Department of Computer Engineering

IR Proximity Sensor-Based Inventory Stock Tracker Using PIC-Family Microcontroller

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Department of Computer Engineering

Executive Summary

Rationale

The rapid growth of small businesses in the Philippines, especially in retail sectors such as groceries and pharmacies, demands an effective yet simple inventory management system. Traditional methods often involve manual counting and paper-based tracking, which can be time-consuming and prone to errors. To address this challenge, this project aims to develop an IR Proximity Sensor-Based Inventory Stock Tracker using a PIC-Family Microcontroller. This system will enable small business owners to manage their inventory efficiently and accurately without the complexities of a traditional database system.

The solution utilizes infrared (IR) technology to detect items as they move in and out of inventory, recording each transaction through a simple user interface that includes a keypad and LCD display. By implementing this system, business owners can minimize human error, reduce the time spent on physical inventory checks, and maintain up-to-date stock levels. This will not only streamline operations but also enhance the overall productivity of small businesses within our local communities.

Moreover, the project is designed with the specific needs of the community in mind, providing a cost-effective and user-friendly tool that supports the unique challenges faced by local entrepreneurs. By focusing on simplicity and efficiency, this system will contribute to the economic growth of small businesses in Cebu, ultimately fostering greater sustainability and resilience within the community.

Problem

How to keep track of certain items that go in and out of inventory?

Goals and Objectives

The goal of this project is to develop an efficient inventory management system using embedded systems technology to track inventory items efficiently and accurately without using the complexity of a database; instead, the researchers will be using a counter to keep track of the successfully scanned items.

Furthermore, the following objectives are to be met:

- Design and development of the systems for the IR sensors, keypad, and LCD display; and
- Design and development of the software that will handle data coming in from the IR sensors, keeping track of the stock of items inputted into the system, and the menu and display system.

Scope & Limitation

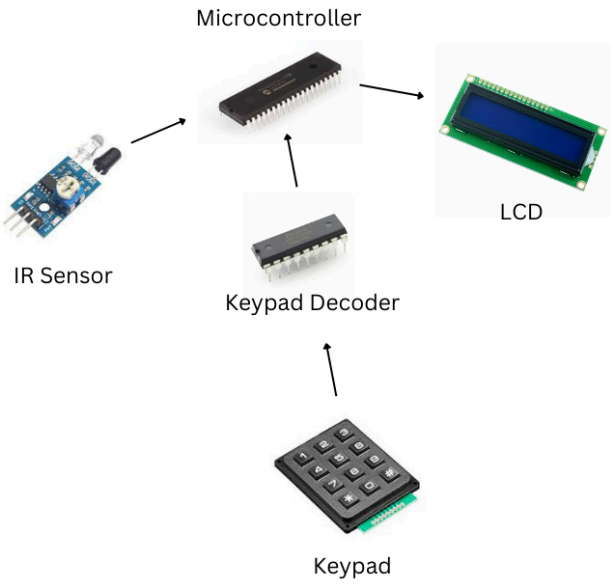
The project's scope involves only the design and implementation of electronic circuitry required for the sensors, the keypad, and the LCD, and the development of the software running on the MCU required for the task to be performed.

The design has the following limitations:

- Data will not be stored into memory and will be wiped after shut down.
- Due to certain limitations with the hardware, different item types in an inventory have to be assigned numerical "item IDs" for stock tracking (e.g. tissues are ID 0001, batteries are ID 0002, etc.).
- The current item type to keep track of has to be selected manually through a menu (i.e. to keep track of the stock of tissues, you have to select its item ID in the menu).
- The amount of item IDs that can be stored during runtime will be limited to only five (5) IDs.
- Item ID range goes from 0000 to 9999.
- The stock of an item will be limited to 100.

Conceptual Framework

The following is the conceptual framework of the proposed project:



The IR sensor and LCD are connected directly to the microcontroller via its data pins. The keypad is interfaced using a keypad encoder, which is then connected to the microcontroller the same way as the IR sensors and LCD.

The IR sensor will be responsible for sensing the presence of an item, the signal of which is then sent to the microcontroller. The microcontroller is responsible for handling the signal sent by the IR sensor, I/O from the keypad and the LCD, and the menu system. The keypad will be used as input from the user for the menu system. Finally, the LCD will display text and data appropriate to the current state of the system.

For a general overview of the system flow, upon startup, the user will be granted with a series of options:

- Stock Tracker Mode
- Browse Item Stocks
- Add Item ID
- Remove Item ID

Stock Tracker Mode is the “main” function of the system. wherein the actual tracking of item stock occurs. The user will be required to input the ID of the item they wish to track the stock of, and whether the count should increment or decrement.

Once a valid ID has been entered, the system will start listening for signals from the sensor. If a LOW signal is detected from the sensor, the system will assume the object that tripped the sensor is the item to be tracked and will automatically increment/decrement the stock of that item.

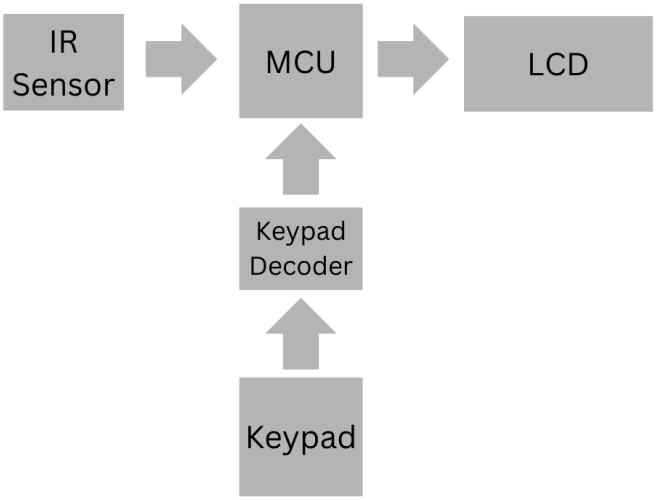
The stock of the item will be displayed on the LCD alongside its ID, and is updated automatically.

