Augmented Reality Head Mounted Display For Infantry Soldiers

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In the name of ALLAH, the Most benevolent, the Most Courteous

CERTIFICATE OF CORRECTNESS AND APPROVAL

This is to officially state that the thesis work contained in this report

"Augmented Reality Head Mounted Display For Infantry Soldiers"

is carried out by

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under my supervision and that in my judgement, it is fully ample, in scope and excellence, for the degree of Bachelor of Electrical (Telecom.) Engineering in Military College of Signals, National University of Sciences and Technology (NUST), Islamabad.

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Date: ___________

DECLARATION OF ORIGINALITY

We hereby declare that no portion of work presented in this thesis has been submitted in support of another award or qualification in either this institute or anywhere else.

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Allah Subhan'Wa'Tala is the sole guidance in all domains.

Our parents, colleagues and most of all supervisor, **Brig Dr Fahim Arif** without your guidance.

The group members, who through all adversities worked steadfastly.

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ABSTRACT

This project aims to create a head-mounted display (HMD) using see-through augmented reality technology for infantry soldiers. The HMD helmet will resemble the HMDs used by pilots and will provide real-time information to the soldier while allowing them to maintain awareness of their surroundings. The information displayed will include time, location coordinates, maps, and heading direction, as well as external accessories such as night vision cameras, RGB sensors, and thermal cameras, which can be seamlessly integrated into the HMD brain to provide real-time data visualization. The chassis of the HMD is built using 3D printing technology and the main project includes a display board connected to two high-resolution LCD panels. The HMD helmet aims to address the challenges of accessibility to primary information, enhance situational awareness, and provide real-time data visualization. The integration of hardware components such as a 3D printed chassis, optics, electronic components, and a Raspberry Pi 3B as a computational machine enables the HMD helmet to deliver vital information to soldiers in the battlefield. The literature discusses the hardware specifications, working mechanisms, software integration, and features of the HMD helmet, highlighting its potential to enhance the effectiveness and survivability of infantry soldiers.

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Chapter 1: Introduction

In modern warfare, infantry soldiers play a crucial role in combat operations and tactical missions. However, they often face challenges in accessing primary information necessary for effective decision-making and task execution. This includes real-time updates on mission objectives, enemy locations, friendly forces' positions, and situational reports. Timely access to such information is vital for situational awareness and can significantly impact the outcome of operations. To overcome these challenges, the development of an AR Head Mounted Display (HMD) helmet specifically designed for infantry soldiers is proposed.

1.1 Overview

Mixed reality (MR) is an emerging technology that blends the real and virtual worlds, creating immersive and interactive experiences. The demand for MR in the military and aviation industries is growing due to the need for enhanced situational awareness and decision-making capabilities. MR head-mounted displays (HMDs) are a critical component of these systems, providing pilots and military personnel with a more comprehensive and immersive view of their environment. In the military, MR is being used to provide soldiers with real-time tactical information, helping them make better decisions on the battlefield. In aviation, MR is being used to enhance pilot training and to provide pilots with more accurate and detailed information about their aircraft and surroundings. With the increasing demand for improved situational awareness and decision-making capabilities, the use of MR in these fields is expected to become more widespread. As a result, the development and deployment of MR systems, including HMDs, will play a crucial role in the future of the military and aviation industries.

1.2 VR, AR & MR:

- Virtual reality (VR), a fully immersive digital environment.
- Augmented reality (AR), an overlay of digital objects on physical environments (e.g., Instagram filters)
- Mixed reality (MR), a hybrid of physical and digital environments in which physical and digital objects can interact.

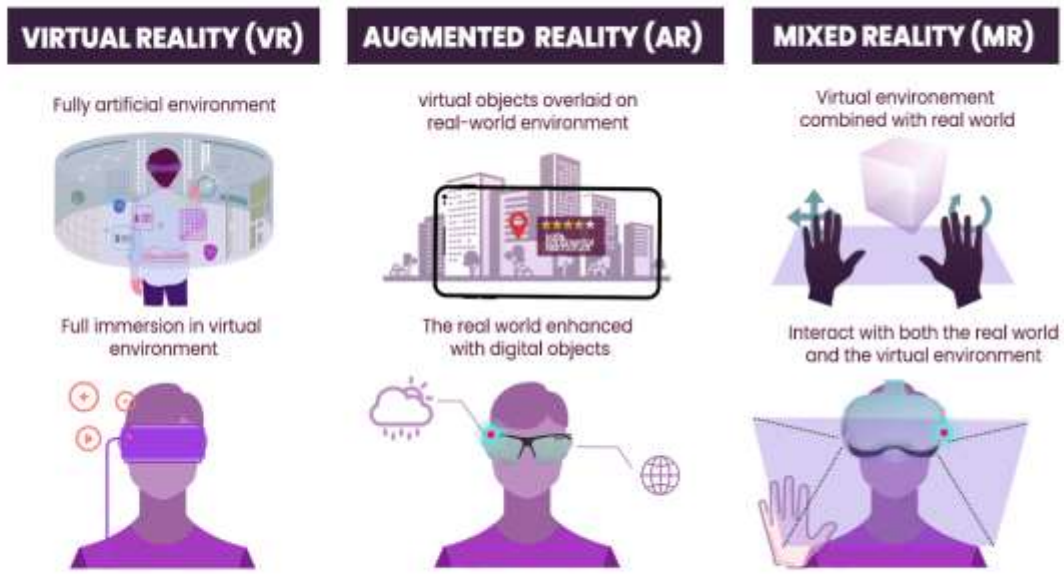

Figure 1 VR, AR, & MR

1.3 Problem Statement

Infantry soldiers face a significant problem in accessing primary information during battlefield and tactical operations. The following specific areas present challenges:

a) Limited Data Availability: In dynamic and rapidly changing situations, soldiers may struggle to obtain up-to-date and accurate information due to communication constraints, technical limitations, or inadequate infrastructure. This can lead to a lack of situational awareness, hindering decision-making.

b) Communication Bottlenecks: Traditional communication channels may experience congestion or disruption, causing delays or loss of critical information. This can impede the timely dissemination of orders, updates, and requests for support, adversely affecting operational effectiveness.

c) Data Overload: On the other hand, soldiers may also face challenges in filtering and processing a vast amount of information from multiple sources. This can result in cognitive overload, making it difficult to identify relevant and actionable intelligence amidst the overwhelming data.

