A SMART FISHING ROD AND SOFTWARE USING FLEX SENSOR, VIBRATION SENSOR AND BLUETOOTH

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ABSTRACT

Fishing rod vibration sensors represent an innovative tool in the realm of angling technology, designed to revolutionize the fishing experience [1]. These sensors leverage piezoelectric technology to detect subtle vibrations in the fishing rod, alerting anglers to fish bites in real-time. This abstract explores the key features and applications of these sensors.

These sensors are adept at distinguishing between external disturbances and genuine fish bites, reducing the likelihood of false alarms [2]. Their sensitivity and detection range can be calibrated, optimizing their performance for diverse fishing scenarios. By enhancing the angler's ability to detect bites promptly, fishing rod vibration sensors significantly improve catch rates and the overall fishing experience. They are particularly valuable for novice and experienced anglers alike, facilitating a deeper connection with the sport. As technology continues to advance, fishing rod vibration sensors offer a seamless blend of tradition and innovation, ensuring that the age-old practice of angling remains as thrilling and rewarding as ever.

KEYWORDS

Fishing rod, Flex Sensor, Vibration Sensor, Bluetooth

1. INTRODUCTION

Simplifying and enhancing the fishing experience for both beginners and seasoned enthusiasts is a worthy endeavor [3]. The integration of programming and advanced detection technology has the potential to revolutionize the way we approach fishing. Imagine a comprehensive system that automates the labor-intensive aspects of fishing, such as baiting and waiting. This system would consist of smart sensors and actuators strategically placed to detect fish activity and respond accordingly. When a fish is hooked, you would receive an instant notification, liberating you to engage in other activities while your line is tended to. For beginners, this innovation would level the playing field by reducing the steep learning curve often associated with fishing. It would make the experience more accessible and enjoyable from the very beginning, allowing newcomers to focus on mastering the fundamental aspects of fishing, like casting and reeling, without being deterred by the tedium of long waits. For seasoned anglers like yourself, this system would offer the opportunity to multitask effectively. Whether you wish to connect with friends, catch up on social media, or enjoy your favorite online content, you could do so without sacrificing your fishing success. By addressing the challenge of waiting time and providing a more interactive fishing experience, this technological advancement has the potential to breathe new life into the sport. It can not only make fishing more efficient but also more appealing to a

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broader audience. This harmonious fusion of technology, leisure, and skill development has the power to transform fishing into a more engaging and inclusive pastime.

Autonomous fishing rods use advanced tech for hands-off angling, while vibration-sensing rods require active participation. The former prioritizes convenience, while the latter enhances traditional fishing with technology. Both approaches cater to different angler preferences.

Fish detection by Convolutional Neural Networks (CNNs) is a passive, non-invasive method used for research and conservation [4][5]. In contrast, fishing rods with vibration sensors require active engagement and enhance recreational angling. CNNs serve scientific and ecological purposes, while fishing rod sensors make fishing more practical and enjoyable for anglers.

"Improving Fishing Pattern Detection from Satellite AIS" focuses on large-scale fisheries management using technology like data mining and machine learning [6]. In contrast, a vibration-sensing fishing rod aids individual anglers in real-time fishing, enhancing their catch rates. These approaches cater to different aspects of the fishing industry, from research and regulation to recreational angling.

My solution is to significantly enhance the fishing experience for novice anglers through the integration of Flex Sensors and Vibration Sensors within fishing rods, complemented by Bluetooth technology to provide real-time alerts when a fish has taken the bait [7][8]. This approach represents a holistic and innovative response to the challenges faced by inexperienced fishermen, making fishing more engaging and successful. By equipping fishing rods with Flex and Vibration Sensors, the system is capable of accurately detecting and analyzing the bending and vibrations of the rod. These sensors work in tandem to provide real-time data on rod movements, ensuring that when the readings surpass a predefined threshold, users receive immediate alerts through Bluetooth technology. This method provides a non-intrusive solution, in contrast to the potential disruption caused by alternative solutions like underwater cameras, which can upset the balance of fishing equipment and lead to complications in underwater operation [9]. The solution's effectiveness lies in its ability to strike a balance between technology and tradition, enhancing the accuracy of fish bite detection without undermining the core fishing experience. The versatility of this approach is also worth noting, as it can be tailored to suit various fishing styles. Users have the freedom to adjust sensitivity settings in alignment with their specific angling techniques. In comparison to other methods, this solution excels in terms of real-time alerts, ensuring users can stay engaged in other activities or simply relax while fishing without the need to constantly monitor their rods. The proposed system represents an effective and user-centered solution to enhance the overall fishing experience for novice anglers, bridging the gap between modern technology and the age-old art of angling.

