WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Hyperion: An Arduino and ESP32-Based Water Quality Monitoring and Application-Controlled Feeding System for Optimized Milkfish (Chanos chanos) Production with Blynk IoT Integration

Basbas, Joeji Bon S[1], Mando, Anthony Jay B[2], Parreño, Aronrex Aris F.[3], Engr. Christian S. Englisa, CpE[4]

[1,2,3]Proponents, [4]Research Adviser
Davao City National High School

ABSTRACT

This study is focused on the bangus (milkfish) aquaculture industry in Davao Region, crucial to the local economy and food supply. Ensuring optimal water quality is essential, but traditional monitoring methods are labor-intensive and prone to inaccuracies. This research presents an Arduino and ESP32-based water sensor robot for enhanced bangus pond management. The system continuously monitors the water's health such as temperature, pH, and also an application-controlled feeding system that promotes accessibility and ease with feeding the bangus. An app is made for this robot to manually be used for manual checking and provide real-time data . The robot's design, development, deployment, and performance in improving water quality and management efficiency are evaluated in which the temperature sensor has an average error of 0.1 °C, the pH sensor having a 0.09 average error and the application-controlled feeding system having a 0.658% average error percentage. By automating monitoring, this research aims to boost the sustainability and productivity of bangus aquaculture in Davao and offers insights for global aquaculture practices.

KEYWORDS: Bangus aquaculture, Water quality monitoring, Arduino-based system, Automated feeding system, Productivity improvement, Davao Region industry, and Application usage

Introduction

Aquaculture is a vital industry worldwide, providing a significant source of food and income for many communities. Maintaining optimal water quality is crucial for ensuring the health and productivity of fish farms. Traditionally, monitoring water conditions and managing feeding schedules has been a labor-intensive process, often relying on manual inspections. These methods can be time-consuming, costly, and prone to human error, leading to inefficiencies. In places like Davao, where the bangus (milkfish) aquaculture industry plays a key role in the local economy and food supply, there is a growing need for more efficient and reliable approaches to manage water quality and automated feeding systems.

To address this challenge, this research explores the development and implementation of an Arduino-based water sensor robot aimed at enhancing the management of bangus fish ponds. The core objective of this study is to create a robotic system that automatically feeds the fish and continuously monitors and records vital water parameters—temperature and pH level—through the ChanoSense app. By automating these monitoring tasks, the proposed system seeks to minimize the need for frequent manual checks and provide real-time data to aquaculturists.

The innovative Arduino-based sensor robot utilizes the adaptability and cost-effectiveness of Arduino technology to offer a practical and scalable solution for aquaculture management. This study covers the design and development of the sensor robot, including the selection of suitable sensors, the integration of data collection and transmission components, and the system's deployment in actual fish cages. The research also evaluates the robot's performance in maintaining water quality and its impact on improving pond management efficiency.

By introducing a more precise and automated method for monitoring water quality and feeding, this research aims to significantly boost the sustainability and productivity of bangus aquaculture in Davao. The outcomes of this study are expected to benefit local fish farmers and contribute valuable insights and techniques to the broader field of aquaculture technology,

with potential applications in similar settings worldwide (Paul, B. 2018). With this, the prototype was designed to control and maintain optimum values for each measured parameter while providing an automatic feeding mechanism.

Methodology

A. Preparation and Collection of Material

Essential components include an Arduino microcontroller, the 2 sensors (pH level and temperature), an Application-Controlled Feeding System, an ESP-32 communication module, a solar Panel and a rechargeable LiPo/Li Ion battery. This systematic approach guarantees an efficient solution for enhancing milkfish cage management. And also, PVC pipes and plywood and styrofoam will be used for making the structural design of the robot to sustain low-cost expenses for the project.