1.4 Proposed Solution

To address the challenges of accessibility to primary information and achieve the defined objectives, the proposed solution is an AR Head Mounted Display (HMD) helmet specifically designed for infantry soldiers. The HMD helmet will leverage advanced technologies, including augmented reality (AR), to provide soldiers with real-time information and enhanced situational awareness.

The HMD helmet consists of a 3D printed chassis, optics such as reflectors and optical combiners, and electronic components, including TFT LCD panels. The 3D printed chassis offers a lightweight and customizable solution, ensuring comfort and durability for soldiers in the field. Reflectors, also known as combiners or lenses, will be used to project digital content onto the soldier's eyes. Transparent acrylic panels with semi-reflective properties will serve as optical combiners, enabling optimal projection angles and delivering the desired visual effects.

The HMD helmet features two TFT LCD panels, each measuring 3.5 inches, with a resolution of 480 x 320 pixels and 18-bit color depth. These panels provide high-quality visual representation, allowing soldiers to view augmented reality overlays seamlessly and clearly.

By combining advanced hardware components and software functionalities, the AR HMD helmet will provide infantry soldiers with a comprehensive solution to overcome the challenges of accessing primary information in the battlefield, enhancing their operational effectiveness and survivability.

Figure 2 Proposed Solution

1.5 Working Principle

The AR-HMD works by using see-through augmented reality technology to display information on the soldier's field of view. The technology uses two high-resolution LCD panels that are mounted in front of the soldier's eyes to display the information. The input for the display board is fed by a working computer running on either Windows or Linux operating systems. An RGB sensor, such as the Intel Realsense, is used to create virtual augmentation.

The AR-HMD also includes external accessories such as night vision cameras, RGB sensors, and thermal cameras that can be seamlessly integrated into the AR-HMD brain to provide real-time data visualization. The information displayed on the AR-HMD is designed to enhance situational awareness and combat effectiveness for soldiers on the battlefield.

1.6 Objectives

The primary objective of the proposed AR HMD helmet for infantry soldiers is to address the before mentioned challenges and enhance their access to primary information. The key objectives include:

a) Visual Augmentation: The AR HMD helmet will provide soldiers with the capability to overlay digital information directly onto their field of view. This will enable them to visualize critical data, such as real-time maps, mission objectives, target locations, and friendly force positions, in real-time and in their line of sight.

b) Situational Awareness: By providing real-time updates and relevant information, the AR HMD helmet aims to improve soldiers' situational awareness. They will have access to a comprehensive and up-to-date picture of the battlefield, including enemy movements, threats, and friendly force activities. This will empower them to make informed decisions and adapt to rapidly changing circumstances.

c) Enhanced Image of the Scene: The AR HMD helmet will enhance soldiers' perception of the environment by augmenting their visual field with digital overlays. This can include highlighting important landmarks, providing thermal imaging, or displaying live video feeds from UAVs or surveillance cameras. By combining physical and digital elements, the helmet will provide a comprehensive and enhanced image of the scene.

d) Navigation and Direction: The AR HMD helmet will incorporate navigation features such as GPS and compass data to assist soldiers in accurate navigation and heading direction. They will receive real-time guidance, including waypoints, routes, and direction indicators, to navigate challenging terrains or reach specific targets efficiently.

e) Provision of Maps and Location Data: The AR HMD helmet will enable soldiers to access detailed maps and location-based data directly through the display. This will allow them to understand the topography, terrain features, and geographical context, facilitating better decision-making and mission planning.

By fulfilling these objectives, the AR HMD helmet aims to provide infantry soldiers with an advanced tool for enhancing their operational effectiveness, situational awareness, and overall mission success.

1.6.1 General Objectives

- The general objectives of the thesis are:
    - To design and develop an AR-HMD that can provide infantry soldiers with real-time information while allowing them to maintain situational awareness of their surroundings.
    - To evaluate the accuracy and usefulness of the displayed information on the AR-HMD.
    - To assess the ease of use of the AR-HMD for soldiers.

1.6.2 Academic Objectives

- The academic objectives of the thesis are:

- To investigate the existing solutions and their drawbacks in providing soldiers with real-time information while allowing them to maintain situational awareness of their surroundings.
- To analyze the working principle of the AR-HMD and its components.
- To evaluate the code and algorithms used to create the virtual augmentation on the AR-HMD.

Chapter 2: Literature Review

A new product is launched by modifying and enhancing the features of previously launched similar products. Literature review is an important step for development of an idea to a new product. Likewise, for the development of a product, and for its replacement, related to traffic system, a detailed study regarding all similar projects is compulsory. Our research is divided into the following points.

- Industrial Background
- Studies Made/Research Papers

2.1 Industrial background

The usage of augmented reality (AR) technology is growing across several industries, including education, entertainment, and business. The development of augmented reality (AR) technology for military use, notably for infantry soldiers in combat, has attracted increasing attention in recent years. The use of augmented reality head-mounted displays (AR-HMDs) is thought to improve soldiers' situational awareness, ability to make decisions, and ability to communicate with one another on the battlefield.

2.2 Recent Studies

The following are some of the recent studies made in this regard:

2.2.1 Study By Tzomakas

Tzomakas et al. (2004) published one of the early studies on the topic, proposing an AR system for military training that combined an HMD and a GPS system to show the location of virtual targets. The device enhanced the soldiers' performance in target engagement and target detection, according to the study.

2.2.2 Study By Korn

In a different study, Korn et al. (2012) created an AR-HMD system for infantry personnel that showed real-time data such mission goals, maps, and the locations of ally and opponent troops. According to the study, the AR-HMD system dramatically increased soldiers' situational awareness and mission effectiveness.

2.2.3 Study By Schuetz

Researchers have more recently looked into the usage of AR-HMDs for specialized military tasks like explosive ordnance disposal (EOD). In a study published in 2019, Schuetz et al. created an AR-HMD system that provided EOD personnel with real-time information regarding explosive devices and their surroundings. According to the study, the AR-HMD technology helped EOD specialists locate and neutralize explosive devices more quickly and accurately.

2.2.4 Studies by Others

There are many different hardware and software solutions that have been suggested for AR-HMD technology. For instance, some research (Korn et al., 2012; Schuetz et al., 2019) have employed specially made HMDs with high-resolution screens and integrated sensors like GPS, accelerometers, and gyroscopes. Other studies have made use of commercially available HMDs like the Epson Moverio BT-300 and the Microsoft HoloLens (Borges et al., 2018). Software-wise, the majority of research have made use of specially created programs that combine data from numerous sources, including GPS, maps, and sensors. For instance, "Virtual Battlespace 2" software by Korn et al. (2012) allows real-time data to be displayed on the HMD. Borges et al. (2018) made use of a specially created piece of software to display 3D models and data overlays on the HoloLens.

