SOCIAL DISTANCING
AND CONTACT TRACING WEARABLE AS WORKPLACE PPE

MICROCONTROLLER SYSTEM DESIGN PROPOSAL

Presented to
the College of Engineering and Architecture of
Malayan Colleges Mindanao, A Mapúa School
Gen. Douglas MacArthur Highway, Davao City

In Partial Fulfillment
of the Requirements for the Course of
CPE103L MICROPROCESSORS Laboratory

JUSTIN ORYAN C. GO

April 2020

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

Background of the Study

With the onset of the global pandemic at 2020, people around the world were at risk of contracting COVID-19. COVID-19 is a highly transmittable disease that is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. The danger of the disease comes from the high transmission rates of the disease. It has also been found by study [2] that the disease is highly transmittable during the incubation period of the disease. As stated by [2] the patient was asymptomatic and considered by people around him to be healthy. The dangers of asymptomatic carriers and the high levels of transmission meant everyone was in possible danger of contracting the disease.

On January 2020, the first suspected cases were found in the Philippines [3]. By the start of March 2020, there has been three confirmed non-local cases of COVID-19 in the Philippines with each patient showing varying levels of severity with the second patient suffering the severest symptoms which ultimately led to death [3]. The coverage of the disease reached multiple regions in the Philippines and by May 2, there were 8772 confirmed cases in the Philippines [4]. The disease was most made worse by the dense population of some places in Manila [3]. Another important factor in the danger of the disease is the lack of vaccine at the time of this study. This meant that there were only non-pharmaceutical methods employed to handle pandemic management.

Statement of the Problem

With the spread of COVID-19 reaching throughout the nation, communities were in constant danger of suffering outbreaks in infection. With evidences that had shown that SARS-CoV-2 can be transmitted in the early stages of infection and transmission can occur even without symptoms, containing the disease would require more than just testing and isolating [2, 5]. It was further stated by [5] that combination of controlling measures is needed to manage the spread of the disease.

Objectives of the Study

The main objective of the study was to produce a wearable that can help maintain social distance in the workplace and provide immediate contact tracing capabilities when needed. The wearable would notify the wearer if anyone is within proximity to maintain proper social distance. Information gathered from the other wearable would be stored in the memory which would provide a list of people to aid in contact tracing instead of recalling the people by memory.

Aside from the main objective, the study also aimed to achieve the following specific objectives. The wearable should be able to detect another similar wearable within one meter from it. The device should also be able to notify the wearer if it detects another wearable that is closer than one meter. Finally, the wearable should store the information of the people that has been in proximity of the wearer.

Significance of the Study

Despite the pandemic, people were still needed to attend work and not all occupations had the capabilities to adapt to the pandemic. Workers were at risk of contracting the disease so additional measures in work would be needed to prevent this. With the proposed wearable in this study, it would be able to assist the wearer in maintaining social distancing as well as provide immediate information for contact tracing. The wearable would be able to provide an additional layer of protection and damage control. Without a vaccine, people were forced to use methods that aimed to reduce the transmission rate to a manageable level.

Scope and Limitations

This study aimed to create a wearable that can assist in maintaining social distance and assist in contact tracing in the workplace. The study would only assess the capabilities of the wearable only in the workplace environment. The study is also limited to only testing the design and functionality of the wearable as the time and resources are limited to implement the wearable in an actual workplace.

Definition of Terms

Contact Tracing – The process of identifying people the infected person has been in recent contact with.

COVID-19 – A disease caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2).

Functional Testing – A process of assessing the system if the functions meet specific requirements.

Rapid Application Development (RAD) – A software development process that prioritized rapid prototyping and iterative development.

Social Distancing – Non-pharmaceutical method of disease prevention where the people maintain a certain physical distance apart.

Wearable – A type of electronic device that the user can wear like an accessory or attached to clothing.

CHAPTER II

REVIEW OF RELATED LITERATURE

Theoretical Background

COVID-19 is a new strain of coronavirus where people infected suffer from mild to moderate respiratory illnesses but those who with underlying problems will more likely develop more serious illnesses [6]. It was then declared as a pandemic by the World Health Organization in March 2020 [7].

As there are no vaccines at the time of the making of this study social distancing has become one of the primary methods to reduce transmission as stated by [8]. Social distancing as defined by [9] is the prohibiting of gathering of large crowds and maintaining 6-foot distance between one another. Social distancing has become one of the primary methods to reduce the risk of transmission that is often paired with other measures such as wearing of masks, washing of hands, and coughing etiquette.

Reducing transmission rates is not the only method to prevent further spread of the disease as actions taken to minimize the spread of the already infected must be prioritized as well. Contact tracing is one the methods to prevent further spread. It was stated by [10] that contact tracing aims to interrupt the chain of transmission by recalling those recent activities and close encounters to find potential people who are potentially infected.