Figure 1. *Collection of Material*

Figure 2. *Collection of Material*

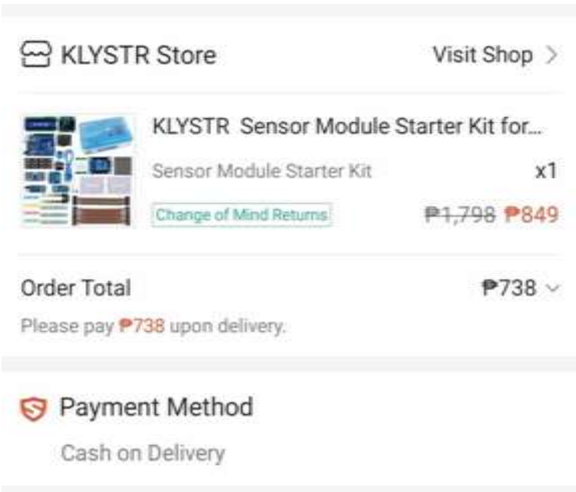


***Figure 3**. Collection of Materials*

B. Structural Design of the Robot

The robot is designed to have a tv-like structure to maximize its surface area for other components to fit in. PVC pipe will also be used as a float for the robot to minimize the cost of the researchers and to have a more stable floating raft for the structure. The 2 sensors will also be placed under the structure depending on the size of the parts, and the automatic feeder will be put above the robot or to be precise inside the half Reuleaux triangle.

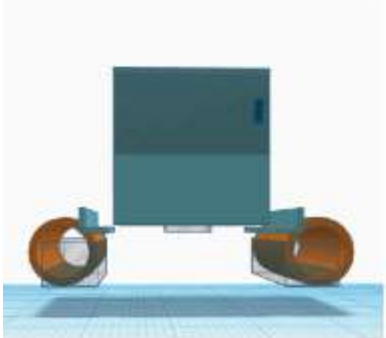


***Figure 4**. Structural Design of the Robot (Side)*

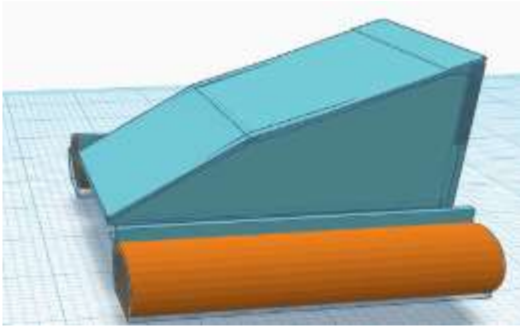


***Figure 4**. Structural Design of the Robot (Front)*

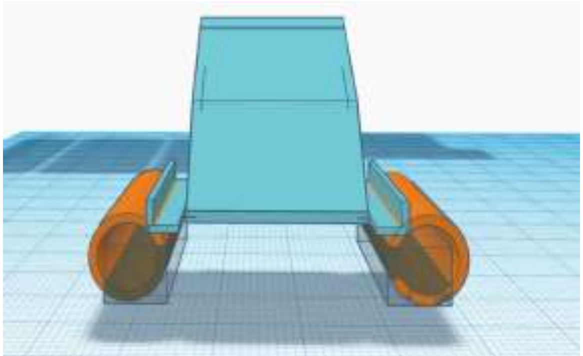


***Figure 5**. Structural Design of the Robot (Back)*

***Figure 6.** Structural Design of the Robot (Inside)*

C. Calibration of Sensors

Calibrating sensors is a vital part of creating and using an Arduino and ESP32-based water sensor robot designed for optimizing bangus fish ponds. This step is crucial for ensuring that the data collected by the 2 sensors—pH level and temperature—is accurate and reliable, which is essential for maintaining good water quality. To calibrate each sensor, you typically follow the manufacturer's instructions. This process often involves exposing the sensors to known reference standards and adjusting their readings accordingly. calibrated using buffer solutions with specific pH values, while a temperature sensor might calibrate the water's temperature. After calibration, the sensors should be tested in a controlled environment to confirm their accuracy. Regular recalibration is also necessary to address any changes in sensor performance over time. By ensuring proper calibration, the robot can provide trustworthy data, which is crucial for effectively monitoring and managing the conditions in the fish cage over time.