2.2.5 Conclusion

In conclusion, the research points to a significant potential for AR-HMDs to improve battlefield situational awareness and combat effectiveness for infantry soldiers. The technological and usability issues with AR-HMDs, such as battery life, weight, and user interface design, still require additional study. Furthermore, studies should be conducted to evaluate the long-term effects of AR-HMDs on soldiers' performance, safety, and health.

Chapter 3: Hardware

3.1 Introduction

In this chapter, we go through how the hardware and software parts of the AR HMD project interface with one another. The 3D-printed chassis, two LCD screens with excellent resolution, the Intel Realsense RGB sensor, and the Raspberry Pi make up the majority of the hardware. The Python programming language will be used in conjunction with a number of libraries and APIs for interface and detection on the software side.

3.2 Hardware Interfacing

Connecting the LCD panels to the Raspberry Pi is the first step in integrating the hardware parts. Power and input signals are supplied by the Raspberry Pi in order to drive the displays. The Pi and the screens both support the HDMI interface, which is used for this.

The Raspberry Pi and Intel Realsense RGB sensor must now be connected. Using the USB 3.0 interface, the Realsense sensor talks with the Raspberry Pi. The Pi needs to be set up to detect the sensor and load the required drivers.

3.3 Working Principles:

The AR HMD helmet integrates various modules and sensors to deliver essential information to infantry soldiers. The key modules and their working principles are as follows:

GPS Sensor (GPS neo6m): The GPS sensor, connected to the Raspberry Pi via GPIO pins, provides real-time location data such as latitude and longitude coordinates, altitude, satellite count, speed, and course. This information enhances soldiers' navigational capabilities and situational awareness.

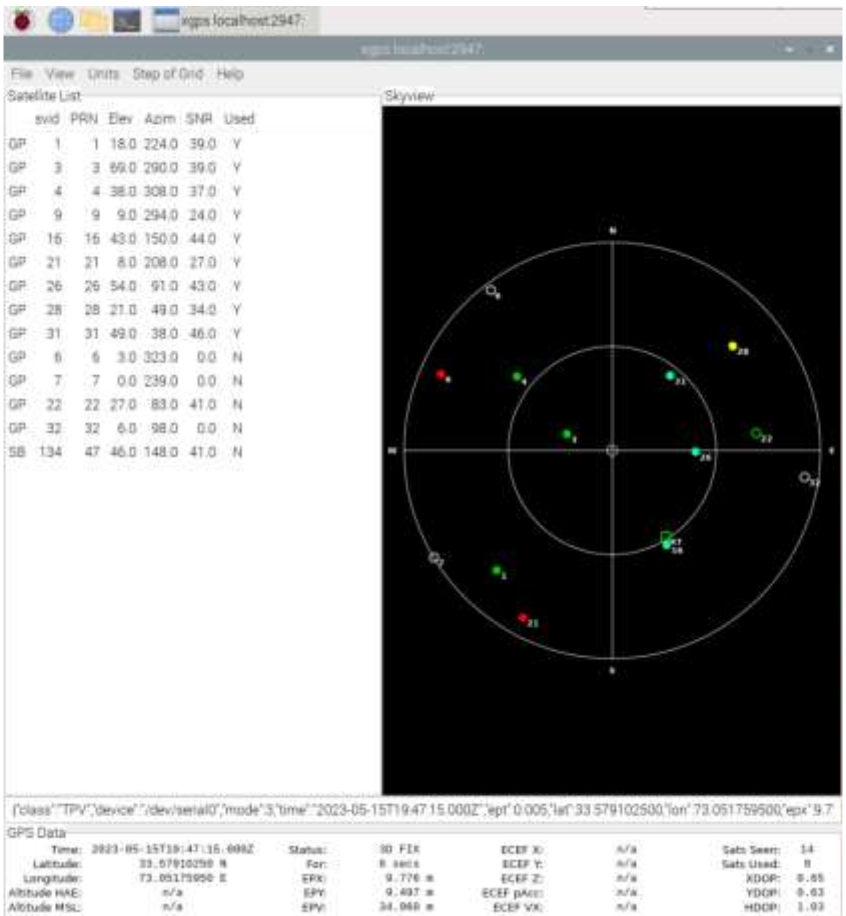

Figure 3 GPS Status

Compass Sensor: The compass sensor, connected to the Raspberry Pi via GPIO pins, enables soldiers to determine their heading direction. By integrating the compass sensor, the HMD helmet provides accurate orientation information, allowing soldiers to maintain their bearing and navigate effectively.

LCD Display: The LCD display, connected to the Raspberry Pi via GPIO pins, presents important information to soldiers through a Python-based GUI. The GUI is designed to provide real-time data overlays, including GPS coordinates, altitude, satellite count, speed, course, compass direction, numeric bearing, time, and date. The integration of Python libraries facilitates data processing and graphical user interface development.

Chapter 4: Software Interfacing

The Python programming language will be used to interface hardware components with software. Python is a good option for this project because it has many modules and APIs for detecting and interacting.

We will be using the following softwares for integration:

4.1.1 OpenCV

OpenCV is a well-known Python computer vision library that offers a variety of image processing and analysis tools. To communicate with the Intel Realsense RGB sensor and process the video stream, we will use OpenCV.

4.1.2 NumPy

A Python toolkit for numerical processing called NumPy offers routines for manipulating arrays and matrices. To modify the visual data collected from the Intel Realsense RGB sensor, we will use NumPy.

4.1.3 TensorFlow

A well-liked machine learning package for Python called TensorFlow offers tools for designing and refining neural networks. The object detection and recognition process, which is a major part of the AR HMD system, will be carried out using TensorFlow.

4.2 Software Integration:

The software integration of the AR HMD helmet involves the following aspects:

Python Programming: The HMD helmet utilizes Python as the programming language for developing the graphical user interface (GUI) and implementing various functionalities. Python libraries for GPS data processing, GUI development, and data visualization are employed to provide soldiers with a user-friendly and intuitive experience.

Google Maps Integration: The HMD helmet has the capability to display maps through integration with Google Maps. This functionality allows soldiers to visualize their location, mission objectives, and points of interest on a digital map, enhancing their situational awareness and mission planning capabilities.

Figure 4 GUI Alpha

Chapter 5: Working

5.1 Information Displayed

The function of our project contains three main functions that focuses on performing language translation, which are image to text translation, voice to text translation, and the QR code translation.