Conceptual Framework

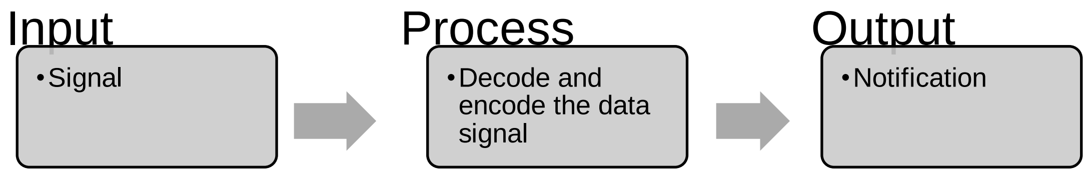

Figure II-1 Conceptual Framework

In this study, the flow of the wearable would be separated into three main divisions: input, process and output. For the input portion of the wearable, it solely consists of one part which is the data signal. This signal is what will be received by other wearables. This signal will carry data needed for the next portion of the wearable, the process. The process portion decodes the data signal to retrieve the needed information to be used for the wearable. The decoded signal would be encoded in the wearable which is responsible for maintaining social distance as well as storing of the needed information for contact tracing. Finally, the output portion of the wearable would happen the conditions were met during the process portion. The wearable would produce an audio and visual feedback to notify the wearers of the proximity of other wearables.

Related Studies

2.1 Importance of social distancing

Social distancing is one of the primary methods to help lower the risk of COVID-19 transmission. A study [11] conducted in Maryland, US has found that a large amount of young people didn't practice social distancing and a month later there was a large amount of new cases which were mostly young people. Social distancing is an effective method to reduce transmission of the disease. The study done by [7] has quantified the short-term effectiveness of social distancing with the model suggesting that social distancing consistently and considerably decreased the number of cases as well as delaying the spread of the disease. This is further supported by the study found at [9] where an increase in social distancing would be associated to a decrease in incidence and mortality rate.

At the time of making this study there are currently no vaccine to help fight against the COVID-19 transmission so non-pharmaceutical methods are currently employed for pandemic management like social distancing. The optimum distance is currently not known but [12] has found that transmission rates were lower for distances greater than 1 meter and the protection against infection increased as the distance increased. It was also report by [11] that people who claim to always practice social distancing outdoors were one tenth as likely to contract COVID-19 than those who never practice it. The goal of social distancing is not to prevent transmission from the disease but slow it down to a maintainable level. So the use of social distancing along with other methods such as wearing of masks to prevent transmission of COVID-19 as stated by [12].

2.2 Importance of Contact Tracing

In the current pandemic, there has been large efforts to stop the spread of the disease but with no current vaccine there has been different non-pharmaceutical methods used to mitigate the spread. Contact tracing is one the alternatives strategies being employed. It is a well-established strategy for disease outbreaks like the current pandemic [10]. A study [13] in Taiwan concluded that the use of comprehensive contact tracing has led to the low number of cases compared to other countries.

Efficient contact tracing is key to minimizing the total amount of potential infected people. The findings of the study [14] has shown that tracing delay or the amount of time it takes to trace the possible infected people is crucial to minimizing transmission. It is important to find an optimum tracing strategy to minimize the delay and provide fast and wide coverage for the best results. The study [15] used contact tracing to find people that the infected has been in close proximity which is within 3 meters and has been in contact for more than 15 minutes. The findings of [15] has shown that, although contact tracing has the potential to stop the spread of further transmissions, it is entirely reliant on the speed and efficacy of the tracing done.

2.3 Workplace challenges during the COVID-19 Pandemic

COVID-19 has created long lasting effects on not just the society but also the economy. The need to socially distance and remain safe from the disease has produced problems for some occupations. The analysis of the study [16] has found that in the US 10% of workers are exposed to the disease at least weekly and 18.4% are exposed at least monthly. The study [17] was able to identify occupations with the highest risk of exposure which are health workers, public transportation drivers, service and sales workers, cleaning and domestic workers, and public safety workers. Work-related transmission should be dealt with as people cannot sustain living without a job. It is further emphasized by [17] that protecting high risk non health care workers as it is harder to trace the source of infection of non-health care workers and not all the jobs are capable of working from home and finally most of the high risk non health care workers are from a relatively lower socioeconomic status.

2.4 Synthesis

COVID-19 has redefined the way society works as the risk of infection has pushed people to change the way they interact. The lack of available vaccine has made non-pharmaceutical methods the only way to prevent the spread of the disease. Social distancing is found to be one of the effective methods for preventing transmission as maintaining distances of more than 1 meter has led to significantly less chance of infection. People who always practiced social distancing has been found to be one tenth likely to transmit the disease than those who does not practice social distancing [11]. Social distancing has been shown to not be enough to stop the spread and is accompanied by other methods to lessen the spread. One of the well-established methods would be contact tracing as this has been performed during other infectious outbreaks. Based on the studies found, time is crucial for effectiveness of contact tracing as being able to stop the spread before more people get infected is not only hard because of the time but also because of the coverage. This study aims to provide a wearable that answers that need as identifying the potential infected in work is important. As mentioned earlier in the study not all workers can cater work from home and high-risk workers needs to additional protection from the disease.