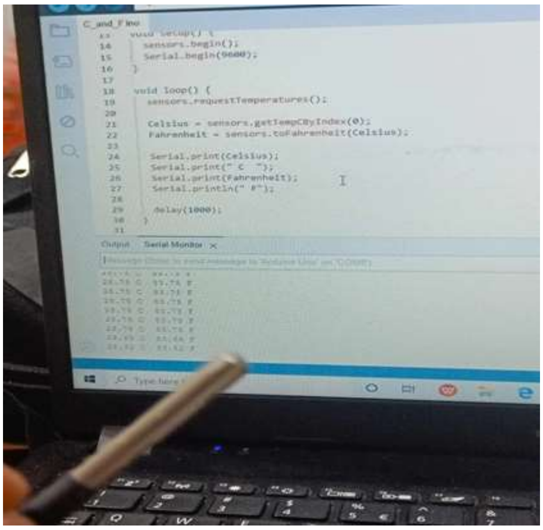


Figure 7: *Calibration of Temperature Sensor*

D. Coding and Programming

Coding and programming are fundamental steps in the development of an Arduino and ESP32-based water sensor robot, determining the robot's functionality and efficiency. This phase begins with developing the code that enables the Arduino Uno R3 microcontroller to interface with the 2 sensors, the pH level and temperature. The primary task is to write code that accurately reads data from these sensors. This typically involves using Arduino libraries and functions specific to each sensor type, ensuring precise data acquisition. control algorithms must be implemented. These algorithms process the sensor data and send it to the user through the app and the user can also control the feeding system through the app.For instance, the application automatically displays the pH and the Temperature level from the readings of the sensor. The code must be tested and debugged extensively to ensure reliability and robustness. Any issues discovered during testing are addressed through iterative refinement of the code. This comprehensive coding and programming step ensures that the robot can autonomously monitor and systematically control the feeding of the fish, effectively optimizing conditions for the health and growth of bangus fish, while also saving time through the application-controlled feeding system, which ensures precise and consistent feeding without the need for manual intervention. Also, the development of integrating the Blynk IoT software was very helpful for the creation of a device capable of automatically displaying the pH and temperature level of the water surrounding the fish cage.

