Development of the foreground process for the PIC16F877A									
Development of the interrupt service routine for the PIC16F877A									
Initial test interfacing of PIC16F877A to laptop using UART and OpenCV									
Development of OpenCV Python API implementation									
Finalizing the layout of MCU and peripheral devices									
Integration testing and design validation									
Submission of Project									

References

[1] Booth Masters. The History Of Photobooths. December 25, 2020. Retrieved April 20, 2023 from https://boothmasters.com/blog/the-history-of-photobooths/.

[2] The next generation of photo booths have their sights set on you. April 11, 2019. Retrieved April 20, 2023 from https://www.theverge.com/2019/4/11/18302414/photobooth-expo-evolution-revival-social-media-online-data-sharing.

[3] OpenCV. Open Source Computer Vision. Introduction to OpenCV-Python Tutorials. Retrieved April 20, 2023 from: https://docs.opencv.org/3.4/d0/de3/tutorial_py_intro.html.