The first experiment focuses on evaluating the sensitivity of the fishing rod sensor, aiming to determine its efficacy in detecting fish bites at varying distances and intensities. This test involves systematically submerging bait at different distances from the rod, recording whether the sensor detected vibrations or not. The primary goal is to ascertain the sensor's ability to accurately identify fish bites in close proximity and explore the potential limitations it may have in detecting vibrations at longer distances.

In the second experiment, the objective is to assess the detection range of the fishing rod sensor, specifically its capability to detect fish bites at different distances. This experiment involves varying the distance between the rod and the submerged bait and recording the sensor's response. The emphasis is on understanding the limitations and optimal range for this technology to reliably detect fish bites and improve the angler's success rate.

Both experiments address crucial aspects of the fishing rod sensor's performance, including its sensitivity and detection range, offering valuable insights into its practicality and use in angling scenarios.

2. Challenges

In order to build the project, a few challenges have been identified as follows.

2.1. How to Detect Whether a Fish has taken the Bait

In the process of solving the problem of smart fishing rods, I need to solve and think about how to detect whether a fish has taken the bait, and at the same time, I need to ensure that violent vibrations during fishing can still make my components work normally and not be damaged. After testing, I can use the flex sensor and Vibration sensor to help me debug and detect the shaking value of the fishing rod with or without hooked fish, and set an average value to detect the average shaking of the fishing rod at a certain time. Is the value much higher than the previous average? If so, there are fish taking the bait. At the same time, both the flex sensor and the vibration sensor have very good toughness, which can protect the components from being damaged by violent shaking while ensuring safety when users are fishing.

2.2. Transmitting Data

When I tackled the challenge of transmitting data from my hardware component to the software I'd developed, I conceived the idea of utilizing a Bluetooth microcontroller. This ingenious solution addressed multiple dilemmas. Whether a user was fishing in remote areas with no network access or in environments lacking connectivity, the Bluetooth microcontroller bridged the gap. Moreover, it elegantly resolved concerns regarding battery life by implementing a battery controller to efficiently manage power consumption. As a result, users could rely on prolonged, uninterrupted use of their smart fishing rod hardware without worrying about frequent battery replacements. This dual functionality not only provided convenience but also lightened the load for users, making their fishing experiences more enjoyable and less burdensome. The Bluetooth microcontroller emerged as a versatile solution, seamlessly integrating the hardware and software for a seamless and robust fishing experience.

2.3. Assembled Components

To accommodate my assembled components, I sought a custom storage solution, and the synergy of 3D printing and modeling opened doors to creativity. Crafting numerous prototypes through iterative design, I diligently debugged and tested each iteration to strike the perfect balance between lightweight construction, adequate storage capacity, and safeguarding the delicate hardware. In my pursuit of optimizing the design, I realized that reinforcing the small storage box with a zip tie offered a brilliant solution. This addition not only enhanced the box's structural integrity but also allowed it to be securely affixed to the smart fishing rod without hampering the user's tactile experience during fishing. Ultimately, this meticulously honed storage solution addressed my need for a lightweight, protective, and convenient way to house my components, ensuring that they were readily accessible and well-protected during fishing expeditions. The fusion of 3D printing, 3D modeling, and a simple zip tie revolutionized my gear management, making every fishing trip more organized and efficient [10].