Browse Item Stocks allows the user to browse through item IDs and their current stock.

Add Item ID allows the user to input an ID, representing an item, to be stored into the system and allow for stock tracking. What ID represents what item is up to the user’s discretion.

Finally, **Remove Item ID** allows the user to remove an item ID from the system.

System Block Diagram



Hardware Design

The system’s hardware components consists of the following:

- One (1) PIC16F877A microcontroller
- One (1) IR proximity sensor
- One (1) MM74C922 keypad encoder

- One (1) 3x4 matrix keypad
- One (1) 16x2 LCD display

The IR proximity sensor has a customizable distance threshold via a potentiometer. It outputs a LOW signal when an object is detected within the distance threshold, and a HiGH signal when not. The sensor's output signal will be sent to the PIC16F877A via one of its data pins.

The 3x4 keypad with MM74C922 encoder serves as the input device for the system's options menu. Certain buttons on the keypad will be used to navigate through the options. The keypad also serves as numerical input when adding or removing item IDs.

Lastly, the LCD will output the appropriate text on its display, such as the options menu text and its selections. If in "stock tracker mode", the LCD will display an item's ID and the current stock that item has. The current stock amount will be updated on the display for every LOW output of the sensor.

Software Design

The system will adopt an item ID system. Each item type will be given a unique ID at the user's discretion, necessary for proper stock tracking. These IDs will be stored in an array, alongside their current stock amount.

For the menu system, it will have four (4) modes:

- Stock Tracker Mode
    - This mode is where the system will begin tracking the stock for a certain item.
    - The user is required to input the item's ID to track the stock of.
        - If the item ID does not exist, it will throw an error and the user will have to try again.
    - The user is also required to choose whether to increment or decrement amount for every sensor detection.
    - Once an item ID has been inputted and increment/decrement selected, stock tracking will begin.
    - For every LOW input from the IR proximity sensor, the stock amount for the chosen item will be updated, and the LCD will refresh with the new amount.
- Browse Items Stocks
    - In this mode, the stored item IDs and their amounts will be displayed on the LCD
    - These can be browsed through using two buttons on the keypad as "backwards" and "forwards" buttons.
    - If no item IDs are present, the user will be notified of such and be returned to the options menu.
- Add Item ID
    - In this mode, the user will input a four-digit ID (representing a type of item) to add to the system.
        - If the inputted ID is already in the system, the user will be notified and returned to the input screen.
        - If no more item IDs can be stored into the system, an error message will be shown and the user will be returned to the options menu.
    - Newly added item IDs will have their stock amount set to the default zero (0).
- Remove Item ID
    - In this mode, the user will input a four-digit ID to remove from the system.

- If the inputted ID is absent in the system, the user will be notified and returned to the input screen.
- If the item ID list is empty, an error message will be displayed and the user will be returned to the options menu.

- Stock amount will also be removed alongside the item ID.

Project Management

Team Composition

Matthew Caballero (Team Leader/Hardware Lead) - Responsible for the management of the project as well as the construction of the electronic circuitry for the system. Represents the team.

Pedrito Edzel Cesar O. Resano Jr. (Member/Software Lead) - Assists the team leader and is in-charge of coding and developing the logic for the system.

Paul Emmanuel Corsino (Member/Software Co-Lead) - Assists the software lead in coding and development of the system.

Task Assignment

1. Design and development of the circuitry - Caballero
2. Development of system firmware - Resano and Corsino
3. Integration testing and design validation - Caballero, Corsino and Resano

Data Presentation and Analysis

The group conducted testing and validation of the system. The purpose of testing was to make sure that the main function of the system, the “Stock Tracker” mode, operates as it should. During testing, different objects were dropped in front of the sensor. Out of twenty drops, the amount of correct detections were recorded.

The following table contains the data gathered from testing:

	No. of Detections at 9.8m/s^2	
	Lit Room	**Dark Room**
White Object	19 / 20	15 / 20
Black Object (Non-Reflective)	2 / 20	0 / 20
Black Object (Reflective)	18 / 20	16 / 20

Conclusion and Recommendations

Conclusion

An IR Sensor-based inventory stock tracker using a PIC-Family microcontroller was achieved. When in Stock Tracker mode, the sensor was able to detect falling white-colored objects well in both lit and dark environments. Reflective black objects fared similarly to white objects in terms of proper detections. Non-reflective black objects had trouble being detected, often not being picked up by the sensors at all.

Recommendations

Based on the project development and the data presented, recommendations are as follows:

- Due to the limitations of the IR sensor, another type of sensor could be used. An ultrasonic sensor would likely suffice.
- For a better detection rate, the sensor and object to be scanned should be placed in a well lit environment.

Development Timeline

Task	April	May		
	4th Week	1st Week	2nd Week	3rd Week
Project Proposal Approval				
Hardware Setup				
Software Development				
Testing and Debugging				
Submission of Project				

References