The AR Head Mounted Display (HMD) helmet provides the following useful data to the user through its graphical user interface (GUI):

5.1.1. Latitude and Longitude:

The HMD helmet displays the real-time latitude (33.57925616666667) and longitude (73.0521705) coordinates of the user's location. This information enables soldiers to accurately determine their position on the battlefield and coordinate with other team members or command centers.

5.1.2. Altitude:

The HMD helmet provides the current altitude (505.2m) above sea level. This data is crucial for soldiers operating in different terrains, allowing them to assess their vertical position and adapt their tactics accordingly.

5.1.3. Satellite Count:

The HMD helmet indicates the number of satellites (04) being used to calculate the GPS position. This information helps soldiers gauge the reliability and accuracy of their GPS signal and ensures they have a sufficient number of satellites for precise positioning.

5.1.4. Speed:

The HMD helmet displays the current speed (0.972) in knots. This data provides soldiers with their movement speed, allowing them to assess their pace, track changes in velocity, and plan their operations accordingly.

5.1.5. Course:

The HMD helmet presents the current course (170.07) in degrees. This information represents the direction of the user's movement and helps soldiers maintain their desired heading, navigate obstacles, and stay on track towards their mission objectives.

5.1.6. Compass Direction:

The HMD helmet indicates the compass direction as "Northeast." This data provides soldiers with a cardinal direction reference, aiding in orientation and navigation, especially in situations where visual landmarks may be limited or obscured.

5.1.7. Numeric Bearing:

The HMD helmet displays the numeric bearing (66.7) that represents the angle between the user's current direction and a reference point. This data helps soldiers accurately determine their bearing relative to a specific target or point of interest, enhancing their ability to navigate and engage with precision.

5.1.8. Time and Date:

The HMD helmet includes a real-time clock that provides soldiers with accurate time and date information. This ensures synchronization with mission timelines, facilitates coordination among team members, and helps maintain operational efficiency.

By presenting this comprehensive set of data, the AR HMD helmet equips infantry soldiers with critical situational awareness, facilitating informed decision-making, effective navigation, and successful mission execution.