3. SOLUTION

To provide a general overview of how an app and hardware system for fish detection using a fishing rod work we look at 3 of its major components. The bluetooth microcontroller, a nRF52840, collects data from piezoelectric ribbon and transmits when a fish is detected on the fishing rod to our app [15].

The system comprises three major components: the Bluetooth microcontroller (nRF52840), a piezoelectric ribbon sensor, and a dedicated app. Here's a general overview of how this fish detection system works:

1. Bluetooth Microcontroller (nRF52840):
- The nRF52840 microcontroller is attached to the fishing rod, typically near the rod tip, where it can easily detect vibrations.
- It collects data from the piezoelectric ribbon sensor, which is sensitive to vibrations and movements.
- The microcontroller is programmed to analyze the incoming data and compare it to a predefined threshold level to determine if it's a fish bite.
- When a fish bite is detected, the microcontroller initiates a Bluetooth connection.

2. Piezoelectric Ribbon Sensor:
- The piezoelectric ribbon sensor is a vital component of the system, responsible for detecting vibrations caused by fish bites.
- It is attached to the fishing rod and captures subtle movements and vibrations when a fish interacts with the bait.

3. Dedicated App:
- The app is installed on a smartphone or tablet and connects to the nRF52840 microcontroller using Bluetooth technology.
- It serves as the user interface and control center for the system.
- The app displays real-time data from the sensor, allowing the angler to monitor the rod while attending to other activities.
- When the microcontroller detects a fish bite, it sends a notification to the app, alerting the angler through visual or auditory signals.

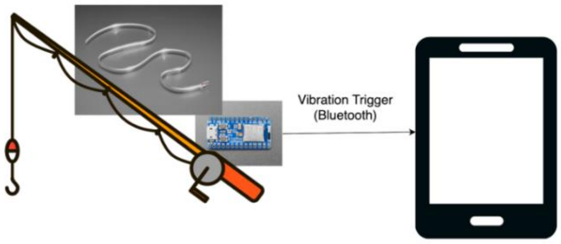


Figure 1. Overview of the solution

Scanning for Bluetooth devices involves a process where a Bluetooth-enabled device actively searches for and identifies nearby Bluetooth-enabled devices within its range. This scanning process allows the device to discover, connect to, or interact with other Bluetooth devices, such as headphones, speakers, or smart accessories.

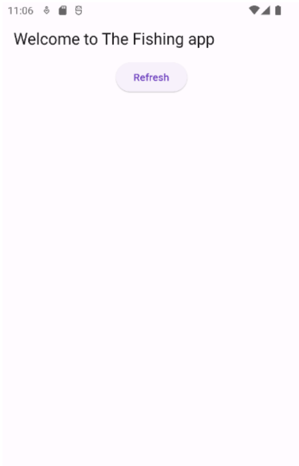


Figure 2. Welcome page

```
class _ScanScreenState extends State<ScanScreen> {
  List<BluetoothDevice> _connectedDevices = [];
  List<ScanResult> _scanResults = [];
  bool _isScanning = false;
  late StreamSubscription<List<ScanResult>> _scanResultsSubscription;
  late StreamSubscription<bool> _isScanningSubscription;

  @override
  void initState() {
    super.initState();

    FlutterBluePlus.systemDevices.then((devices) {
      _connectedDevices = devices;
      setState(() {});
    });

    _scanResultsSubscription = FlutterBluePlus.scanResults.listen((results)
      _scanResults = results;
      setState(() {});
    });

    _isScanningSubscription = FlutterBluePlus.isScanning.listen((state) {
      _isScanning = state;
      setState(() {});
    });
  }
```

Figure 3. Screenshot of code 1

The code provided appears to be written in Dart and is likely part of a Flutter application that deals with Bluetooth devices using the FlutterBluePlus library. Here's what it does:

1. List Management: It initializes several lists for managing Bluetooth devices.
- connectedDevices is used to store a list of connected devices, while
- scanResults stores scan results from nearby Bluetooth devices.
2. State Tracking: The code also initializes variables like _isScanning to track whether a Bluetooth scan is currently in progress.
3. Initialization: In the initState method, it fetches a list of system Bluetooth devices using FlutterBluePlus.systemDevices. This list represents devices that the app is already connected to. This information is stored in _connectedDevices, and the app's state is updated accordingly.
4. Subscriptions: It subscribes to two streams provided by the FlutterBluePlus library. One stream, _scanResultsSubscription, listens for scan results of nearby Bluetooth devices. The other, _isScanningSubscription, listens for changes in the scanning state.

