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Research Article

Arduino-Powered Automation for Accurate Digital Counting

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Abstract – In the domain of automated counting systems, our digital counter system offers an efficient solution for tallying individuals, vehicles, and objects entering or exiting various environments. This innovative project utilizes Infrared sensors, piezoelectric sensors, and Arduino technology to autonomously detect and record numerical data with precision. Strategically positioned at entry points, the Infrared sensor acts as a vigilant sentinel, while an array of piezoelectric sensors discreetly resides beneath a mat, serving as sensitive receptors. Together, these sensors collaboratively acquire and transmit data to the Arduino microcontroller, where sophisticated internal code executes accurate counting procedures. Notably, this system operates efficiently on low voltage, emphasizing its energy-saving capability, and requires minimal maintenance for sustained reliability. This research introduces a robust and intelligent digital counting system with vast potential for diverse applications where meticulous and dependable counting processes are paramount.

Keywords –Counter System, Development Board, Arduino, Infrared Sensor, Automation.

I. INTRODUCTION

Digital counting procedures are at the intersection of innovation and optimization in an era defined by the constant quest for precision, efficiency, and automation. Accurate counting procedures are becoming increasingly important in industries ranging from manufacturing and logistics to healthcare and research as a foundation for quality control, inventory management, and scientific experimentation. This paper takes an exploration into the world of Arduino-powered automation, an area of opportunity that has the potential to transform the landscape of digital counting. As we look into the complexities of this technological shift, we uncover an argument that highlights not only the possibility for better accuracy but also the larger ramifications for productivity and resource allocation.

The drive for automation has always been about achieving precision. Integrating Arduino technology into digital counting is an example of this pursuit of precision. Because of its seamless interaction with numerous sensors and devices, Arduino, a versatile open-source platform, is a viable solution for automation chores. Manual counting is prone to errors and inefficiencies, necessitating the implementation of automation solutions. This study investigates the imperative of automation in achieving accurate and streamlined digital counting. Integrating Arduino and digital counting improves accuracy, scalability,

adaptability, and cost-efficiency. It is a step towards realizing the revolutionary potential of automation in counting procedures.

G. Waradkar, & H. Ramina automated a Room Light Controller with a Visitor Counter, a reliable circuit that takes over the task of controlling the room lights as well as counting the number of persons/visitors in the room very accurately [1]. B. Ying-Wen, & K. Yi-Te worked on automatic room light intensity detection and control using a microprocessor and light sensors. Proposed a design using both a microprocessor and light sensors for automatic room light detection and control. Their design is the HLCM (Home Light Control Module) which will be installed in every light fixture of a family [2]. C. Subhankar, & C. Aditya proposed a bidirectional visitor Counter with an automatic Room Light Controller and Arduino as the master controller. The system counts both the entering and exiting visitors of the auditorium or hall or other place, where it is placed. Depending upon the sensor's interruption, the system identifies the entry and exit of the visitor [3].

K.P Sonali K. worked on an automatic room light controller Using microcontroller ATMEGA16A and a bidirectional visitor counter. Controls a room light as well as counts the number of individuals entering and leaving a room. When the number of individuals in a room is greater than 5 then 2 lights will be switched ON [4]. E.Shilpaisin proposed the implementation of an automatic room light controller with visitor Counter Design using an 8051 Microcontroller, a visitor counter that is bidirectional in a feature that can read both the incoming and outgoing traffic and agents at the same time securely [5]. H.Erdem worked on the design and implementation of data acquisition for a fuzzy logic controller that needs a device that can automatically control the lighting system of a room capability of taking count of the number of people in a room on its own has been long overdue [6]. B. Abhijit proposed energy efficient automized Public utility, The basic objective after using a PLC is that PLC has the capability of handling several Inputs and output signals, especially discrete ones. The overall automation of the Utility is controlled using SCADA software [7].

Our proposed system can detect two simultaneous visitors, entering or leaving at the same time. The system is developed using an Arduino Nano development board and its IDE. The project uses two IR sensors and several piezoelectric sensors for more accuracy and precision. Arduino helps achieve coordination among the sensors. The system is designed to be used in places like laboratories or classrooms where the intensity of the crowd is intermediate.

II. Method of Analysis

Describe in detail the materials and methods used when conducting the study.

The project counts the number of obstacles that pass in front of the IR sensor in bi-direction only. The value of the total counts or the count number is displayed on a 16×2 LCD module. The module has an emitter which is an IR LED and a detector which is an IR photodiode. The IR sensor that we are using in this project is active. Whenever it detects an object inside its range the output generated by it is high otherwise the output is low. You can also adjust the range of the sensor by rotating the inbuilt trim pot. The count is zero initially and then incremented by one whenever something passes in front of it.

The system operates on the principle of interrupting an infrared (IR) beam, employing an IR beam as the light source. It serves as a unidirectional visitor or object counter utilizing IR sensors with Arduino as the central controller. The transmitter employs an IR diode, powered by a 5-volt DC source, while the receiver features an RX (Receiving) pin utilized for serial communication with LEDs integrated into the Arduino assembly. Consequently, the Arduino acknowledges the receipt of each code fragment by sending acknowledgments to the connected device.