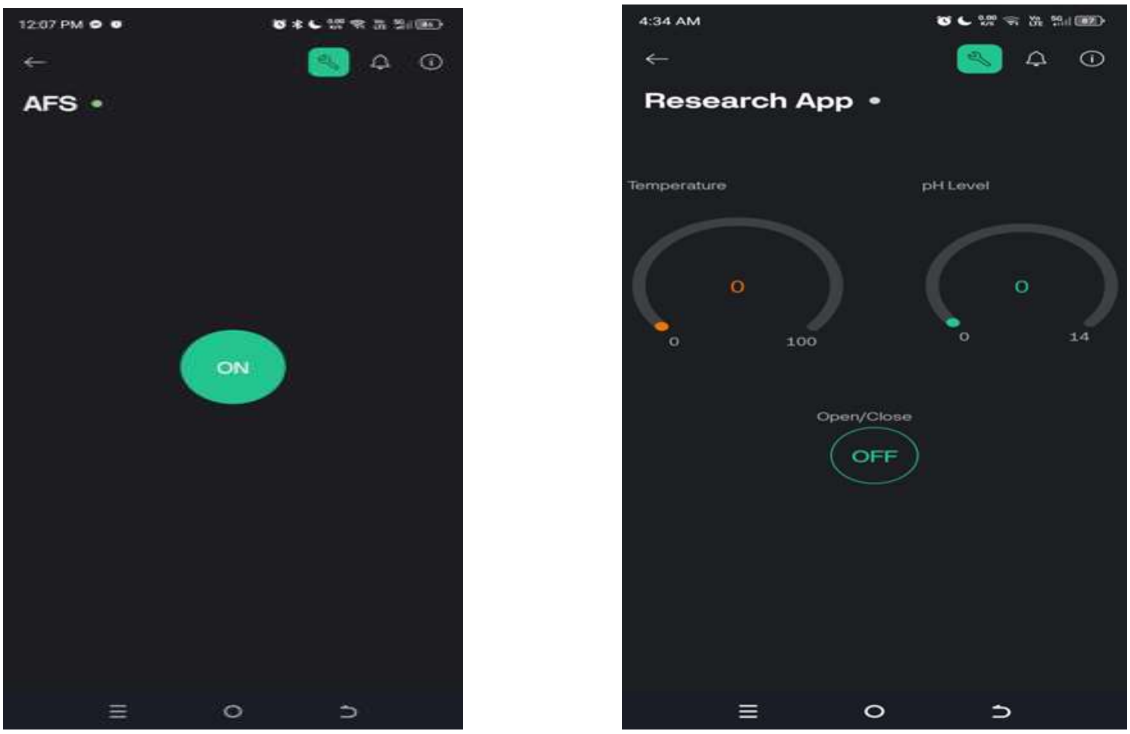


Figure 8. *Blynk IoT Device*

Figure 10. *Front-End Blynk Web Dashboard*

Figure 9. *Blynk Datastream programming*

Figure 11. *Back-End Blynk Web Dashboard*

E. Deployment Preparation

Adjustments to the programming and hardware setup are essential after the initial test results to enhance performance. It's crucial to ensure that the deployment site, such as a fish cage or ponds, is equipped with the necessary infrastructure. This means checking for reliable power sources and sufficient WiFi range. Environmental factors also play a significant role; the robot must be capable of withstanding local weather conditions and the specific characteristics of the water. By preparing thoroughly for deployment, the risk of operational failures is minimized, and the robot's efficiency in monitoring and managing the pond environment is maximized. This preparation ultimately contributes to the health and productivity of the bangus fish and timesaving for the farmers (Grothmann et al., 2010). .

Conceptual Framework

This is designed to streamline and enhance aquaculture practices through automation. At its core, this framework integrates real-time monitoring of key water quality parameters—specifically temperature and pH levels—using Arduino-based sensors. These environmental factors are vital for the health and growth of milkfish in aquaculture systems.

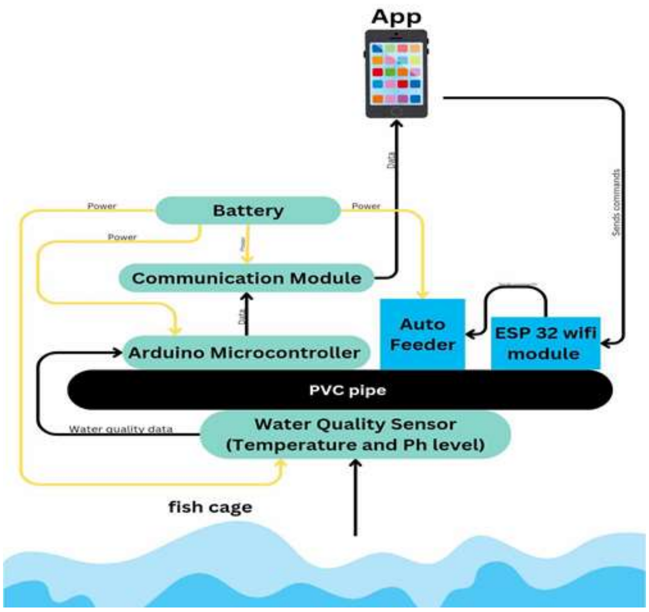


Figure 12. *Testing Set-Up Diagram*

At its core, the framework integrates water quality sensors (for measuring temperature and pH levels) with a Blynk IoT platform that controls feeding processes. By automating the monitoring of critical parameters like temperature and pH, the system provides continuous, real-time data, reducing the need for manual inspections that are often labor-intensive and prone to human error.