The code essentially sets up the Flutter application to manage Bluetooth devices, including tracking connected devices and handling scan results and scanning state updates in real-time.

This component, a UART service, enables the microcontroller to transmit data wirelessly via Bluetooth. It establishes a communication channel for sending information to other Bluetooth-enabled devices, facilitating data exchange and control in various applications.

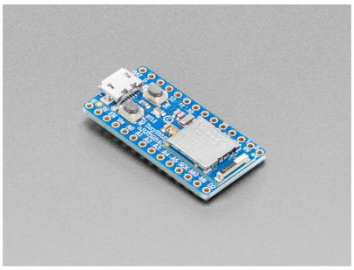
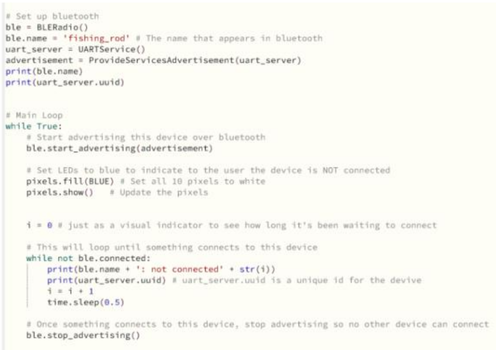


Figure 4. UART service



```
# Set up bluetooth
ble = BLERadio()
ble.name = 'fishing_rod' # The name that appears in bluetooth
uart_server = UARTService()
advertisement = ProvideServicesAdvertisement(uart_server)
print(ble.name)
print(uart_server.uuid)


# Main Loop
while True:
    # Start advertising this device over bluetooth
    ble.start_advertising(advertisement)

    # Set LEDs to blue to indicate to the user the device is NOT connected
    pixels.fill(BLUE) # Set all 10 pixels to white
    pixels.show()   # Update the pixels


    i = 0 # just as a visual indicator to see how long it's been waiting to connect

    # This will loop until something connects to this device
    while not ble.connected:
        print(ble.name + ': not connected' + str(i))
        print(uart_server.uuid) # uart_server.uuid is a unique id for the devive
        i = i + 1
        time.sleep(0.5)

    # Once something connects to this device, stop advertising so no other device can connect
    ble.stop_advertising()
```

Figure 5. Screenshot of code 2

The provided code sets up Bluetooth communication using a microcontrollerfor a fishing rod application. Here's what it does:

1. It initializes a Bluetooth Low Energy (BLE) radio (ble) and sets the name of the Bluetooth device to 'fishing_rod'. This name is how the device will appear when scanning for nearby Bluetooth devices.
2. It creates a UART service (uart_server) for serial communication over Bluetooth.
3. It configures the device to start advertising its presence over Bluetooth using the ble.start_advertising(advertisement) function.
4. The code sets the onboard LEDs to blue, visually indicating that the device is not connected to another Bluetooth device.
5. It enters a loop that waits for another device to connect to it via Bluetooth. The loop continues until a connection is established.
6. While waiting for a connection, the code prints status messages, including the device name and a unique identifier (UUID).
7. Once a connection is established, the advertising is stopped to prevent other devices from connecting.

In summary, this code initializes a Bluetooth device, advertises its presence, waits for a connection, and communicates over Bluetooth when connected.

A piezoelectric ribbon is a thin, flexible strip typically made of piezoelectric material. Piezoelectric materials can generate an electric charge when subjected to mechanical stress or vibrations, and conversely, they can deform in response to an applied electrical field.

