PROJECT REPORT

On

"WEARABLE OSCILLOSCOPE SMART WATCH"

Submitted in the partial fulfillment for the award of Bachelor of Engineering in

ELECTRONICS & TELECOMMUNICATION ENGINEERING

At

ATMA MALIK INSTITUTE OF TECHNOLOGY & RESEARCH,AGHAI

Submitted to

UNIVERSITY OF MUMBAI, MUMBAI

PROF. SONAL PATIL

(Project Guide)

Submitted by

KARAN D. PATIL

RITURAJ S. KUMAWAT

ANITA D. NEMAN

SHIVANI S. NIKAM

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

2024-25

ATMA MALIK INSTITUTE OF TECHNOLOGY & RESEARCH, AGHAI

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that,

"Karan Patil, Rituraj Kumawat, Anita Neman, Shivani Nikam"

have submitted a report on the basis of the project work on

"WEARABLE OSCILLOSCOPE SMART WATCH"

As a partial fulfillment towards the completion of "Fifth Semester" of course in Engineering in the branch of Electronics and Telecommunication during the academic year 2024-25.

Prof. Sonal Patil	**Prof. Sonal Patil**	**Dr. D. D. Shinde**
(Project Guide)	(H.O.D.-EXTC)	(Principal)

External Examiner

ACKNOWLEDGEMENT

We feel great sense of gratitude and achievement by presenting project report on,

"WEARABLE OSCILLOSCOPE SMART WATCH"

We wish to express our profound thanks to our Project Guide: **Prof. Sonal Patil Mam** for their meticulous planning, the valuable time that they spent with us, discussing our dissertationideas and helping us jump over any hurdles that would come our way.

We would also like to express our sincerest gratitude to our Electronics and Telecommunication staff for help to carry out literature survey, research and comparative study which have led to the selection of dissertation.

We also want to thank our respected principal **Dr. D. D. Shinde Sir** for providing us with the basic infrastructure and other facilities.

Finally, we want to say thanks to all of our friends who helped us directly or indirectly in the completion of project.

Karan D. Patil – 10
Rituraj S. Kumawat - 06
Anita D. Neman - 07
Shivani S. Nikam - 08

ABSTRACT

Oscilloscopes are used to display changes in electrical signals over a period of time in terms of X and Y axis, displayed on a calibrated scale.

We here develop a smart watch with built in oscilloscope that takes electronics, troubleshooting and development to the next level. The system is basically a wearable device that puts the oscilloscope on your wrist for use as and wherever you desire.

For this system we make use a battery powered device with battery charging and monitoring circuitry. This checks for battery level and also alerts for charging if battery low and auto cut off battery protection from overcharging. We here develop a Low frequency oscilloscope that covers frequency range upto 20 Khz DC. Also it can deliver a maximum sampling rate of 50000 samples/sec. This will allow for 60 pixels placed on y axis depending on the analogue signal.

The circuitry utilizes a single operation amp IC that is LM358 which incorporates two operation amps inside one single chip. As the info sign will be AC and we don’t have split rail development, there are two operation amps (from a single Op-Amp 8 pin package) used to make the sign ac coupled. Both the operation amp is taken care of with a reference voltage that is utilized to balance the sign and utilizing simple data sources it is plotted on the extension chart.

The offset can be changed utilizing the potentiometer (which is having 100K opposition). Both the operation amp are set with a similar negative criticism with a x5 gain setting. Other than this the OLED is connected over the A4 and A5 is the I2C SCL and SDA pin with a 4.7K draw up resistor. It could work with a basic USB connector. The buttons are utilized to set the parameters of the Oscilloscope.

We hereby use an Arduino Nano board to monitor and analyze these signals and display on the OLED display. A small battery is used to power the entire operation. This entire setup is mounted on a wrist band so as to make it portable and easy to use.

CONTENTS

CHAPTER 1

1.1 INTRODUCTION

Oscilloscopes are used to display changes in electrical signals over a period of time in terms of X and Y axis, displayed on a calibrated scale.
We here develop a smart watch with built in oscilloscope that takes electronics, troubleshooting and development to the next level. The system is basically a wearable device that puts the oscilloscope on your wrist for use as and wherever you desire.