CHAPTER III

METHODOLOGY

Research Design

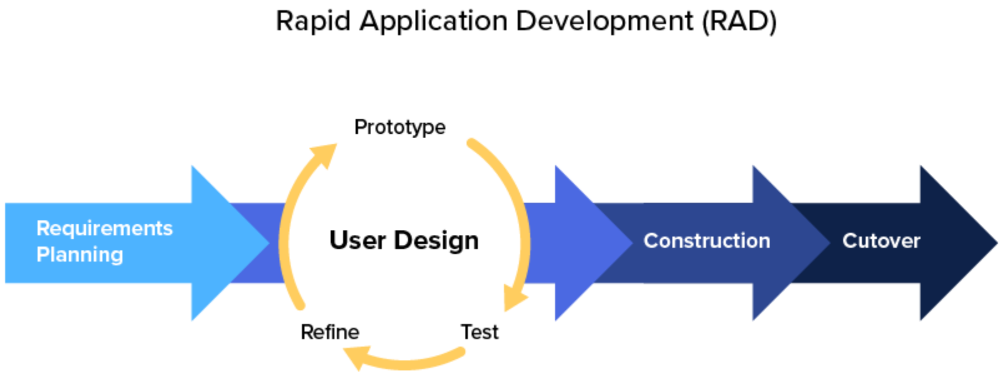

Figure III-1 Rapid Application Development Model

This study would make use of a prototyping method to create and test the desired output of the study. The study would use the rapid application development (RAD) model, a process commonly used for software development, for the design process. The intention behind using this model would be the use of rapid prototyping in the output as the wearable was simple enough to forgo extensive planning and documentation, and it would have the benefit of being able to observe live results and adapt better to any discovered information.

In order to test each iteration of the wearable, the wearable will undergo functional testing. The wearable would have its main functions accessed on whether it meets the specific objectives of the study. It would perform more iterations until it has met all the specific objectives of the study and the wearable no longer needs any further improvements.

Research Procedure

The conceptualization of this study first began with the context of the COVID-19 pandemic which was at the time of the making of this study. Using initial research on the topic and gathering data from different studies the basic idea of the study was formed. Social distancing and contact tracing had been found to be one of the proven methods to reduce transmission rate. Once the idea was formed the study then begun its proper start as the construction of objectives and further research on related literature was conducted to help understand the context of the problem. The formulation of preliminary research plans as well as the material were made in preparation for the actual design implementation. The conceptual framework was then designed to display what the wearable would need and perform. The reading of more studies was made to define the theories behind the problem and as well as establish as review of related literature.

Technical Design Workflow

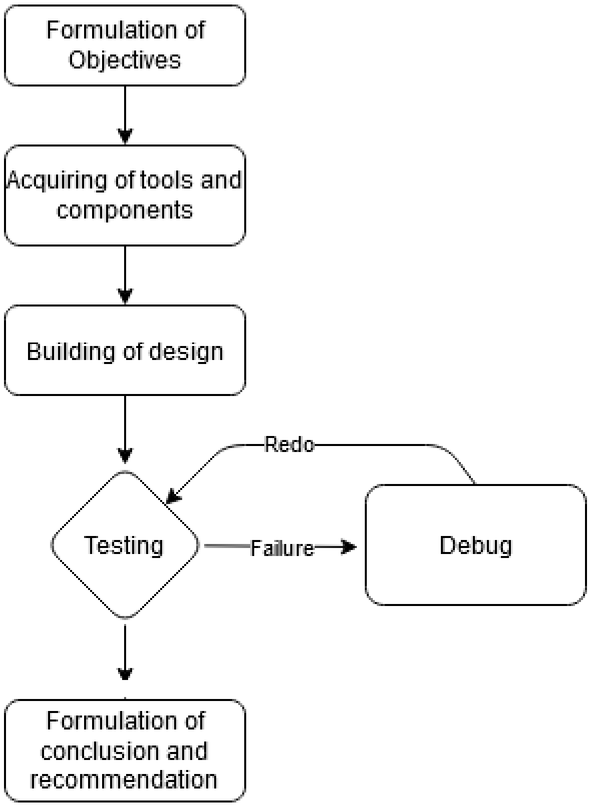

Figure III-2 Technical Design Workflow

3.1 Formulation of objectives

Before starting the production of the wearable, formulation of the objectives was needed to know what the goals for this wearable were. Creation of the main objective as well as additional sub-objectives would help determine the needed actions later as well. For this study, the main objective would be to be able to create a wearable that can assist in maintaining social distance as well as provide contact tracing capabilities as well when needed. Once the objectives have been set, it had to be achievable, measurable, and relevant in the current situation when the study was being conducted.