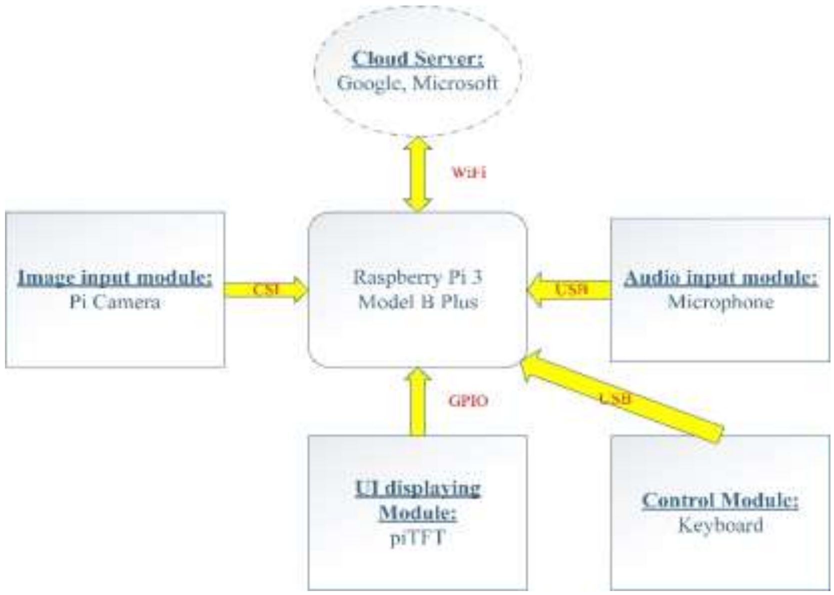

Figure 5 Hardware design

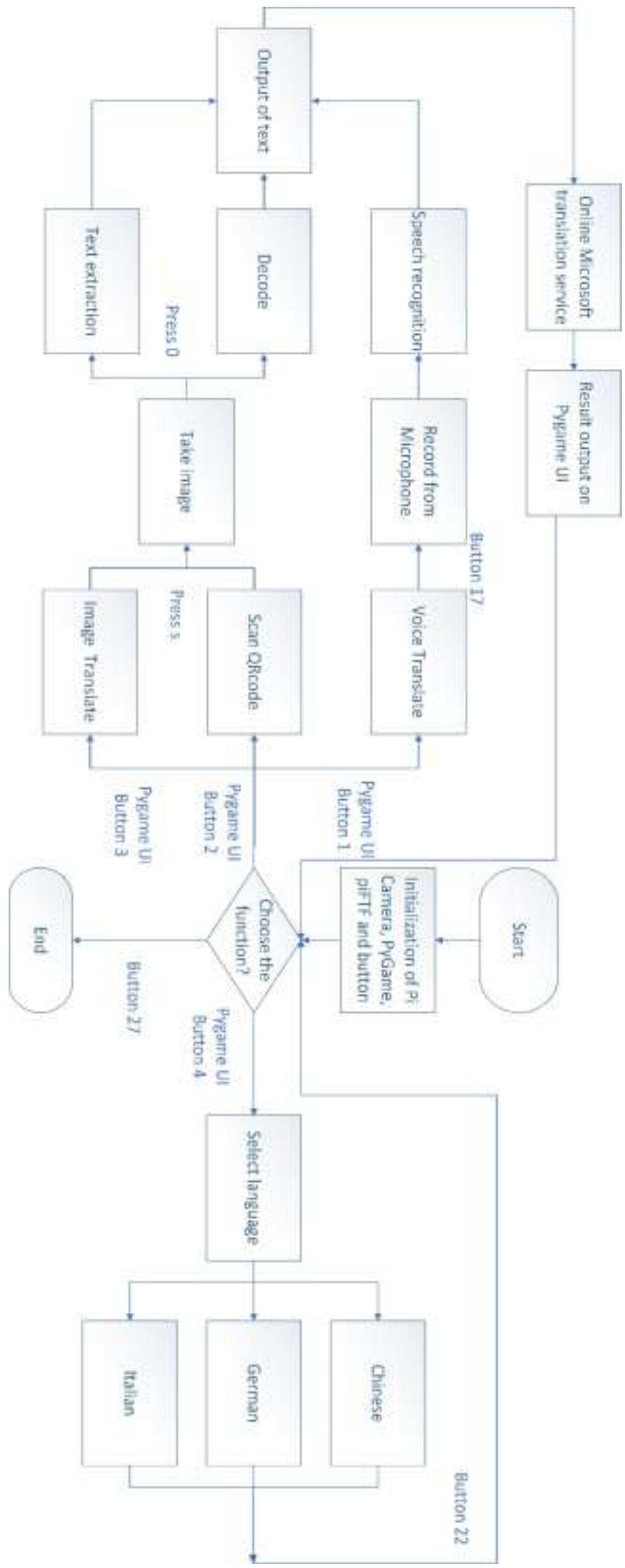

Figure 6 Software design

5.2 Image to Text translation

The first function is the image to text translation, the user could take an image of the words or sentences that they want to translate, and then the piTFT will display the translated result. In order to do this, the text in the image need to firstly be extracted. As a result, an OCR (Optical Character Recognition) library need to be implemented here to recognize the text information in the image. The OCR library we chose to use is Tesseract, which is an open source engine. It has wrappers for different languages, and the wrapper we implemented in our program is pytesseract because the program is based on Python. In the beginning, pytesseract need to be installed on the raspberry pi. Then it can be called by our program. The operation procedure of this function is shown below in Figure 7.

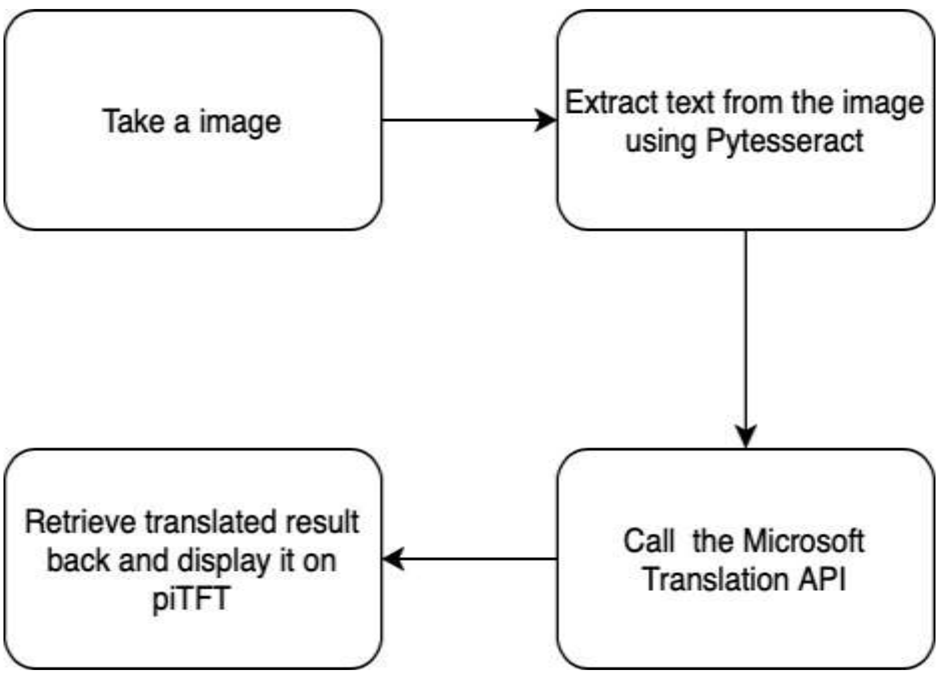

Figure 7 Stage of Image Translation

The first stage is image taking, here we connect PiCamera to the raspberry pi and initialize the camera when function is called. Then the program will wait for the key press from the keyboard to take an image. When the specific key is pressed, the image will be taken and pytesseract will be used to extract the text from the image using the command "text = pytessearct.image_to_string(image)". This command will return the extracted text and then the program will transfer to the third stage, which calls the Microsoft text translator API to translate the text into the specific language. In order to call the API and send request to the API, we need to specify the API key and the endpoint, so that the message could be successfully send to the API and the API could response with the result. Here we set the API key and the endpoint as the environment variable. So that the program could check the environment variable to see if the key and endpoint is correct. The language we want to translate to could also be specified by the user, we will discuss the language setting in the following section. Finally, the translate result will be displayed on the piTFT.

5.3 Voice to Text translation

The second function is the voice to text translation, the user could say some words or sentences through the microphone which is connected to the raspberry pi and the voice could be recorded and saved to a specific path. Then it is important to recognize the text content in the voice file. In order to perform voice recognition, we chose Google Speech-to-Text API, which could recognize more than 120 languages. It can also process real-time streaming or prerecorded audio. The operation procedure of this function is shown below in figure KK. In the first stage, the user could input voice through the microphone, which is connected to the raspberry pi. In order to realize this, the pyaudio will be firstly initialized. Meanwhile, the sampling rate and channel are set to be 44100 and 1 respectively. The reason that the channel need to be set as 1 is that pyaudio could only support single channel input. In order to start the recording, we implement button 17 to control the recording procedure. If the button 17 is pressed, which will pull down the GPIO 17, the recording will start and stop until the button 17 is released. The voice file will be saved and the state will transfer to the second stage. In this stage, the voice file will be sent to the Google speech-to-text API, then the API will response with the extracted text message. The text message will then be sent to the Microsoft text translator API and the translated result will be displayed on the piTFT.