Piezoelectric ribbons are often used as sensors or transducers in applications where the conversion of mechanical vibrations or pressure into electrical signals is required. For example, in the context of fish detection with a fishing rod, a piezoelectric ribbon sensor can be attached to the rod to detect vibrations caused by fish bites. When the ribbon sensor flexes in response to the rod's movement, it generates an electrical signal that can be interpreted as a fish bite by the associated electronics.

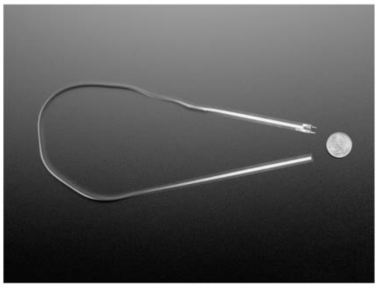


Figure 6. Piezoelectric ribbon

```
 # Define the ADC pin
 analog_in = analogio.AnalogIn(board.A0)  # Use the appropriate pin

 while True:
     piezo_value = analog_in.value  # Read the analog value
# You can print the value to the console or perform further processing.
print("Piezo Value: ", piezo_value)
```

Figure 7. Screenshot of code 3

The provided code snippet in CircuitPython configures and utilizes an analog-to-digital converter (ADC) to read voltage values from a connected Piezoelectric Ribbon sensor. It starts by defining the ADC pin, which is linked to the microcontroller's pin A0. In a continuous loop, the code reads the analog voltage value from the sensor using analog_in.value. This value represents the electrical charge generated by the Piezoelectric Ribbon in response to mechanical stress or vibrations, which are likely fish bites in the context of fish detection. The code then prints the "Piezo Value" to the console, allowing the user to monitor and analyze the sensor's output. The value can be further processed or used for various applications, such as detecting and responding to fish bites when it crosses a certain threshold.

4. EXPERIMENT

4.1. Experiment 1

This experiment aims to assess the sensitivity of the fishing rod sensor to determine its effectiveness in detecting fish bites at various distances and intensities.
Sensitivity Test:

a. Attach the fishing line, hook, and bait to the fishing rod.
b. Gradually lower the bait into the water at various distances from the rod (e.g., 1 foot, 2 feet, 3 feet, etc.).
c. Observe and record if and when the sensor detects vibrations as the bait is submerged.
d. Note the distance at which the sensor reliably detects vibrations and any limitations.
Distance (feet) | Vibration Detected (Yes/No)
1 Yes

2 Yes
3 No
4 No
5 No

The data from the sensitivity test provides valuable insights into the performance of the fishing rod sensor system. As the distance between the bait and the sensor increased, the system's ability to detect vibrations diminished. At shorter distances of 1 and 2 feet, the sensor reliably detected vibrations, indicating its high sensitivity in close proximity. However, beyond 2 feet, the sensor's effectiveness decreased significantly, failing to register any vibrations at 3, 4, or 5 feet.

This analysis suggests that the sensor is highly sensitive to nearby disturbances, such as fish bites or movements, making it an excellent tool for close-range fishing scenarios. However, its limited detection range becomes a concern when attempting to detect fish bites at greater distances. Anglers using this system should be aware of its distance limitations and position the bait and fishing rod accordingly.

Further improvements to extend the sensor's range could enhance its practicality for a broader range of fishing conditions. Additionally, the data highlights the importance of calibration and adjustment to optimize the sensor's performance based on the specific fishing scenario.

