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2EAI-ES2-2324-Depthmonitor

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Abstract

This application note (AN) documents the development of a depth monitoring system using the Arduino Nano BLE Sense microcontroller. The hardware setup integrates various sensors, the details of which will be explained later in this document. The primary objective of this project is to gain insight into different sensor technologies by comparing their performance and accuracy.

The research within this AN give an in-depth examination of the Arduino microcontroller and the diverse array of sensors employed. Additionally, it delves into the programming language utilized for the project. This programming language serves as the foundation for advancing towards a functional product.

A systematic approach has been employed to achieve a working final product, incorporating cost-effective solutions. The in-depth research conducted prior to reaching the original project scope has been instrumental in ensuring the project's success.

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# Introduction

This development paper delves deeper into the journey of creating and implementing a monitoring project, undertaken as a crucial part of the academic curriculum at PXL Digital. The project is divided into three key phases: the initial research phase, where we explored hardware and method options; the testing phase, where sensors and tools were put through their paces; and the implementation phase, where everything was brought together into one final product.

In the research phase, we delved into a range of hardware possibilities, including the Arduino Nano BLE Sense, and identified suitable software tools. This phase was pivotal in getting a grasp of what the sensors and tools could do, understanding their strengths and limitations.

Moving on to the testing phase, we conducted direct experiments with the researched sensors and the Arduino Nano BLE Sense. These tests were crucial in making final decisions about the project.

The final implementation phase marked the culmination of our efforts, where we integrated all the tested elements to craft a fully functional monitoring system. Here, our focus was on refining the user experience and ensuring the system's reliability across various conditions.

The paper is organized to walk the reader through each stage of the project development process. Following the introduction, the Materials and methods section provides a detailed description of Hardware and software used. The Results section presents the outcomes of the testing phase. A more in-depth discussion of these results is found in the Discussion section, and the paper concludes with a summary of findings.

# Material and methods

## Materials

### Arduino nano 33 BLE sense

Afbeelding met tekst, schermopname

Automatisch gegenereerde beschrijving

The Arduino nano served as the main board for driving the project, and to understand the pin layout the manual provided by the company Arduino was consulted. Reading the documentation provided insights into the board’s pin configurations, functions, and usage.

Let's delve into the impressive array of features this board offers:

**1.** **Bluetooth Connectivity:** Harness the power of a robust 2.4 GHz Bluetooth® 5 Low Energy module, complete with an internal antenna. This feature enables seamless data transmission between various devices.

**2.** **IMU for Motion Detection:** With the LSM9DS1 inertial measurement unit onboard, there is access to a 3D accelerometer, gyroscope, and magnetometer.

**3.** **Python Support:** The potential of MicroPython, an implementation of the Python® programming language with a subset of the Python® standard library. This enables streamlined programming directly on the board, enhancing development efficiency.

**4. Microphone Integration:** Utilize the integrated omnidirectional digital microphone (MP34DT05) to capture and analyze real-time sound data.

**5. Proximity and Gesture Detection:** Leverage the capabilities of the built-in APDS9960 sensor to detect proximity and interpret gesture inputs.

**6. Barometric Pressure Sensing:** Incorporating the LPS22HB barometric pressure sensor enables precise measurement of atmospheric pressure, ranging from 260 to 1260 hPa. This data can be further processed to calculate accurate altitude above sea level, enriching your project's environmental awareness.

**7. Temperature and Humidity Sensing:** Benefit from the HTS221 capacitive digital sensor, designed to measure relative humidity and temperature with impressive accuracy (± 0.5 °C).

### PEPPERL+FUSHS Ultrasonic sensor

Jasper geef wat informatie mee

Afbeelding met cirkel, licht

Automatisch gegenereerde beschrijvingThis ultrasonic sensor is regularly used for industrial applications. It is robust and has numerous features. Moreover, it is easy to set manually. It features the following pinout:

Afbeelding met tekst, Lettertype, lijn, schermopname

Automatisch gegenereerde beschrijving

The connections should be made as follows, considering the cable used.

1. Brown cable: connected to 24V source.
2. White cable: not connected.
3. Blue cable: connected to ground of the source.
4. Black cable: connected to voltage divider (to Arduino analog pin)
5. Gray cable: not connected.

Afbeelding met tekst, schermopname, lijn, Lettertype

Automatisch gegenereerde beschrijving

### LV-MaxSonar-EZ

With 2.5V – 5.5V power the LV-MaxSonar-EZ provides very short to long-range detection and ranging in a very small package. The LV-MaxSonar-EZ detects objects from 0-centimeters to 6.45 meters and provides sonar range information from 15 cm to 6.45 meters with 2.5 cm precision.

This sensor has the following seven pins:

1. BW: This is a pin that can be used to select whether a TX output is required or not. When set high, the sensor is in 'chaining mode'. The TX output will then send a single pulse instead of a serial signal.

2. PW: This pin shows the pulse width representation of the measured distance. The scaling factor is 147uS per inch.

3. AN: this pin outputs an analogue signal with a scaling factor of Vcc/512 per inch. For example, if a voltage of 3.3V is applied to the input, the output voltage at this pin will be 6.5mV per inch. This is roughly equivalent to 2.6 mV per inch. This pin is used in this application to read the analogue distances.