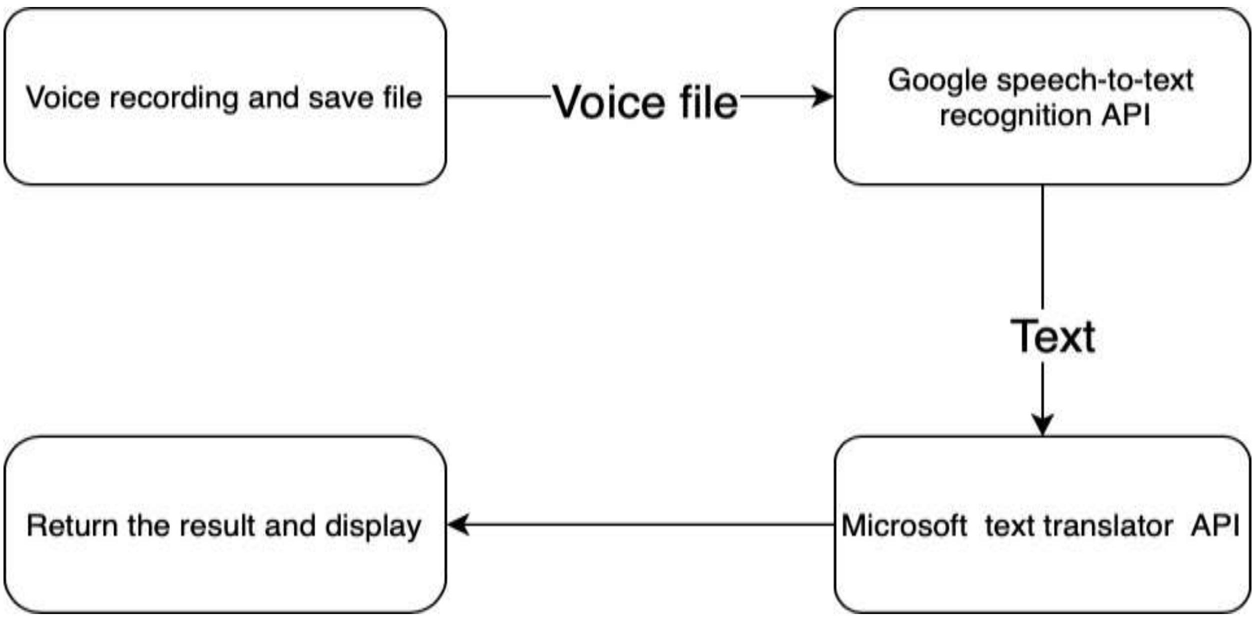

Figure 8 Stage of Voice Translation

5.4 QR code to Text translation

The third function is the QR code to text translation, this function will make it possible for the translator to recognize the QR code and response with the text information behind it. In order to recognize the QR code, we implemented pyzbar, which is a QR code recognition library that could be used in Python. This function is quite similar to the image translation function. Firstly, the user could take a image of the QR code, the stage taking procedure is same as the image translation function. Then the image will be saved to a specific path. Pyzbar will read in the image from that specific path and decode the image into text message using the command “pyzbar.decode(image)”, the command will return the extracted text message and the message will be sent to the Microsoft Translation API.

5.5 Translating Language setting

Our translator will also allow the user to modify the language they want to translate to by choosing the language from the language setting mode of our translator. The language we implemented into our translator are Chinese, Deutsch, Italian. The Microsoft Translation API could support more than 50 languages, we will add more languages into our translator in the future to support wider usage

Chapter 6: Testing

6.1 UI design of the translator

The UI design of our translator is shown below in figure 5, there are four buttons in the first level, “image-T”, “voice-T” and “QR_Scan” are the translation function buttons. If the user click “settings” button, the language will be set.

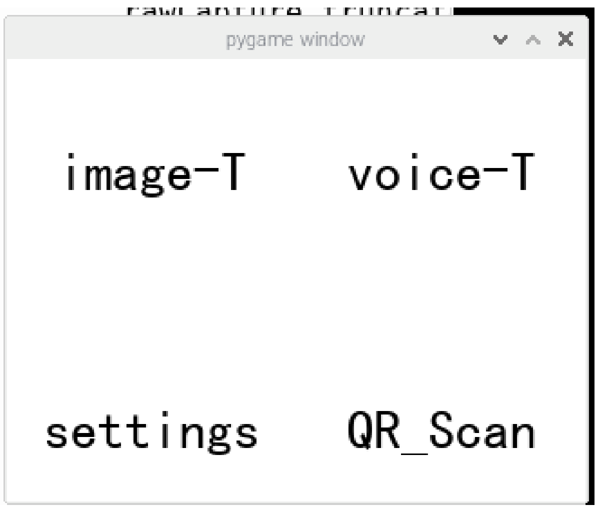

Figure 9 Beta UI of HMD

Some problems appear in the progress of tesing. First, the operation of the mouse is not so sensitive and the program ran quite slowly. Then we found out that the execution of the program occupied most of the resources of the CPU. The reason that caused this problem is that we didn’t add enough sleep time before the start of next iteration in Pygame UI, so that the loop just kept iterating all the time, and the mouse operation could not get enough resource.

When we tried to use piTFT, the piTFT had some problems and we found the error information as shown below in Figure 6. We guessed the piTFT was broken and could not be used as a touch screen(the functions of display is normal). The Reason that caused this problem is that we left the outside connection of the piTFT in the air instead of connecting to the breadboard. So the pins of the piTFT got shorted and destroyed the chip that control the touchscreen.

We designed the UI for our whole project. It had a 3-level menu and we used 4 buttons. At first, a problem happened as shown below in Figure 7. But when we used the original document, no problem happened. The reason is we ran the original document, we used "python XXXX.py" and the pytesseract is installed in the home/pi/lib and the UI version is run by "sudo python XXXX.py", the library in usr/lib does not have this library. The way to solve this problem is by copying the tesseract file into the Python 2.7 file under the usr/lib route.

Figure 10 Pi TFT error

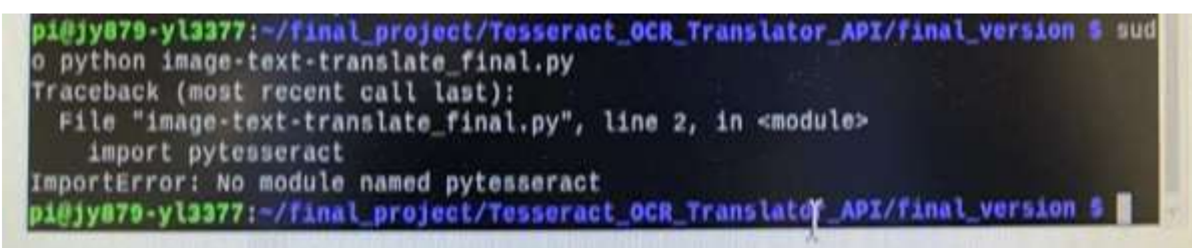

Figure 11 Sudo error

6.2 Image Translation test

First, we chose the image-T button, and the default language is Chinese. The program called the Picamera, a frame window would be initialized, as shown in figure 8. The text in the image is Accelerator and the result could be sent back and displayed on the piTFT, as shown in figure 12.