3.2 Acquiring of tools and components

The second step would be the acquiring of the needed tools and components. Once the objectives have been set, planning, and acquiring the needed tools to achieve the goals were the next priority. With the tools and materials, the wearable would be one step closer to being built as the objective of this step was to be able to get the means needed to execute the intended design.

The decision of choosing what components to use in the wearable would lie in this portion of the study as there would be different factors that will affect what components would be used. The functionality as well as the availability were two of the most important factors in the decision and the price as the wearable must also be economical.

3.3 Building of design

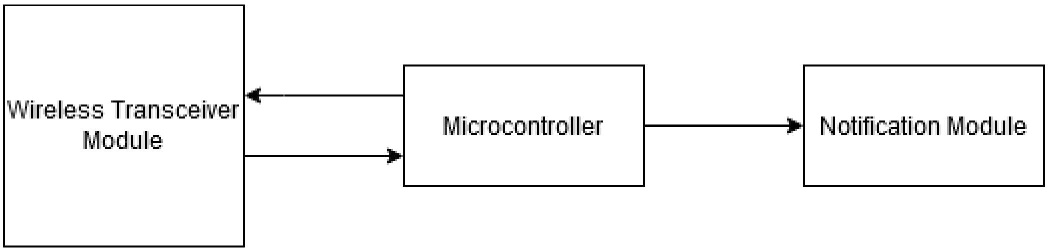

Figure III-3 Block Diagram

After preparations were finished in the previous step, it was time to finally create the wearable. Using the tools and materials acquired in the previous step, the wearable will be made. The wearable would be made with a microcontroller and the wireless transceiver module as its key components.

The use of the microcontroller is that it would perform all the processes as well as control the other modules connected to it. The transceiver module would be the one responsible for receiving the data signal for the microcontroller to analyze. The transceiver module would also transmit its own signal coming from the microcontroller. The use of the notification module was for the event that there would be a signal then the microcontroller would access that the notification module to let the wearer know of another wearable in vicinity.

3.4 Testing and debugging

Once the wearable was past the development stage, the next step was to test if there were any mistakes in production as well as any lacking functionality in the wearable. For this stage the wearable would undergo functionality testing in order to meet the set requirements for it. Tests such as the reliability of data signal recognition were repeated for each iteration of the refinement. This was to not only test the functionality but also to learn if there were more room for improvement in the wearable.

In this stage, the wearable would not proceed until it meets the needed functionality of the wearable. If it does not meet the needed requirements, then the wearable would go into the debugging phase as analysis on what went wrong, and actions made to correct the mistakes were done. After debugging, the wearable would then be tested again, and the cycle would repeat until it meets the requirements. It would then proceed to the next step the objective achievement analysis stage.

3.5 Formulation of conclusion and recommendation

The final stage of the study was to form conclusions as well as recommendations for further studies related to this. Using the information learned from the previous stages the researcher would form a conclusion and use the knowledge learned to help future researchers by suggesting further actions to be done.

CHAPTER IV

RESULTS AND DISCUSSION

Results

The process of producing a working prototype took a longer amount of time than initially planned. This led to fewer amounts of iterations but in the end the wearable was still able to meet the required capabilities. The creation of the wearable can be separated into two sections the hardware and the software.

4.1 Hardware

Figure IV-1 Wearable Prototype

The initial plan for the hardware of the wearable was to utilize a radio wave transceiver to handle the transfer of data between wearables but due to unforeseen circumstances and the limited time frame the design of the wearable shifted to ultrasonic communication. The component used for this design was the HC-SR04 which is an ultrasonic sensor used to determine the distance of an object. As the component doesn't inherently transmit or receive data, the component was repurposed as the transducers were the only component needed in the HC-SR04. The benefit given by the HC-SR04 was the cost effectiveness of the component as it was affordable and was a common electronic component.

Figure IV-2 HC-SR04

The wearable communicates at 40 kHz frequency as this was operable frequency of the HC-SR04. Due to the raw nature of ultrasonic waves, the transducers do not contain data, so part of the design was to be able to transmit data using the component. The details of the data transmission will be explained in the software section, but the basics of the design would be that it transmits a bit by turning on and off. So, a high bit is when there is a signal and low if there is no signal. This communication would be done in half duplex which means the wearables would take turns in transmitting and receiving. This was done as the wearables will run the risk of crosstalk when not in half duplex which leads to a distorted signal.

Aside from the data transmission, the wearable also needs a feedback system to let the wearer know if they are other wearables nearby. The design makes use of a piezo buzzer and a simple led to let the wearer know when the wearable receives a signal.