4. RX: When this input is high (or just open), the sensor is in "ranging" mode.

5. TX: a serial signal is output from this pin when BW is low.

6. VCC: input voltage, can range from 3V - 5.5V.

7. GND

### PING Ultrasonic Sensor

The PING))) ™ ultrasonic sensor provides an easy method of distance measurement. This sensor is perfect for any numbers of applications that require you to perform measurements between moving or stationary objects.

Afbeelding met elektronica, Elektronische engineering

Automatisch gegenereerde beschrijving

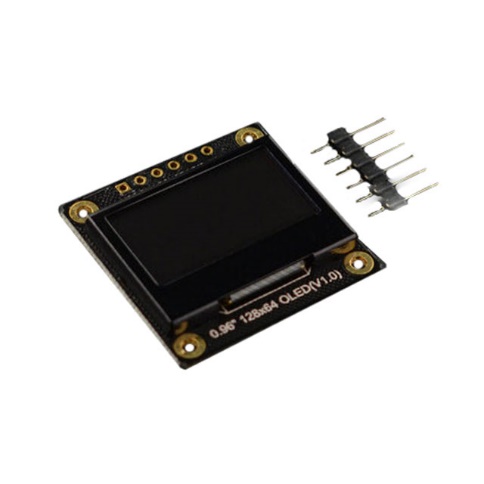
Interfacing to a microcontroller is a snap. A single I/O (input/output) pin is used to trigger an ultrasonic burst and then listen for the echo return pulse. The sensor measures the time required for the echo return and returns this value to the microcontroller.

Key features:

* Provides precise, non-contact distance measurements within a 3cm to 3m range.
* Simple pulse in/pulse out communication requires just one I/O pin.

### MONOCHROME Display

An OLED (organic light-emitting diode) has many advantages over traditional LCD displays, including a faster response speed, thinner profile, and lower power consumption. An OLED can be widely used in mobile devices for display applications.



The display areas are 0.96” and uses an IC SSD1306 chip. The screen supports I2C communication and refresh rates up to 60Hz. With a regular operating voltage of 3.3V ~ 5V, this display is easy to work together with a lot of microcontrollers.

### Analog distance sensor



Jasper geef wat informatie mee

### Digital distance sensor



Jasper geef wat informatie mee

## Methods

### Altium Designer

The electrical wiring schematics were created using Altium Designer, a professional-grade software widely used in the industry. Fortunately, our school provided us access to this powerful tool, enabling us to produce detailed designs for our project.

### Arduino IDE

The open-source Arduino software (IDE) is a powerful tool designed to simplify the development and deployment of code for Arduino boards. It provides an easy-to-use, user-friendly interface that allows both beginners and experienced developers to write, edit and upload code seamlessly.

### Oscilloscope

Jasper gaan we hier iets van de oscilloscope zetten of niet?

# Results

## Components

### PEPPERL & FUSHS Ultrasonic sensor

### Analog distance sensor

### LV-MaxSonar-EZ

## Total project

# User Experience

Beschrijf hier het resultaat vanuit gebruikersperspectief. Koppel de verschillende onderdelen die de gebruiker tegen kan komen aan de keuzes die gemaakt zijn en eventuele verbeteringen die nu nog mogelijk zijn. Een effectieve gebruikerstest door een panel is niet altijd mogelijk, maar indien die er is, voeg je die hier toe met de gegeven feedback en de bespreking ervan. De hoofd vraag is voornamelijk : hoe is er rekening gehouden met de gebruiker tijdens de ontwikkeling?

Zorg dat je hier niet in de technische details gaat die in resultaat staan, maar beantwoord wel volgende deelvragen : Hoe zal de gebruiker het product zien en kunnen hanteren? Welke onderdelen verbeteren de gebruikerservaring? Zijn er mogelijke verwarringen of foutieve manieren om het product te gebruiken? Welke veiligheid en/of begeleiding is er voorzien naar de gebruiker toe? Hoe is de leercurve van dit product? Wordt er bepaalde beginkennis verwacht van de gebruiker? Hoe zit het met functiebeperkte gebruikers?

# Discussion

Reflecteer en bespreek in dezelfde structuur als hierboven elk (deel)resultaat. Koppel het resultaat terug naar de onderzoeksvraag of een deelvraag of probleemstelling. Geef een verklaring aan de resultaten en durf iets te concluderen. Wat kan je uit de objectieve resultaten afleiden of concluderen ?

Zorg voor validiteit van het onderzoek. Waarom was het nuttig? Wat was de meerwaarde? Wat weet je nu meer? Wat mis je nog van informatie en kan je aanraden als vervolg?

Koppel elk eindresultaat aan de verwachtingen en maak suggesties voor verder onderzoek (i.e. Future work). Wat had je verwacht? Bewijst dit nu iets? Of waarom is het volgens jou niet gelopen zoals verwacht? Wat kan er nu verder onderzocht worden?

# Conclusion

Throughout this project, we have done thorough research on various sensors and the Arduino Nano to build our complete solution. Working with new sensors has helped each team member learn more about hardware. Exploring how different sensors work has been a valuable learning experience for everyone involved. We have encountered challenges and discovered new things along the way, which has made us more knowledgeable about hardware systems. As we move forward, we are excited to use what we have learned in future projects.

# Reference list

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# Attachment