Electronics and Embedded Systems Development
ELNC-6008
Practical Project Report

E-Pager

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by

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Executive Summary

The E-Pager project solves the shortcomings of various commercial workplace communication systems including speakerphones walkie-talkies and public announcement systems that are widespread in retail stores and supermarkets. Business solutions at present frequently prove inefficient because of background noise interference and inferior range capabilities and privacy issues.
The system uses PIC18F45K22 microcontroller with ESP8266 Wi-Fi module to deliver a secure efficient real-time communication platform. The system enables secure message transfer between managers and employees over wireless TCP networks using individual or group communication. The user devices have LCD displays and keypads which enable the message exchange function. The Prototype includes MPU6050 sensor-driven step counting and allows future development of heart rate monitoring along with server-based data storage.
The system provided message viewing through its LCD display function while enabling control of device targeting through individual IDs for employees and basic sensor data acquisition. Message acknowledgment and heart rate tracking technology remain part of the proposed future development even though they were omitted from the presentation due to time limits.

The developed system demonstrates how low-cost dynamic networks could enhance workplace communication and monitoring thus boosting operational output and employee supervision.

Acknowledgements

We would like to thank our instructor Xiaoming Guo for the demonstration of the device and Andrew Lambert for the component procurement for the device

1. Introduction

The team researched the current existing systems used in big box stores to communicate amongst the employees are the public announcement systems to relay commands. This is mainly a one-way form of communication and is inefficient when compared to the real time system based on Wi-Fi we are proposing to build.

2. Technical Problem and Solution

2.1 Technical Problem

Speaker phone communication in supermarkets results in ineffective communication. This is mainly due to the noise interference and lack of privacy. Background noise in supermarkets make it difficult to interpret the message and often disturbs the customers. Since the announcements are public, it must be vague so that customers aren't privy to any sensitive information and cannot give accurate commands which leads to confusion and delays. The existing communication system such as walkie talkies or pagers have limited range, potential interference and no connection with the digital system.

2.2 Technical Solution

The proposed system effectively addresses the limitations of the traditional communication system by offering a worn solution enabling secure communication over the Wi-Fi. The employers can send commands to each individual employee with no delays. Connection to the digital space makes it open to new integrations and features. It will also allow to track employee step sensor data, ensuring productivity within employees.

2.3. Overview of the design

The system is implemented using the PIC18F45K22 microcontroller and ESP8266 Wi-Fi module to enable wireless communication for workplace efficiency. The microcontroller manages input operations, message transmissions and sensor interfacing, while the Wi-fi module provides seamless wireless communications and transmissions, allowing messages to be sent remotely. MPU-6050 sensor is used to track the steps which is only kept on the employee device for the prototype.

2.3.1. Sensors utilised

The MPU6050 is an inertial measurement sensor, this variant has a gyroscope and an accelerometer. The gyroscope helps us get the orientation of a person, while the accelerometer helps us determine movement. This system is useful to gather step data of a person in real time.
The ESP can periodically send the sensor information to keep track of the employee on an hourly basis. Even though this functionality of sending the step data through ESP is not implemented in our prototype, this can be implemented with the existing design thus kept for future scope. This technology promises to deliver an improved workplace communication through its lack of complexity, quick and accurate communication, increased workplace safety, overall efficiency.

3. Main Body

3.1. Purpose

Speaker phone communication in supermarkets results in ineffective communication. This is mainly due to the noise interference and lack of privacy. Background noise in supermarkets makes it difficult to interpret the message and often disturbs the customers. Since the announcements are public, it must be vague so that customers aren't privy of any sensitive information and cannot give accurate commands which leads to confusion and delays. The existing communication systems such as walkie talkies or pagers have limited range, potential interference and no connection with the digital system.

3.2. Scope of Deliverables

Wi-Fi Transmission for message sending using TCP and pre-existing Wi-Fi network. The employee and manager device will have keypad and LCD for ease of conversation. We wished to add an acknowledgement from the employee side and it was missed out from our project demonstration for ease of demonstration. A heart rate sensor was also originally proposed which was also missed out for ease of demonstration.

A manager will initiate the conversation by selecting a command to send to a particular person. After checking the command, the manager will send the same command over the TCP protocol, and it will be received by the employee that it was intended for. Since the devices are on the TCP network, we have their link IDs, and they are always communicating bidirectionally. The link IDs for each device are different and unique on the connected network. Using this we are selectively sending data to the devices.

The client devices will be equipped with an LCD and a Keypad for ease of communication. The command will be displayed in the LCD as they are issued by the manager. The command is right now only displayed for a 3 second interval. But in the future, it will be displayed till the message is acknowledged by the employee in question. A step sensor (MPU-6050) is integrated with the client side(employee) which can be read when a button is pressed by the employee.