For this system we make use a battery powered device with battery charging and monitoring circuitry. This checks for battery level and also alerts for charging if battery low and auto cut off battery protection from overcharging. We here develop a Low frequency oscilloscope that covers frequency range upto 20 Khz DC. Also it can deliver a maximum sampling rate of 50000 samples/sec. This will allow for 60 pixels placed on y axis depending on the analogue signal.

The circuitry utilizes a single operation amp IC that is LM358 which incorporates two operation amps inside one single chip. As the info sign will be AC and we don't have split rail development, there are two operation amps (from a single Op-Amp 8 pin package) used to make the sign ac coupled. Both the operation amp is taken care of with a reference voltage that is utilized to balance the sign and utilizing simple data sources it is plotted on the extension chart.

The offset can be changed utilizing the potentiometer (which is having 100K opposition). Both the operation amp are set with a similar negative criticism with a x5 gain setting. Other than this the OLED is connected over the A4 and A5 is the I2C SCL and SDA pin with a 4.7K draw up resistor. It could work with a basic USB connector. The buttons are utilized to set the parameters of the Oscilloscope.

We hereby use an Arduino Nano board to monitor and analyze these signals and display on the OLED display. A small battery is used to power the entire operation. This entire setup is mounted on a wrist band so as to make it portable and easy to use.

1.2. PROBLEM DEFINITION

- **Signal Acquisition**: The device must accurately capture and display a wide range of electrical signals for effective analysis.

- **User Accessibility**: It should provide an intuitive interface that allows users to easily interpret and interact with waveforms.

- **Battery and Connectivity**: The smartwatch needs to maintain efficient battery life and reliable connectivity for data transfer without compromising performance.

1.3 OBJECTIVE

- **Real-Time Signal Analysis**: Develop a smartwatch that enables users to monitor and analyze electrical signals in real-time for immediate insights.

- **User-Friendly Design**: Create an intuitive interface that simplifies waveform visualization and interaction, catering to both professionals and hobbyists.

- **Enhanced Portability**: Ensure the device is compact and lightweight, providing effective functionality without sacrificing comfort or ease of use.

- **Robust Connectivity**: Implement reliable wireless connectivity for seamless data transfer and integration with other devices and applications.

- **Extended Battery Life**: Optimize power consumption to ensure the smartwatch can operate for extended periods without frequent recharging, enhancing user convenience.

CHAPTER 2

2.1. LITERATURE SURVEY

A literature survey on wearable oscilloscope technology reveals a growing interest in integrating advanced signal processing capabilities into compact, user-friendly devices. Recent studies emphasize the importance of miniaturization of electronic components, allowing for the development of high-performance microcontrollers and sensors suitable for wearable applications. Innovations in analog front-end design and analog-to-digital converters (ADCs) have improved the accuracy and responsiveness of measurements. Additionally, research highlights the role of wireless connectivity, enabling real-time data transfer to smartphones or cloud platforms for enhanced analysis and storage.

User interface design has also been a focal point, with emphasis on intuitive controls that facilitate quick adjustments and visualizations of waveforms. The application of low-power techniques is crucial in extending battery life, making these devices practical for everyday use. Overall, the literature underscores the potential of wearable oscilloscopes in diverse fields, including education, healthcare, and engineering, driving further exploration and development in this innovative area.

The literature also addresses the importance of ergonomic design and the aesthetic appeal of wearable devices. Researchers emphasize that comfort and usability are critical factors in user adoption, prompting innovations in flexible electronics and materials that can conform to the wearer's body. This focus on design has led to prototypes that not only function well but also look appealing and fit seamlessly into everyday wear.

In terms of connectivity, advancements in Bluetooth and Wi-Fi technologies have paved the way for remote monitoring and control, allowing users to access real-time data on smartphones and tablets. This capability enhances the utility of wearable oscilloscopes in professional settings, where quick data analysis and sharing are essential.