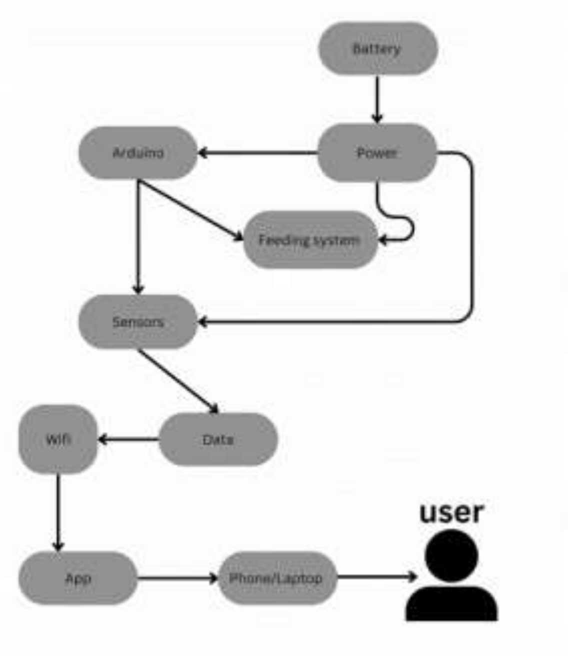


Figure 13. *Communication Flow Chart*

Additionally, the automated feeding system dispenses food based on real-time water conditions, which helps in preventing overfeeding and optimizing feed usage, leading to reduced waste and cost. This automated process is further enhanced by the Blynk IoT integration, allowing for remote management and monitoring, which makes it more accessible and efficient for farmers.

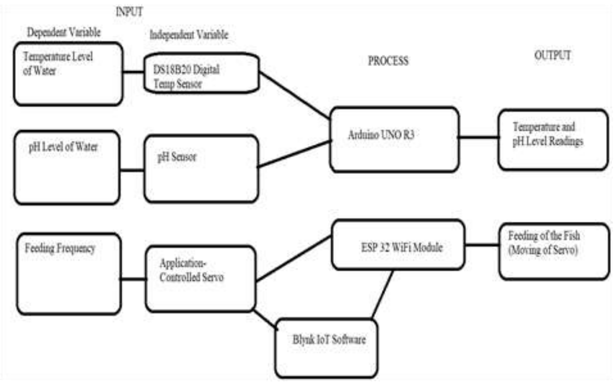


Figure 14. *Flow Chart*

This illustrates the process of monitoring water parameters and controlling fish feeding in a bangus aquaculture system. The input section includes three dependent variables: water temperature, pH levels, and feeding frequency. These inputs are monitored or controlled through respective sensors: a DS18B20 digital temperature sensor for water temperature, a pH sensor for pH levels, and an application-controlled servo for feeding frequency. The Arduino UNO R3 processes the sensor data, while the ESP32 WiFi module, connected to the Blynk IoT software, controls the manual feeding system. The outputs include real-time readings of temperature and pH levels and automated feeding of the fish through the servo motor.