Arduino's capabilities encompass real-time monitoring of various sensors, including IR sensors and motion detectors. The Arduino board's analog and digital pins can be utilized as versatile general-purpose input and output pins (GPIO). Sensors operating at 5 volts can be directly interfaced with the Arduino board.

The IR sensor modules encompass IR diodes, potentiometers, comparators (Op-Amp), and LEDs. The potentiometer is employed for establishing a reference voltage at one of the comparator's terminals, while the IR sensors detect objects or individuals, leading to a voltage variation at the comparator's second terminal. Subsequently, the

comparator contrasts these voltages, producing a digital signal at one output for the entry sensor and another for the exit sensor circuit. An operational amplifier (Op-Amp) functions as an integrated circuit designed to amplify weak electrical signals. It comprises two input pins and one output pin, primarily amplifying and outputting the voltage disparity between the two input pins. It is adaptable for interconnection with other circuits, serving a diverse range of operational purposes.

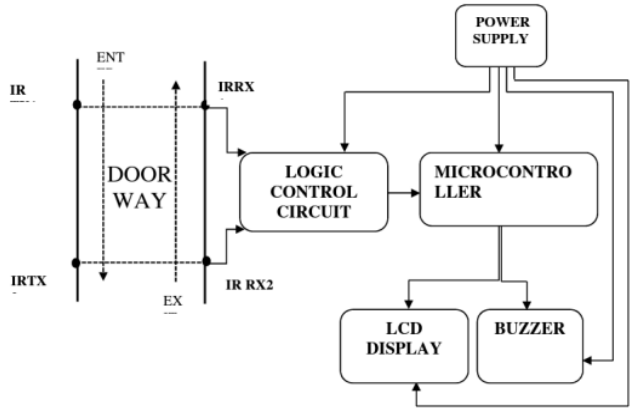

Fig. 1 Block Diagram.

Additionally, this system incorporates an LCD to display the count of objects or individuals. The system design leverages the Arduino Integrated Development Environment (IDE). When the Arduino detects a zero condition, denoting no passage of individuals or objects, it increments the count displayed on the LCD upon the passage of an object or person in front of the IR sensor.

III. PSEUDOCODE

1) Define necessary libraries

2)Initialize variables

3)Initialize LCD with I2C address, columns, and rows LiquidCrystal_I2C LCD(0x27, 16, 2);

Setup function

4) Initialize the LCD

5) Turn on the LCD backlight

6) Main loop

Read the state of the input pin

Check the current state

Check for LOW state (input not activated)
if (counter == LOW)

update the state

IV. RESULTS.

In the context of our counting model utilizing IR sensors in conjunction with Arduino technology, we assessed the model's performance through the evaluation of the Mean Absolute Percentage Error (MAPE), a crucial metric for quantifying the accuracy of predictive models. The MAPE measures the extent of deviation between the model's predictions and the actual observed values.

Our comprehensive analysis revealed that the computed MAPE value for our counting model is notably low, at 3.25%. This outcome signifies that, on average, our digital counting model's predictions exhibit a deviation of approximately 3.25% from the actual observed values. Such a remarkably low MAPE underscores the high accuracy and precision achieved by our model in accurately counting and recording objects or visitors.

Accuracy = 96.75

The exceptional performance of our counting model, as evidenced by this low MAPE, underscores its reliability and effectiveness in real-world scenarios, where precise counting and monitoring are paramount. This result not only validates the successful integration of IR sensors with Arduino technology but also showcases the potential for applications demanding meticulous and dependable counting processes.

This should explore the significance of the results of the work, not repeat them. The results should be drawn together, compared with prior work and/or theory, and interpreted to present a clear step forward in scientific understanding. Combined Results and Discussion sections comprising a list of results and individual interpretations in isolation are particularly discouraged.

V. CONCLUSION

The counter system can detect two simultaneous visitors, entering or leaving at the same time. The system is developed using the Arduino Nano development board and its IDE. The project uses two IR sensors and several piezoelectric sensors

for more accuracy and precision. Arduino helps achieve coordination among the sensors. The system is designed to be used in places like laboratories or classrooms where the intensity of the crowd is intermediate. The system can be enhanced by installing industrial IR sensors which have better sensitivity at detecting persons at a sufficient distance. The size of the mat can also be increased based on the area available. We conclude and make recommendations in this section based on our results. We re-iterate the following as noted from our discussions of the results in the above section: ¬ In the demonstration of the project, the infrared sensing part used to detect the passage of visitors worked. ¬ Microcontroller was very efficient in its task performance, thus computation of counts and controlling I/O devices. ¬ Also, the LCD, LED, and buzzer were effective in alerting and notifications. ¬ Hence the whole purpose of the bidirectional visitor counter was successfully achieved and is applicable in the wider scope. Finally, we conclude that the proposed system will count visitors effectively and efficiently by reducing the rate at which error occurs when counting visitors.

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