CHAPTER 3

3.1. METHODOLOGY

3.1.1 Block Diagram:

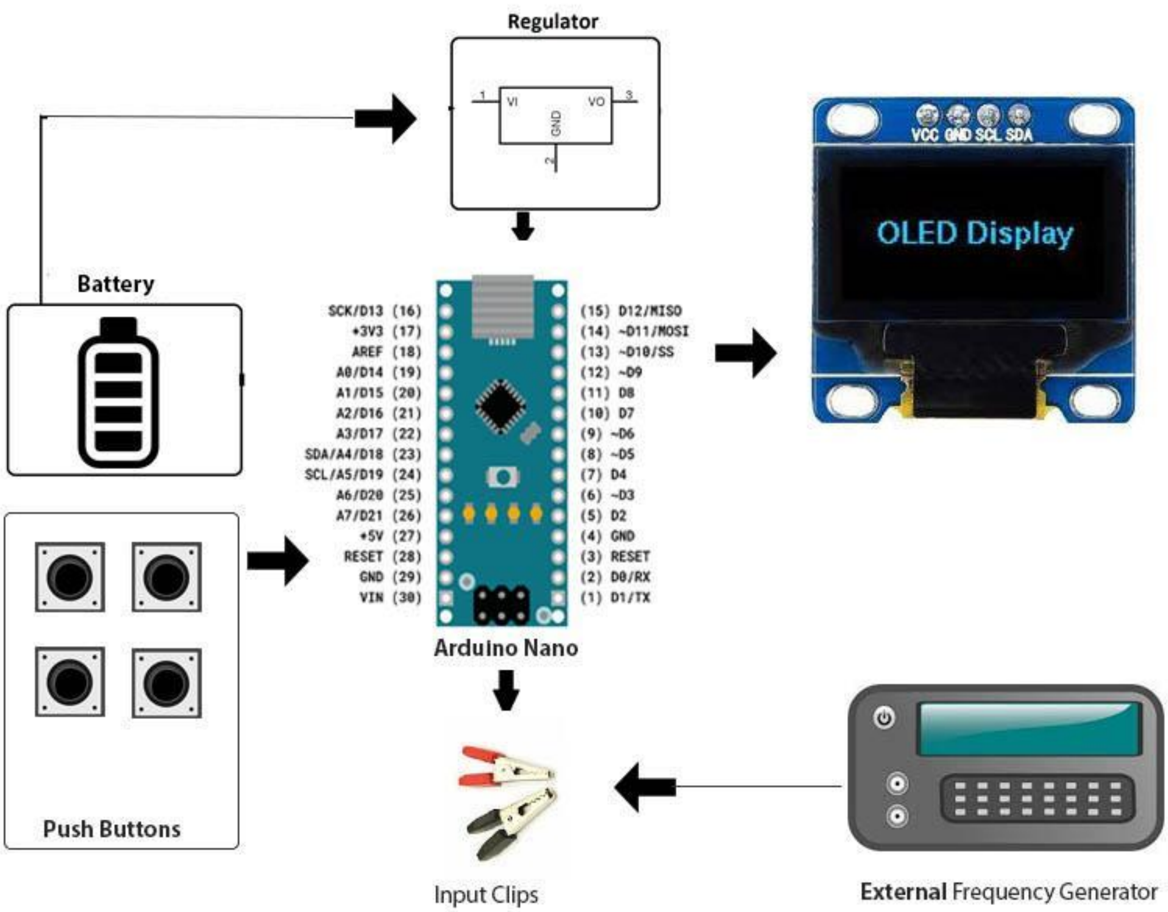

Fig no. 3.1.1 Basic block diagram of Wearable Oscilloscope smart watch.