3.3. Proposed Improvement

The improvement to our system is as follows:

- Waiting for acknowledgment from employees
- Making sure the client (employee) is always connected to the network and is available to send and receive data
- Encrypted data send between devices
- The step data will be sent to a server on average of all employees for the employer to monitor employee performance and activities for better productivity.
- A heart rate sensor can be implemented to increase the productivity of the employee and increase the functionality of the prototype

3.4. Proposed Benefits

The team is proud to inform you that we were able to send and receive data from the client and were able to replicate the same on another device making successful two-way communication. With this we can decrease the latency between sending and receiving data in superstores and other big box stores.
With the noise present in the stores, it is not sure to ascertain if the employee received the data or not. But with the use of our protocol, it is easy to determine whether the client received the data or not. This is the current measure to understand the acknowledgement that needs work.
The latency will be reduced between manager and employee communication, and this will help in the overall efficiency of the workplace.
The keypad, LCD and other devices make it so that the manager can be on the move while commanding his employees.
The employees can keep track of their steps and can achieve a benchmark day by day to increase productivity.

3.5. Preferred Embodiment

The project is housed in a breadboard and it is wirelessly connected to the network of the hospital. Data is transmitted wirelessly between the client and the server. Here the server acts as the manager and the client the employee. Data transferred from the manager when a command is sent and is displayed in the employee device. The LCD is used for displaying the command. We want the employee to be able to send a acknowledgement to the manager but that is not yet integrated into the device.