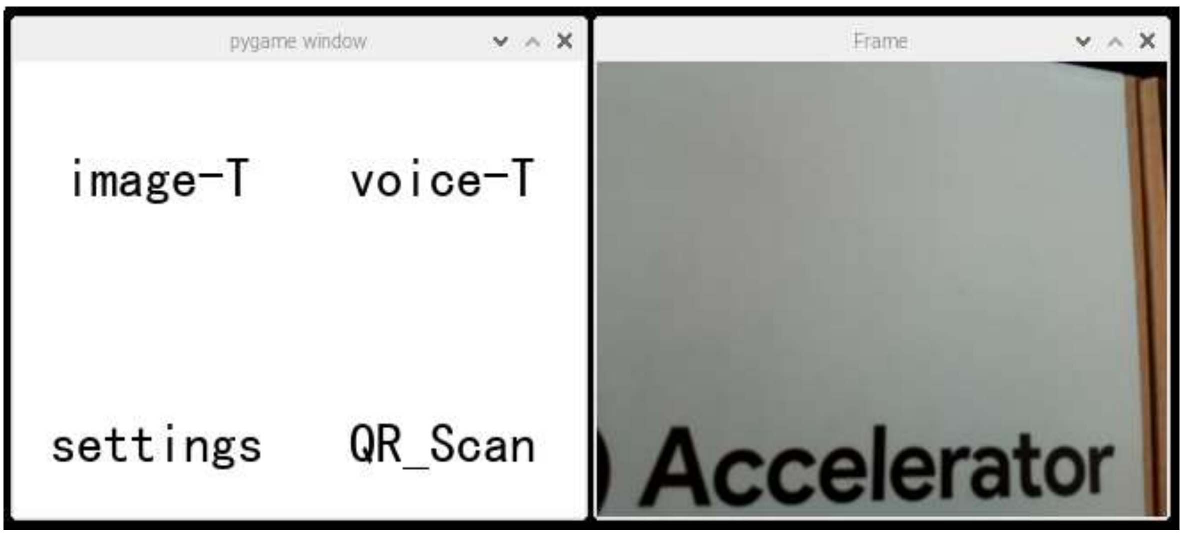

Figure 12 Take a photo

Figure 13 Return result

When we tested English, Chinese and Japanese in the tesseract program, it reported the “ascii” error of encoding and decoding . We found that some used text contained special letters and symbols and in python it used ascii encode format as default. The solution to this problem is using UTF-8 encode format. We added a header clarifying using UTF-8 encode in this program to our program, fixed.

In the translation step of our program, the text received from Microsoft Service was in the format of JSON, so the result of translation showed “\n” . This is caused by “new line” coding in ascii, which is used in python. To solve this problem, we deleted “\n” in the result of OCR and replaced it with a blank space, but the translation result with multiple paragraphs only has one paragraph. To solve this problem, we took a picture with one paragraph at a time.

6.3 Voice Translation test

After the image translation test was finished, we pressed the button 17 on the piTFT, the program went back to the first page. Then we chose voice-T button and started the test for the Voice translation. As shown below in figure 10, the program started voice recording as soon as the button 17 was pressed and stopped recording when button 17 was released. We said Good morning through the microphone and the translated text was successfully displayed on the piTFT, as shown below in figure 11.

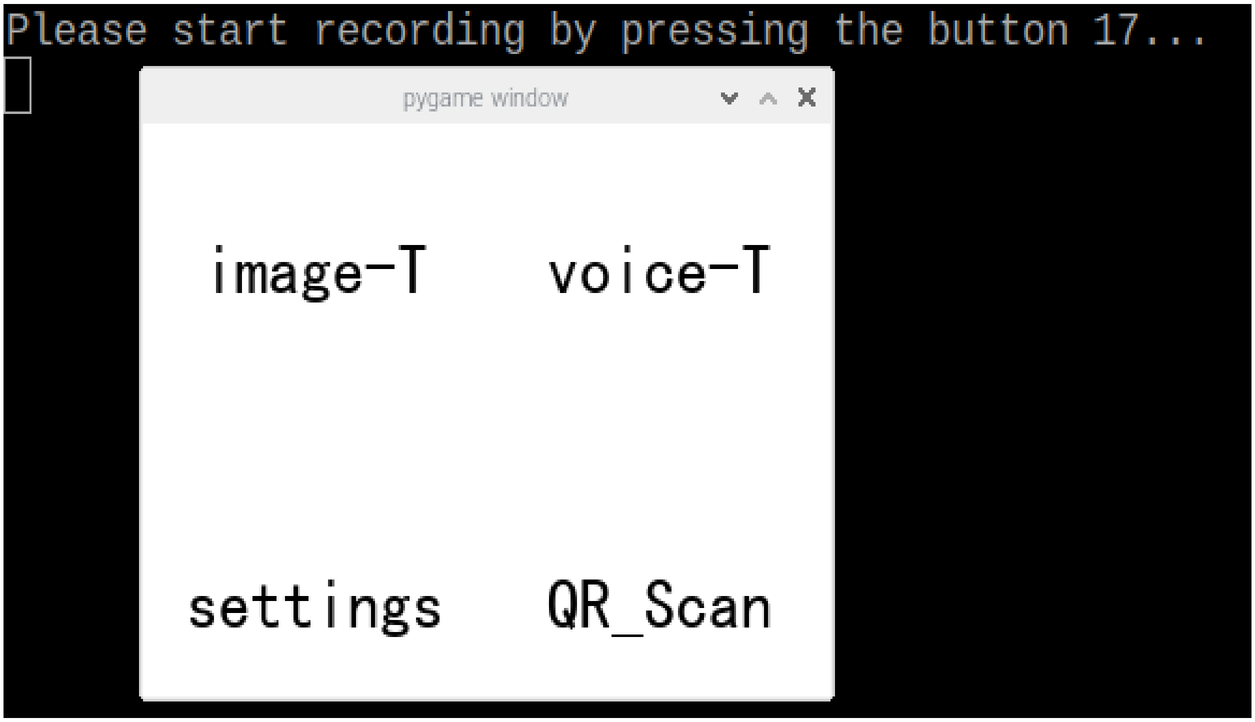

Fig.14 Prepare for recording

Fig.15 Return result

When we chose a speech recognition API for R-Pi, at first, we hoped to use the online API directly. However, almost all the speech recognition only provided SDK API and we had to give up the original method and choose this new method. Then, we chose Recognize speech from Microsoft Cloud Service and we thought this is a simple method. But the SDK of Cloud service requires the 64-bit Operating System and the Debian Ver.10 Operating System for R-Pi 3 B+ is a 32-bit system. Hence, we had to install Google-cloud service SDK. After initialization, we could get a text output from a voice input. In addition, we should upload the audio document in the format of wav with one voice channel and sample rate in range from 8000 to 48000.

6.4 QR Code Translation test

Then we began the test for QR Code translation. To begin with, we used a QR Code online generator to generate a QR code which contain "Hello World" text. Then we chose the third function "QR_Scan" and took an image of the QR Code, as shonwn in figure 12 Then the translated text was successfully displayed on the piTFT, as shown in figure 15.