3.1.2 HARDWARE REQUIREMENTS

- Arduino Nano
- OLED Display
- Battery
- Battery Controller
- Wrist Strap
- Push Buttons
- LED’s
- PCB Board
- Resistors
- Capacitors
- Transistors
- Cables and Connectors

3.1.3 SOFTWARE REQUIREMENTS

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based onWiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

CHAPTER 4

4.1.Future Work

The Future work on wearable oscilloscopes can focus on several key areas to enhance their functionality and user experience. First, implementing advanced signal processing algorithms, including machine learning techniques, can significantly improve real-time signal analysis and anomaly detection, allowing the device to interpret complex waveforms more effectively. Second, exploring innovative battery technologies, such as solid-state batteries or energy harvesting solutions, can extend operational time and enhance power management strategies, enabling longer usage between charges. Finally, developing more intuitive user interfaces—potentially incorporating gesture controls or augmented reality features—can improve usability and accessibility, making the device easier to operate in various settings and appealing to a broader user base.

4.2. Application

- **Biomedical Monitoring**: Wearable oscilloscopes can be used to monitor vital signs such as heart rate and electrical activity (e.g., ECG), providing real-time data for health professionals. This application is particularly valuable for patients with cardiac conditions, enabling continuous monitoring and early detection of anomalies.

- **Audio Engineering**: In the field of audio engineering, wearable oscilloscopes can assist sound technicians in real-time waveform analysis during live performances or studio recordings. This allows for immediate adjustments to sound quality, frequency response, and signal integrity, enhancing overall audio fidelity.

- **Educational Tools**: Wearable oscilloscopes can serve as innovative teaching aids in physics and engineering education. By providing hands-on experience with waveform analysis, students can engage more deeply with concepts such as signal properties, circuit behavior, and electronics, fostering a practical understanding of theoretical principles.

4.3. Advantages

Portability: Their compact design allows for easy transport, ideal for fieldwork and remote diagnostics.

Real-Time Data Access: Users can observe and adjust signals immediately, crucial for timely decision-making.

User-Friendly Interface: Intuitive controls make them accessible to users of varying expertise, from students to professionals.

Multi-Functionality: Capable of measuring diverse signals, these devices are versatile across various applications.

Enhanced Learning Experience: They provide hands-on opportunities in education, promoting deeper engagement with complex concepts.

4.4. Disadvantages

Limited Bandwidth: Due to their compact size, wearable oscilloscopes may have lower bandwidth compared to traditional bench oscilloscopes, limiting the types of signals they can accurately measure.

Battery Life Constraints: Extended use can quickly drain batteries, requiring frequent recharging and potentially limiting operational time in field settings.

Durability Issues: Wearable devices may be more susceptible to damage from environmental factors (like moisture, dust, or impacts), necessitating careful handling and protective casings.

Processing Power: The compact design may restrict the processing capabilities, affecting the complexity of signal analysis and limiting advanced features.

Cost: High-quality components and advanced features can make wearable oscilloscopes relatively expensive, which may not be feasible for all users or institutions.

CHAPTER 5

5.1 Conclusion

In conclusion, wearable oscilloscopes represent a significant advancement in portable signal measurement technology, offering numerous benefits such as portability, real-time data access, and user-friendly interfaces. Their versatility allows for applications across diverse fields, including biomedical monitoring, audio engineering, and education. However, challenges remain, including limitations in bandwidth, battery life, and durability, which must be addressed to maximize their potential.

As technology continues to evolve, future developments in processing power, design, and connectivity will likely enhance the functionality and applicability of wearable oscilloscopes, making them indispensable tools for both professionals and educators. Overall, their integration into various sectors promises to drive innovation and improve efficiency in signal analysis and monitoring.

5.3 References

1) **Gonzalez, R. C., & Woods, R. E.** (2018). *Digital Image Processing*. Pearson.

2) **Sharma, A., & Kumar, S.** (2020). "Wearable Devices for Biomedical Applications.

3) **Pahlavan, K., & Krishnamurthy, P.** (2019). *Principles of Wireless Networks: A Unified Approach*. Prentice Hall.

4) **Xu, Y., & Wang, J.** (2021). "Recent Advances in Wearable Electronics: A Review." *Journal of Materials Chemistry C*, 9(22), 6801-6812.

5) **Bohorquez, J. A., & Pineda, J. A.** (2021). "Wearable Oscilloscopes: A Practical Guide." *IEEE Transactions on Industrial Electronics*, 68(5), 4223-4231.