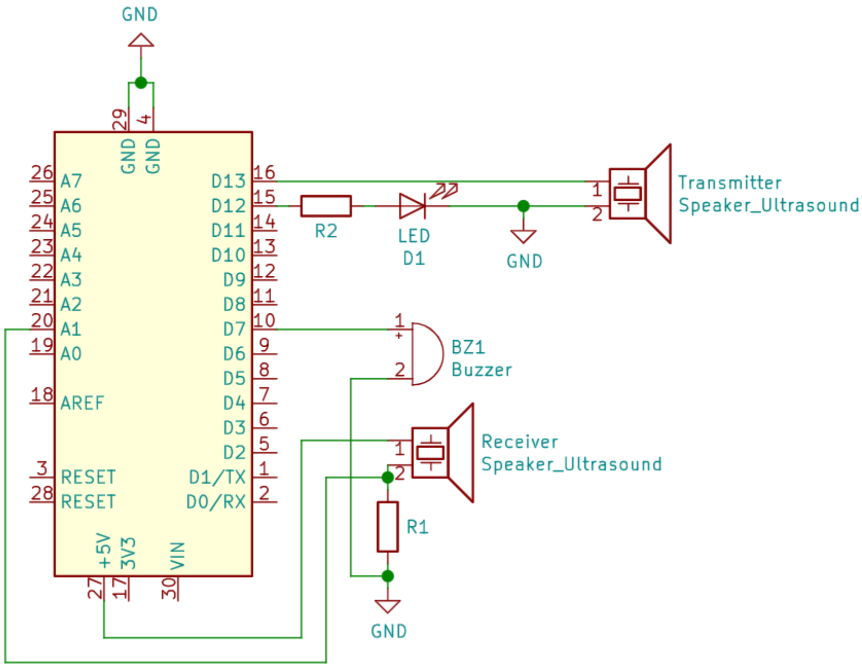

Figure IV-3 Wearable Schematic

As seen from the figure above, the design of the wearable is relatively simple to build which makes it easy to replicate and produce. The software performs most of the work which makes the circuit simple to build. Limitation found in the design would be the narrow signal range as angling the transmitter would make it impossible for the receiver to intercept the signal. This can be attributed to the size of the transducers as it they are narrow and that leads to the signal to be narrow as well.

4.2 Software

As mentioned in the previous section, most of the work is done by the software as the design of the hardware is just sensors and actuators. The software of the wearable was coded in Arduino IDE. Most of the codes found in the software was made for this wearable. Aside from importing the functions for the EEPROM, everything else is part of the basic Arduino functions or made from scratch.

Each wearable will be assigned with a unique 8-bit sequence which will serve as their identification number when contact tracing is needed. This 8-bit sequence will also be the signal to be transmitted by the wearable. The 8-bit sequence will be enclosed with leading bits and trialing bits.

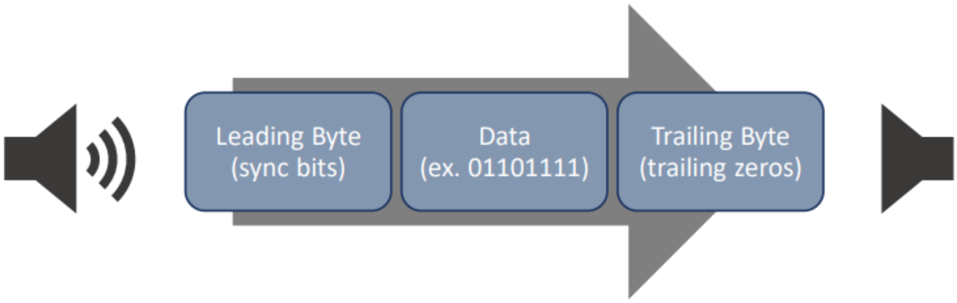

Figure IV-4 Data Transmission

The purpose of enclosing the 8-bit sequence with leading bits are to enable the receiver to read the sequence at the correct timing. The design borrows ideas from synchronous communication where the signal has regularly spaced bits which is the 8-bit and it has a synchronous portion to enable the receiver to read the following bits at the correct timing. This leading bit will be responsible for syncing and rejecting signals. The sequence also contains a trailing bit to give the receiver time to ready for the next sequence.

The process of communicating will be separated by two main functions which is the read and write function. The write function sends a tone at 40 kHz through the ultrasonic transducer at a given interval. This will be the 8-bit sequence with the leading and trailing bits. The wearable would continually output a write if there is no received signal. Once a signal is received then the wearable would go into the read function. The read function would be separated into two smaller functions which is the calculate the syncing interval and the reading of the 8-bit sequence. The syncing interval is calculated by the duration of the first half of the leading bit and then the second half is responsible for the rejection or acceptance of the sync value. It would then use the sync value to decode the 8-bit sequence. Once decoded it would then save the sequence in the EEPROM.

Discussion

For testing the objectives of the wearable, a receiver node was designed aside from the wearable prototype. The wearable was designed to not only fulfill the objectives and specific objectives but also additional features which were decided upon during the creation of the paper. The additional features are as follow:

- Design a wearable and a signal receptor/receiver node.
- The device must be ergonomically designed.
- The identification of the closed contact is stored in the memory of the wearable
- The user is alerted through an audio-visual notification.
- The device must be able to transmit and receive signals to and from other wearables.