For Temperature Sensor

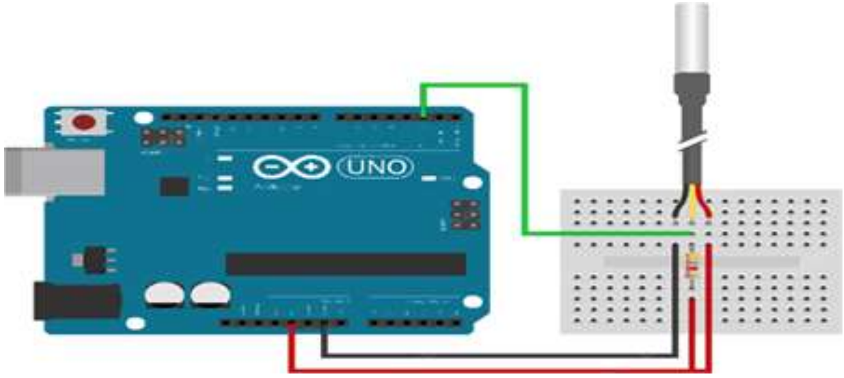


Figure 14. Schematic Diagram for Temp Sensor

For pH sensor

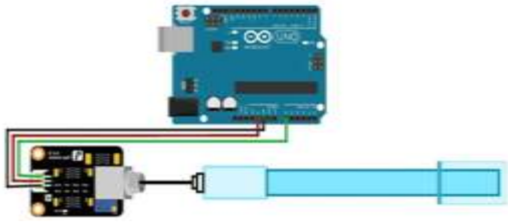


Figure 15. *Schematic Diagram or pH Sensor*

For Servo

Schematic Diagram

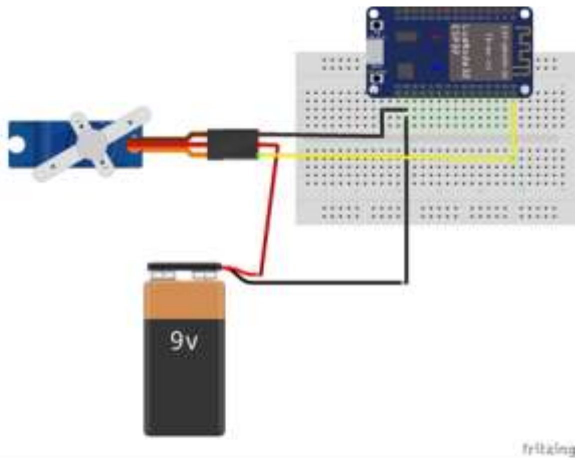


Figure 16. *Schematic Diagram for Servo*

Risk and Safety

The development and deployment of an Arduino and ESP32-based water sensor robot for bangus fish ponds involve several safety considerations. Electrical safety; components must be insulated to prevent electric shocks or short circuits. Mechanical safety; with moving parts needing enclosures to avoid injury, and clear safety instructions for users. Chemical safety should be managed by using corrosion-resistant materials and regular maintenance to prevent contamination. Environmental impact must be minimized to protect local ecosystems, with careful design and environmental assessments. Operational safety involves preventing accidents during deployment and retrieval, with proper training and safety equipment for personnel. Data security is essential if the robot transmits information wirelessly; encryption and secure protocols should be used. Battery safety must be addressed by using certified batteries and incorporating monitoring features to prevent overheating or leakage. Addressing these risks through thoughtful design and maintenance is key to ensuring safe and effective operation of the sensor robot.

Results and Discussion

This study monitored water temperature, pH levels, and used an Application-Controlled Feeding System to improve milkfish farming. Water temperature plays a crucial role in fish growth and survival. According to the sensor readings, the temperature fluctuated between 24°C and 29°C, which is well within the ideal range for tropical species like bangus. These values align with established guidelines, which indicate that "Tropical species will die at temperatures of 10 to 20 degrees-C, and most do not grow at temperatures below 25 degrees-C." (Boyd C., 2018). While the temperature occasionally dropped slightly below 25°C, it remained close enough to avoid any negative impact on growth rates. The system's ability to continuously monitor and maintain the temperature around 25°C ensured that the fish remained in a growth-conducive environment, minimizing the risk of poor health or stunted development.

The pH level is another critical factor for the health of fish in aquaculture. The data collected indicated that the pH levels ranged from 7.1 to 8.3, which is considered optimal for fish farming, staying within the acceptable range of pH 6.5 to 9.0 for fish culture. As referenced, "A value of 7 is considered neutral, neither acidic nor basic; values below 7 are considered acidic; above 7, basic." (n.d., 2024). The relatively neutral pH levels recorded suggest a stable aquatic environment, preventing stress or harmful conditions for the fish. The monitoring system's real-time data transmission allowed immediate corrective actions if the pH levels showed signs of deviating from the acceptable range, helping to maintain a balanced environment. The feeding system in the prototype was operated manually through the Blynk app, where users had to press a button to dispense food. This manual system ensured control over the timing and quantity of food released, reducing the risk of overfeeding. The data from the prototype showed that the manual feeding process worked effectively in conjunction with the environmental monitoring, allowing farmers to feed the fish at the optimal times based on real-time water quality conditions.

Significant improvements in maintaining stable pH level and temperature indicate that the Arduino and ESP32-based system was effective in measuring and feeding efficiency which can lead to enhancing productivity in fish pond management. The data analysis section would find that the application-controlled system considerably improves the sustainability and production of the bangus aquaculture business by providing superior water quality control with less manual involvement and an efficient feeding system to avoid over feed.