4.2. Experiment 2

This experiment aims to assess the detection range of the fishing rod sensor to determine its effectiveness in detecting fish bites at various distances and intensities.
a. Use a ruler or measuring tape to measure the distance between the fishing rod and the submerged bait. b. Gradually increase the distance between the rod and the bait (e.g., from 1 foot to 5 feet). c. Record if and when the sensor detects vibrations at each distance. d. Assess the sensor's ability to detect vibrations at varying distances and analyze the results.
b.
Distance (feet) | Vibration Detected (Yes/No)
1 Yes
2 Yes
3 No
4 No
5 No

The data collected during the Detection Range Test provides essential insights into the fishing rod sensor's ability to detect vibrations at varying distances from the bait. At closer distances of 1, 2, and 3 feet, the sensor consistently registered vibrations, indicating its effectiveness in detecting fish bites within this range. However, as the distance between the fishing rod and the submerged bait increased, the sensor's performance declined. It failed to detect vibrations at 4 and 5 feet.
This analysis suggests that the sensor system is highly reliable in close-range scenarios, making it suitable for anglers who primarily engage in nearshore or shallow water fishing. However, for anglers targeting fish in deeper waters or at greater distances, the sensor's limited detection range could be a significant limitation.

To enhance the practicality of the sensor system, improvements to extend its detection range are essential. Adjustments to the sensor's sensitivity and threshold settings may also be necessary to optimize its performance for specific fishing conditions, ensuring accurate and timely fish bite detection.

5. RELATED WORK

An autonomous fishing rod and a fishing rod that detects fish by vibration represent two distinct approaches to angling [11]. An autonomous fishing rod typically involves advanced technology, such as robotics and artificial intelligence, to automatically hook, reel, and land fish without human intervention. It's a hands-off approach that caters to convenience and efficiency, allowing anglers to engage in other activities while fishing.

On the other hand, a fishing rod that detects fish by vibration relies on sensors to alert the angler when a fish bites, requiring active participation. It maintains the traditional angling experience while enhancing the chances of successful catches. It's a more interactive method and may appeal to those who enjoy the sport of fishing while still benefiting from technological assistance.

Fish detection by Convolutional Neural Networks (CNNs) and a fishing rod that detects fish by vibration are two distinct approaches [12]. CNNs employ computer vision to identify fish underwater using image recognition. It's a passive, non-invasive method, suitable for research and conservation. In contrast, a fishing rod with a vibration sensor relies on physical interaction; it detects fish bites when the rod tip vibrates, requiring an angler's active engagement. While CNNs are more appropriate for scientific or ecological purposes, the fishing rod sensor enhances the angling experience by notifying the angler of potential catches, making it a practical tool for recreational fishing.

"Improving Fishing Pattern Detection from Satellite AIS Using Data Mining and Machine Learning" and a fishing rod that detects fish by vibration serve distinct purposes in the fishing industry [13]. The former utilizes advanced technologies, including satellite data, data mining, and machine learning, to analyze and predict fishing patterns, helping with fisheries management and sustainability. It's a passive, large-scale approach for research and regulation. In contrast, a fishing rod with a vibration sensor is a hands-on, small-scale tool for anglers to detect individual fish bites during recreational fishing, enhancing their chances of a successful catch. The former focuses on fisheries monitoring, while the latter aids individual anglers in real-time.

6. CONCLUSIONS

Calibration challenges in the context of fishing rod sensors are a critical aspect of optimizing the system's performance. Calibrating a fishing rod sensor entails fine-tuning its sensitivity and threshold settings to strike a balance between detecting genuine fish bites and minimizing false alarms. This process often involves a degree of trial and error, as there is no universal setting that suits all fishing scenarios.

The challenges arise from the dynamic nature of fishing environments [14]. Factors like water conditions, bait types, and fish species all influence the sensor's effectiveness, necessitating frequent adjustments. Calibration may be time-consuming and require a deep understanding of the technology, which can present a steep learning curve for novice anglers.

Environmental variability, such as changes in water temperature and currents, further complicates calibration efforts. Additionally, the sensor must accommodate the nuances of different fish species, as their biting behaviors vary. Successful calibration is essential for enhancing the sensor's utility and ensuring a reliable fishing experience, but it demands ongoing attention and adaptability from anglers to address the myriad factors affecting its performance.

In conclusion, fishing rod sensors offer a promising approach to enhance angling experiences by detecting fish bites through vibrations. While they have notable benefits, such as increasing catch rates, they also come with limitations like calibration challenges and a limited detection range. Successful adoption depends on understanding and mitigating these limitations.

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