Specific objectives completion

The wearable was able to achieve the objective to make a wearable that can aid in social distancing and contact tracing. The device can notify the wearer if another wearable is nearby up to 0.5 meters from the wearable. It can as well save the unique 8-bit sequence to its EEPROM which will be used for contact tracing within the workplace. This also fulfills the specific objective to detect another similar wearable to within a meter. The wearable would then notify the user using a buzzer and led flashing which is another of the specific objective. The final specific objective is also fulfilled when the EEPROM stores the 8-bit sequence.

Features accomplishment

For the features, the first was to create a wearable and receiver node. The presence of the wearable already accomplishes this feature. For the receiver node, it was implemented on breadboard and has the same configuration as the wearable but without an enclosure and external power source.

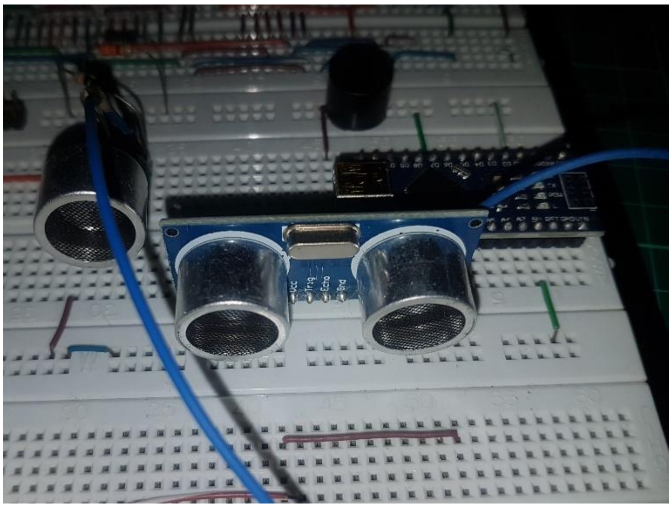

Figure IV-5 Node/Receiver

For the ergonomics of the design, its form factor is small enough to be carried around. It is also light enough to be carried without being cumbersome. The measurements of the wearable are 11 cm by 8 cm by 4 cm. This is small enough to be carried around and thus fulfills the feature.

Figure IV-6 Height of Wearable

Figure IV-7 Width of Wearable

Figure IV-8 Length of Wearable

The identification of the close contact as well as the audio-visual notification is fulfilled and are like the specific objectives which were already explained. For the final feature which is the wearable must be able to transmit and receive signals to and from other wearables, data communication is established between devices and the details on how it is implemented are seen in the results section above. The wearable is capable of serial half duplex communication to transmit and receive signals from similar wearables.

CHAPTER V

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

For this study, the goal was to make a wearable to help in social distancing and contact tracing. This was chosen as a way to help in the COVID-19 pandemic because during the time of conducting there were no vaccines yet and the only way to control the spread of the disease is through non-pharmaceutical methods like social distancing and contact tracing.

The study made use of RAD (rapid application development) inspired model to help in creating a working prototype as soon as possible. The wearable would transmit a signal containing its unique 8-bit identification sequence. It would also listen for any incoming signals and when detected it would decode the signal and store the decoded 8-bit sequence in its memory.

The wearable was able to transmit the signal using ultrasonic transducers repurposed from an HC-SR04 module. The signal was encoded by the transmitter and then decoded by the receiver which will be then saved to the memory as well as provide an audio-visual notification based on the specific objectives and features.

Conclusion

From the summary, the researcher can conclude that the wearable was able to achieve the objective as well the five features given. The wearable was able to transmit and receive data to and from other wearables but at certain limitations. The limitations discovered was due to the nature of ultrasonic waves the signal can only be transmitted Infront of the wearable limiting the sensing capabilities when the signal comes from other directions.

Recommendations

With the limitations in mind, the researcher recommends further experimentation with other data transmission mediums as the ultrasonic data was limited as seen from the results section. Another recommendation on data transmission is to find an omnidirectional transmitter and receiver to be able to detect wearables at any direction. One last recommendation is to further develop the design by reducing the form factor and finding a smaller enclosure.

Cost of Wearable

Item	**Cost (Php)**
Arduino Nano V3.0	200.00
HC SR04	60.00
Enclosure	180.00
Lithium Ion Battery	55.00
DC Step Up Converter	45.00
18650 Battery Holder	60.00
Miscellaneous	150.00
Total Amount	**750.00**

Table 1 Cost of Wearable

The total cost of the wearable is displayed in the table 1. The individual costs of the components are also displayed in the table. The miscellaneous cost would consist of the smaller components that are not listed in the table which have negligible costs individually such as the LED and speaker as well as other extra expenses.

References

[1] M. A. Shereen, S. Khan, A. Kazmi, N. Bashir and R. Siddique, "COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses," *Science Direct,* vol. 24, pp. 91-98, 2020.