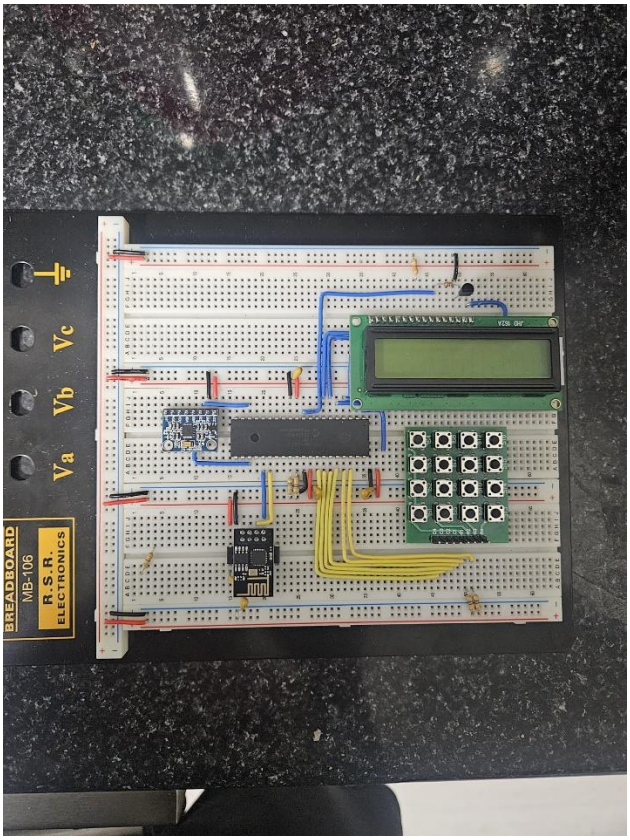

Figure 1 Prototype image

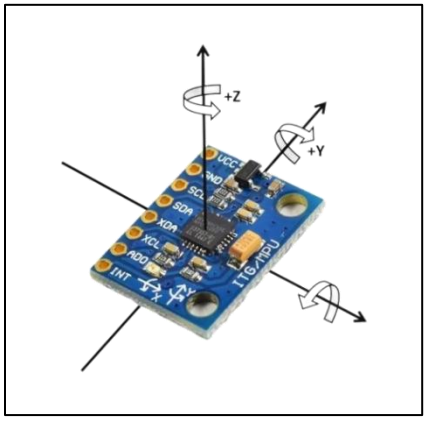

Figure 2 MPU Sensor

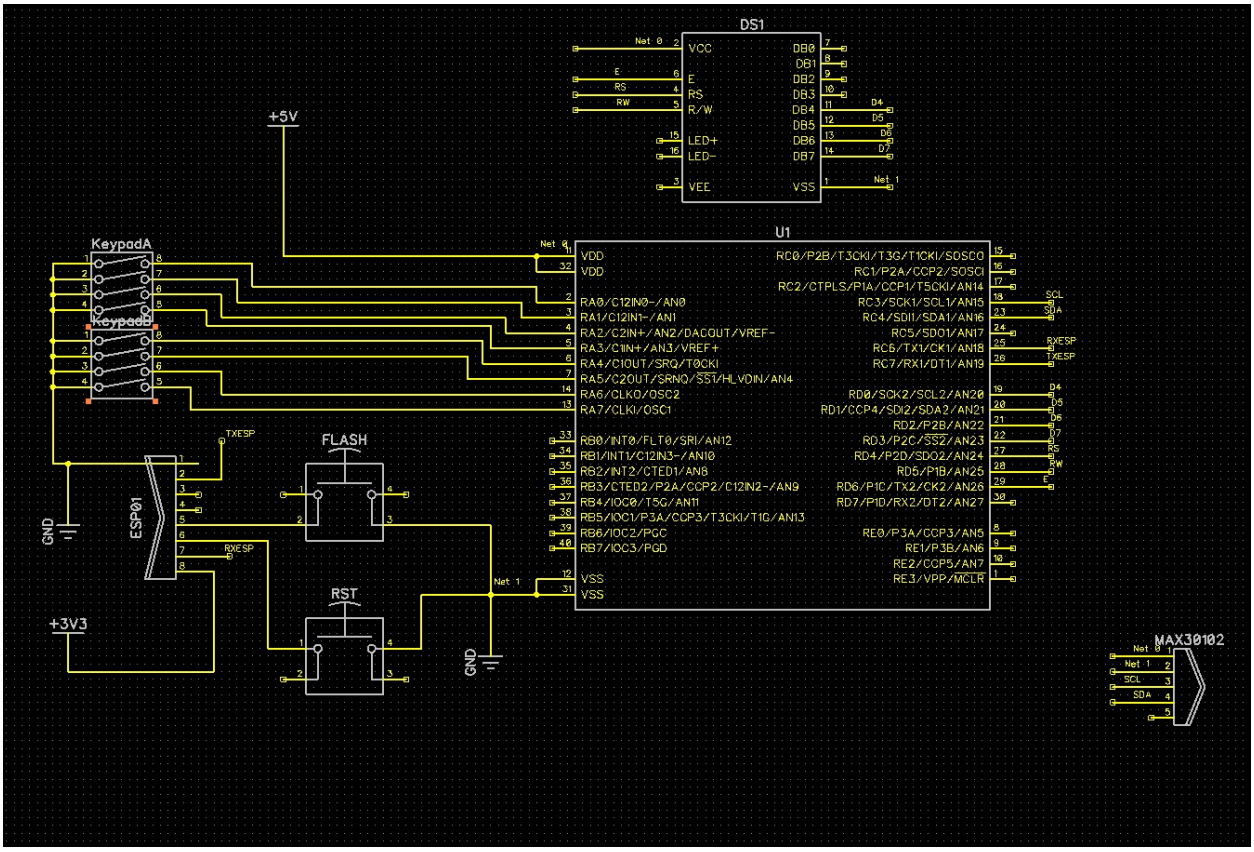

Figure 3 Dip Trace Schematic

3.6. Workflow

Devices connect between each other using Wi-Fi communication. Manager (server) select the name of the employee to be connected and send the message after choosing the instruction. On the other end the employee(client) get a message showing the instruction and sender name. The device is built in a convenient way where multiple switches are used for selecting instructions and a single key for each sending message and choosing recipient name. After sending a message a confirmation message will pop up on the screen for a few seconds thus helping the employee to understand message is sent. Alternatively, when a message is received, it is retained on the screen, ensuring the employee to read the message.

3.7. Block Schematics

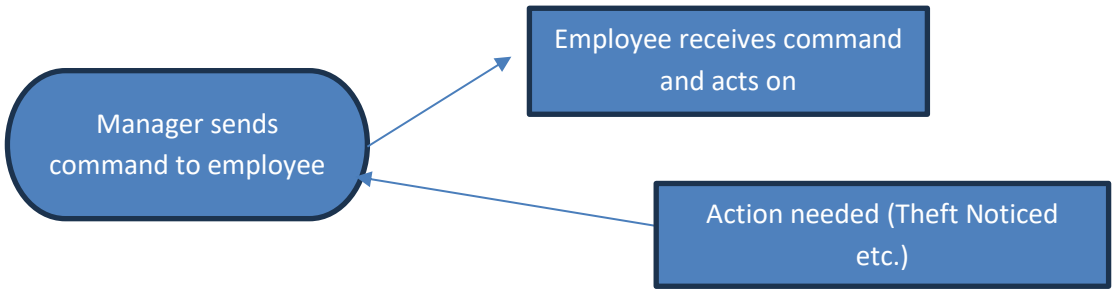

Figure 4 Block Schematic

3.8. Justification of design decisions

The team used the cheapest variant of the ESP8266 available to make the device as affordable as possible. Due to this we needed to use as little GPIO pins as possible for sending data, hence we used the UART protocol. Using only the Tx and RX pins of the ESP we communicated with it using the AT commands.
The team used the PIC18F45K22 as we were most used to the microcontroller and the team was fluent in its libraries.
The team utilized the MPLAB C18 Libraries to use the delay, UART and I2C protocol. The UART was utilized for the communication between PIC18F and ESP01. The I2C protocol is used for the interface between the MPU6050 and the PIC18F for fetching the step count of the employee.
The client and the manager are equipped with a keypad and LCD, this for message receiving and acknowledging.

4. Conclusion

The team successfully communicated amongst the devices using TCP and displaying messages on the LCD screen. The manager can successfully select the commands to send to the employees.
We want to make the employee give an acknowledgement for the message received and integrate a heart rate sensor, so that on average on a work shift bases the step count and heart rate of an employee is sent back to the server and is logged in the database.

5. Recommendations

- The acknowledgement for employees to the manager for received messages
- The introduction of heart sensor for the heart data of the employee
- Integration of the step count and employee data to a database for monitoring.

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