Figure 14 Scan QR code

Figure 15 Return result

6.5 Language Setting test

The default language is Chinese, the user could select language from the “settings” button on the first page, the page button layout of the language setting page is shown below in figure 14. And the test result for both Deutsch and Italian are shown below in figure 15 and figure 16. The voice input is “Good Morning”.

Figure 16 Menu of language

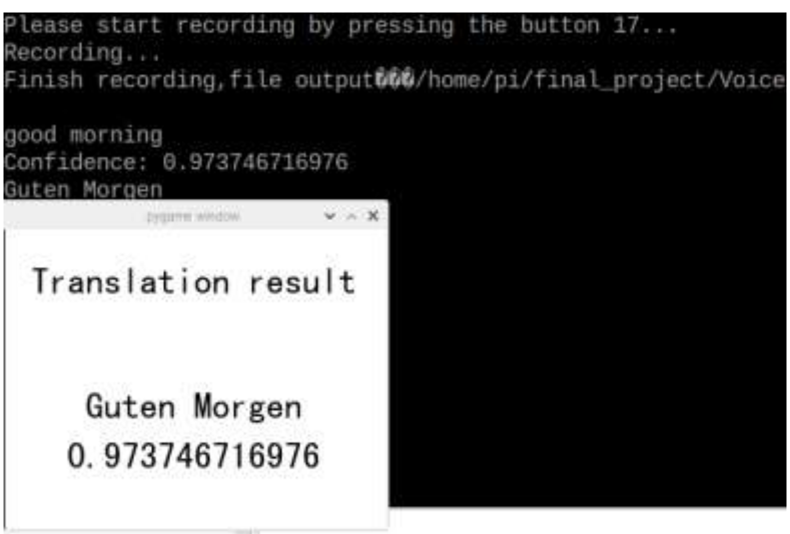

Figure 17 Deutsch

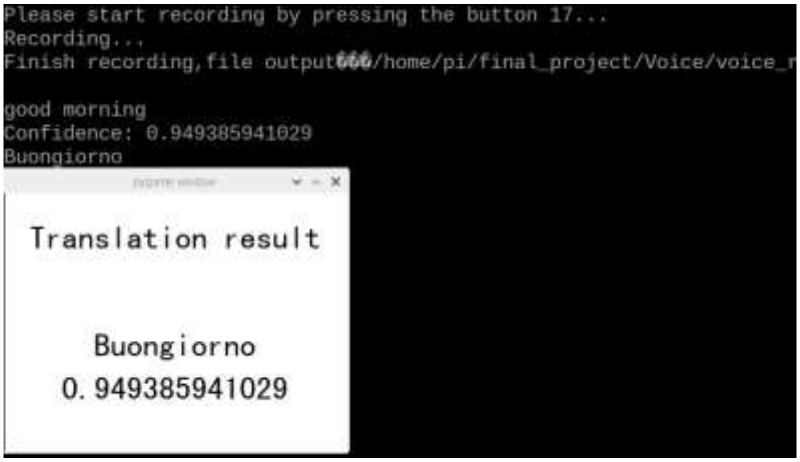

Figure 18 Italian

6.6 Result

We compiled the OpenCV "cmake" in our R-Pi, it took a lot of time to finish this process. But we found it was useless for us to do this step, we only imported the cv2 library in the Python program and installing OpenCV is enough.

All in all, the three translation function could perform accurate text recognition and translation. The language setting function could make the translator to have wider applications. Although the translator has reached our expectation and our team has perfectly met the goal outlined in the description, there still remains a lot of improvement for us to do. We will keep making the performance of our translator better in the future.

Figure 19 Demo

Figure 20 A Soldier wearing Head Mounted Display

Chapter 07: Conclusion

7.1 Concluding Overall Integration

The design and execution of a head-mounted display (HMD) for infantry soldiers that uses see-through augmented reality technologies are detailed in this thesis. The soldier can stay aware of their surroundings while receiving real-time information through the HMD. Time, location coordinates, a map, and heading direction are all presented, along with data from external accessories like night vision cameras, RGB sensors, and thermal cameras that are seamlessly integrated into the HMD brain to display data in real-time.

7.1.1 Project's Success

The project's success is determined by the veracity and applicability of the data provided, as well as by how simple it is for soldiers to utilize the HMD. The HMD gives soldiers better situational awareness, which can significantly increase their battlefield combat efficiency.

7.1.2 Future Work

Although the project's objectives have been met, there are still a number of areas where work has to be done to boost the system's efficiency. Future works include the following :

AI and machine learning technologies are integrated to assess data and help soldiers' decision-making. The inclusion of voice and gesture recognition capabilities to enable hands-free operation. The creation of more precise and accurate sensors to enhance the quality of the information provided. The power supply system needs to be improved in order to extend the HMD's battery life. The incorporation of wireless connectivity to permit the sharing of data in real time and interoperability between soldiers. The creation of a tougher, more resilient chassis to survive combat situations and challenging environs. To verify the system's efficacy in boosting situational awareness and combat effectiveness, it will undergo testing and evaluation in realistic combat scenarios.

In conclusion, our experiment has shown how HMD technology may enhance soldiers' battlefield situational awareness and combat effectiveness. A higher level of situational awareness, decision-making support, and communication skills for soldiers may be achieved through the continued development and integration of cutting-edge technologies.

References and Work Cited

1. Azuma, R. T. (1997). A survey of augmented reality. Presence: Teleoperators & Virtual Environments, 6(4), 355-385.
2. Bimber, O., & Raskar, R. (2005). Spatial augmented reality: Merging real and virtual worlds. A K Peters/CRC Press.
3. Bohus, D., Horvitz, E., & Hovel, D. (2003). Augmenting soldier vision with microdisplay technology. In Proceedings of the 6th International Symposium on Wearable Computers (pp. 23-30).
4. Huang, L., & Wang, L. (2014). Real-time pedestrian detection in surveillance videos based on HOG and linear SVM. Journal of Electronic Imaging, 23(4), 043005.
5. Microsoft. (n.d.). Microsoft HoloLens. Retrieved from **https://www.microsoft.com/en-us/hololens**.
6. Realsense. (n.d.). RealSense™ technology. Retrieved from **https://www.intel.com/content/www/us/en/architecture-and-technology/realsense-overview.html**.
7. Unity Technologies. (n.d.). Unity – Manual: Vuforia AR engine. Retrieved from **https://docs.unity3d.com/Manual/Vuforia.html**.

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