[2] L. Huang, X. Zhang, X. Zhang, Z. Wei, L. Zhang, J. Xu, P. Liang, Y. Xu, C. Zhang and A. Xu, "Rapid asymptomatic transmission of COVID-19 during the incubation period demonstrating strong infectivity in a cluster of youngsters aged 16-23 years outside Wuhan and characteristics of young patients with COVID-19: A prospective contact-tracing study," *The Journal of Infection,* vol. 80, no. 6, 2020.

[3] E. M. Edrada, E. B. Lopez, V. J. B, E. P. S. Villarama, B. F. Dagoc, C. Smith, A. R. Sayo, J. A. Verona, J. Trifalgar-Arches, J. Lazaro, E. G. M. Balinas, E. F. O. Telan, L. Roy and M. Galon, "First COVID-19 infections in the Philippines: a case report," *Tropical Medicine and Health,* vol. 48, no. 1, 2020.

[4] E. P. Salva, J. B. Villaram, E. B. Lopez, A. R. Sayo, A. M. G. Villanueva, T. Edwards, S. M. Han, S. Suzuki, X. Seposo, K. Ariyoshi and C. Smith, "Epidemiological and clinical characteristics of patients with suspected COVID-19 admitted in Metro Manila, Philippines," *Tropical Medicine and Health,* vol. 48, no. 51, 2020.

[5] A. J. Kucharski, P. Klepac, A. J. K. Conlan, S. M. Kissler, M. L. Tang, H. Fry, J. R. Gog and W. J. Edmunds, "Effectiveness of isolation, testing, contact tracing, and physical distancing on reducing transmission of SARS-CoV-2 in different settings: a mathematical modelling study," *The Lancet,* vol. 20, no. 10, pp. 1151-1160, 2020.

[6] "World Health Organization," World Health Organization, [Online]. Available: https://www.who.int/health-topics/coronavirus. [Accessed 17 October 2020].

[7] L. Matrajt and T. Leung, "Evaluating the Effectiveness of Social Distancing Interventions to Delay or Flatten the Epidemic Curve of Coronavirus Disease," *Emerging Infectious Diseases,* vol. 26, no. 8, pp. 1740 - 1748, 2020.

[8] J. A. Weill, M. Stigler, O. Deschenes and M. R. Springborn, "Social distancing responses to COVID-19 emergency declarations strongly differentiated by income," *Proceedings of the National Academy of Sciences,* vol. 117, no. 33, pp. 19658 - 19660, 2020.

[9] C. Davis, "Effects of social distancing on COVID-19 incidence and mortality rates," Fred Hutch, 17 August 2020. [Online]. Available: https://www.fredhutch.org/en/news/spotlight/2020/08/phs_vopham_med.html. [Accessed 18 October 2020].

[10] I. Braithwaite, T. Callender, M. Bullock and R. W. Aldridge, "Automated and partly automated contact tracing: a systematic review to inform the control of COVID-19," *The Lancet Digital Health,* 2020.

[11] Johns Hopkins University Bloomberg School of Public Health, "COVID-19 study links strict social distancing to much lower chance of infection," ScienceDaily, 10 September 2020. [Online]. Available: https://www.sciencedaily.com/releases/2020/09/200910110824.htm. [Accessed 17 October 2020].

[12] D. K. Chu, E. A. Akl, S. Duda, K. Solo, S. Yaacoub and H. J. Schünemann, "Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis," *The Lancet,* vol. 395, no. 10242, pp. 1973 - 1987, 2020.

[13] H.-Y. Cheng, S.-W. Jian, D.-P. Liu, T.-C. Ng, W.-T. Huang and H.-H. Lin, "Contact Tracing Assessment of COVID-19 Transmission Dynamics in Taiwan and Risk at Different Exposure Periods Before and After Symptom Onset," *JAMA Internal Medicine,* vol. 180, no. 9, p. 1156, 2020.

[14] M. E. Kretzschmar, G. Rozhnova, M. C. J. Bootsma, M. V. Boven, W. J. H. H. M. V. De and M. J. M. Bonten, "Impact of delays on effectiveness of contact tracing strategies for COVID-19: a modelling study," *The Lancet Public Health,* vol. 5, no. 8, 2020.

[15] M. J. Keeling, T. D. Hollingsworth and J. M. Read, "Efficacy of contact tracing for the containment of the 2019 novel coronavirus (COVID-19)," *Journal of Epidemiology and Community Health,* 2020.

[16] University of Washington, "COVID-19 crisis: Millions of US workers at risk of infections on the job," ScienceDaily, 29 April 2020. [Online]. Available: https://www.sciencedaily.com/releases/2020/04/200429105834.htm. [Accessed 18 October 2020].

[17] F.-Y. Lan, C.-F. Wei, Y.-T. Hsu, D. C. Christiani and S. N. Kales, "Work-related COVID-19 transmission in six Asian countries/areas: A follow-up study," *Plos One,* vol. 15, no. 5, 2020.