Day	Sensor Temp (°C)	Reference Temp (°C)	Error (°C)	Sensor pH	Reference pH	Error (pH)
1	27.2	27	0.2	7.4	7.3	0.1
2	28.1	28	0.1	7.6	7.5	0.1
3	26.9	27.1	-0.2	7.5	7.4	0.1
4	25.8	26	-0.2	7.8	7.7	0.1
5	27	27.1	-0.1	7.4	7.3	0.1
6	27.5	27.4	0.1	7.3	7.4	-0.1
7	28.3	28.2	0.1	7.5	7.6	-0.1
8	26.4	26.5	-0.1	7.6	7.5	0.1
9	27.6	27.7	-0.1	7.7	7.6	0.1
10	27.2	27.1	0.1	7.4	7.3	0.1
11	26.9	27	-0.1	7.3	7.2	0.1
12	28	28.1	-0.1	7.5	7.4	0.1
13	27.4	27.3	0	7.6	7.6	0
14	27.9	28	-0.1	7.8	7.7	0.1
15	27.8	27.5	-0.3	7.9	7.8	0.1

Table 1. *Data Gathered from the pH and Temperature Sensor with Reference Devices Used.*

The first table involves gathering daily pH and temperature readings from the sensors over a 15-day period. Consistency is key in this stage, as the readings must be taken at the same time each day to minimize the influence of daily environmental fluctuations. This regularity helps maintain uniformity across all data points, allowing for an accurate assessment of the sensor's performance. Once the sensor readings are recorded, they are compared to a reliable benchmark, such as a calibrated commercial pH/temperature meter. These reference tools are known for their accuracy, and comparing the sensor data to these established standards is necessary to validate whether the sensors are functioning correctly. The reference temperature and pH indicates the results of the commercially used meter for its credibility. If the sensors consistently produce readings that align with the benchmark, it indicates that they are reliable and accurate.

Test Day	Expected Amount (grams)	Dispensed Amount (grams)	Error (grams)	Error Percentage (%)
1	500	505	5	1%
2	800	795	-5	-0.63%
3	1,000	1,000	0	0%
4	600	605	5	0.83%
5	700	690	-10	-1.43%
6	900	910	10	1.11%
7	1,200	1,210	10	0.83%
8	1,500	1,495	-5	-0.33%
9	1,800	1,790	-10	-0.56%
10	2,000	2,005	5	0.25%
11	500	505	5	1%
12	800	805	5	0.63%
13	1,000	1,010	10	1%
14	1,400	1,395	-5	-0.36%
15	2,000	1,990	-10	-0.50%

Table 2. *Accuracy Test of the Application-Controlled Feeding System (500g to 2kg Range)*

This table is for the accuracy test of the application-controlled feeding system that is critical to ensure that the system performs as expected in real-world conditions, especially in applications like aquaculture where precise control over feeding is crucial. The purpose of this test is to verify that the system consistently dispenses the correct amount of food according to pre-set values, within an acceptable margin of error.

Results and Discussion

The development of the Arduino and ESP32-based water sensor robot for bangus cages yielded promising results, highlighting its effectiveness in enhancing aquaculture management. The robot successfully monitored critical water parameters, such as temperature and pH levels, providing real-time data that enabled timely adjustments to maintain optimal conditions for fish health. Additionally, the automated feeding system operated efficiently, dispensing food at programmed intervals, which reduced manual intervention and improved feeding consistency.

For Table 1., we applied the formula for **margin of error** (or **absolute error**) to determine how accurately the sensors for **temperature** and **pH** are performing over a 15-day period.

Error = |Sensor Value−Reference Value|

Where:

Sensor Value is the reading taken from the system's sensor (either temperature or pH).

Reference Value is the reading taken from a calibrated, reliable benchmark tool (e.g., a high-accuracy pH meter or thermometer).

Once we have the absolute errors for all 15 days, the next step is to compute the average error. The average error provides an overall assessment of how well the sensor is performing across the entire testing period.

Average Error:

=15∑Absolute Errors /15 Days

For temperature:

For the 15 days, we sum up all the individual absolute errors and divide by 15 (the total number of days). For example, the error values over the 15 days might look like: **0.2, 0.1, 0.2, ...**, and we compute:

Average Error for Temperature:

Error (°C)
0.2
0.1
-0.2
-0.2
-0.1
0.1
0.1
-0.1
-0.1
0.1
-0.1
-0.1
0
-0.1
-0.3

Table 3. *Errors for Temperature*

Temperature= 0.2+0.1+0.2+0.2+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0+0.1=1.5

1.5/15 = 0.1 °C

This gives us an **average temperature error of 0.1°C**, which indicates that the temperature sensor is very precise, with only minor fluctuations from the reference readings. The errors in the sensor's readings are relatively small, and the average error of 0.1 suggests that the system is operating with high accuracy. This indicates that the system is well-calibrated, and there is little deviation from the reference measurements. This level of precision is crucial for applications where small changes in temperature or pH can significantly impact outcomes in aquaculture.