SOURCE CODE

```
#include <EEPROM.h>

String id="11001100";
int eepromLen;
unsigned long periods=0;
unsigned long sendPeriods=300;

void setup()
{
  Serial.begin(9600);
  pinMode(A1,INPUT);//receiver

  pinMode(7,OUTPUT);//buzzer
  pinMode(13,OUTPUT);//transmitter
  pinMode(12,OUTPUT);//led
  eepromLen = EEPROM.read(0);
  Serial.println(eepromLen);
  digitalWrite(12,HIGH);
}

void loop()
{

  while(!(decodeBit(sendPeriods)))
  {
    Serial.println("waiting");
    dataStream(id);
  }

  readBit();

  //save to eeprom
}
//Half Duplex
void readBit() //reads the byte of information and transmit its own byte
{
  bool sync = false;
  int count =0;
  while(!sync && count <=5)
  {
```

```
  sync = syncBit();
}
if(count >=5)
{
  for(int x = 0; x<2;x++)
  {
    Serial.println("writing");
    dataStream(id);
  }
  return;
}

int arr[] = {0,0,0,0,0,0,0,0};
Serial.println("reading");
for(int x = 0; x < 8; x++)
{
  arr[x] = decodeBit(periods);
}

digitalWrite(12,LOW);
tone(7,600);
delay(50);
noTone(7);
digitalWrite(12,HIGH);
delay(50);
tone(7,1000);
digitalWrite(12,LOW);
delay(100);
noTone(7);
digitalWrite(12,HIGH);

for(int x  = 0; x < 8;x++)
{
  EEPROM.write(eepromLen, arr[x]);
  Serial.print(arr[x]);
  eepromLen+=1;
}
EEPROM.write(0,eepromLen);
Serial.println("");

for(int x = 0; x<2;x++)
```

```
    {
      Serial.println("writing");
      dataStream(id);
    }
}
//READ
bool decodeBit(unsigned long period) //function to get a bit with sample time of period
{
  unsigned long now = millis();
  int count = 0;

  while(millis()<now+period)
  {
    int val = analogRead(A1);
    //Serial.println(val);
    if (val > 0)
    {
      count = 0;
    }
    else
    {
      count++;
    }
  }

  if (count >= 40)
  {
    return false;
  }
  return true;
}

bool syncBit() //syncs the transmitter and reciever
{
  int count = 0;

  unsigned long now = millis();
  while(count < 40)
  {
    int val = analogRead(A1);
    //Serial.println(val);
```

```
    if (val > 0)
    {
      count = 0;
    }
    else
    {
      count++;
    }
  }

  periods = (millis() - now)/3.1;
  if(periods <= 200)
  {
    return false;
  }
  now = millis();
  Serial.println(periods);

  if (decodeBit(periods))
  {
    return false;
  }
  if (!(decodeBit(periods*2)))
  {
    return false;
  }
  if (decodeBit(periods))
  {
    return false;
  }
  if (!(decodeBit(periods)))
  {
    return false;
  }
  return true;
}

//WRITE
void startBit()
{
  highBit(sendPeriods);
```

```
  highBit(sendPeriods);
  highBit(sendPeriods);
  lowBit(sendPeriods);
  highBit(sendPeriods);
  highBit(sendPeriods);
  lowBit(sendPeriods);
  highBit(sendPeriods);
}

void endBit()
{
  lowBit(sendPeriods);
  lowBit(sendPeriods);
  lowBit(sendPeriods);
  lowBit(sendPeriods);
}


void dataStream(String id)
{
  startBit();
  int len = id.length();

  for(int x = 0; x < len; x++)
  {
    if(id.charAt(x) == '0')
    {
      lowBit(sendPeriods);
    }
    else
    {
      highBit(sendPeriods);
    }
  }
  endBit();
}

void highBit(unsigned long period)
{
  unsigned long now = millis();
  while(millis() < now + period)
```

```
  {
    tone(13,40000);
  }
  noTone(13);
}

void lowBit(unsigned long period)
{
  unsigned long now = millis();
  while(millis() < now + period)
  {
  }
}
```

Justin Oryan C. Go

104 Francisco st., Juna Subdivision, Matina, Davao City

0922-887-5087

jogo@mcm.edu.ph

BS Computer Engineering Student

Globally competitive computer engineering student. Proficient in different programming languages such as Java and C#.

Skills and Competencies

- Programming (Java, Python, PHP)
- Troubleshooting
- Basic Photo and Video Editing Skills
- Proficient Oral and Written Communication Skills
- People Skills
- In-depth Microsoft 360 skills

Educational Background

Tertiary Education

Malayan Colleges Mindanao
(2018-Present)
McArthur Highway, Matina, Davao City PH

Secondary Education

General Santos Hope Christian School
(2012-2018)
Block 8 Salvani St, General Santos City, 9500 South Cotabato

Awards and Certifications

- Intel-FPGA Seminar and Workshop
- Mindanao Summer Programming
- Auditor for the ICPEP (Institute for Computer Engineers in the Philippines) Student Edition (2019-2020)
- Secretary for the ICPEP Student Edition (2018-2019)