Average Error for pH:

Error (pH)
0.1
0.1
0.1

0.1
0.1
-0.1
-0.1
0.1
0.1
0.1
0.1
0.1
0
0.1
0.1

Table 4. *Errors for pH*

pH= 0.1+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0.1+0+0.1=1.3

1.3/15= 0.0867 ≈ 0.9

This result shows that, on average, the pH sensor deviates by 0.09 units from the reference values, a very minor inaccuracy that confirms the sensor's accuracy. Such a little variance indicates that the sensor is extremely dependable, producing consistent and trustworthy results during the 15-day test period. A variance of 0.09 is well within the allowed range for most aquaculture applications, indicating that the water pH is effectively monitored for optimal fish health. As a result, the pH sensor's accuracy enables the system to maintain consistent water conditions, boosting fish health and lowering the chance of errors in feeding and water management.

For Table 2., the table depicts an accuracy test carried out over 15 days in which the system dispensed varied amounts of food ranging from 500 grams to 2,000 grams. The test compares the predicted food amount, which is a predetermined figure for each day, to the dispensed amount, which is the amount of food delivered by the system. This comparison enables us to compute the error (the difference between expected and dispensed amounts) and the error percentage for each day. The error % is computed using the following formula:

Error (grams)	Error Percentage (%)
5	1%
-5	-0.63%
0	0%
5	0.83%
-10	-1.43%
10	1.11%
10	0.83%
-5	-0.33%
-10	-0.56%

5	0.25%
5	1%
5	0.63%
10	1%
-5	-0.36%
-10	-0.50%

Table 5. *Error and Error Percentage of the Accuracy Test of the Application-Controlled Feeding System (500g to 2kg Range)*

The average error and average error percentage are used to assess the performance and accuracy of the Application-Controlled Feeding System in delivering food to the fish. These metrics are crucial for evaluating how well the system is functioning, ensuring that the correct amount of food is dispensed consistently over time. By calculating the average error, we can determine whether the system tends to overfeed or underfeed, which could affect the health of the fish and the efficiency of the aquaculture operation. A low average error indicates that the system is performing reliably, consistently dispensing the desired amount of food within a narrow margin of error.

The **average error** is calculated by summing up the **absolute errors** for all 15 days and dividing by the number of days the same for the **average error percentages.**

Average Errors:

5+5+0+5+10+10+10+5+10+5+5+5+10+5+10= 85

85/15 = 5.67 grams

Average Error Percentage: 1+0.625+0+0.83+1.43+1.11+0.83+0.33+0.56+0.25+1+0.625+1+0.36+0.5=9.87%

9.87/15 = 0.658%

These findings indicate that, on average, the system dispenses food with an error of roughly 5.67 grams per day and an error percentage of around 0.66%. This implies that the feeding system is very accurate and works within acceptable limits for aquaculture operations. A limited margin of error ensures that fish receive the proper quantity of nutrition, avoiding problems such as overfeeding, which can lead to water contamination, and underfeeding, which can hamper fish growth. Furthermore, the consistency of the error indicates that the system is dependable for long-term usage, making it an effective tool for aquaculture managers seeking to maintain appropriate feeding schedules while lowering operational expenses. This level of precision is crucial to preserving the health and production of fish.

Conclusion

In conclusion, the development and deployment of the Arduino and ESP32-based water sensor robot with an application-controlled feeding system, have demonstrated significant potential in optimizing bangus fish cages management in Davao. The system's ability to automatically feed the fish, continuously monitor and record essential water quality, provides aquaculturists with accurate, real-time data and work-saving, thereby reducing the need for labor-intensive manual inspections. This automated approach not only enhances the efficiency and reliability of water quality management but also contributes to the sustainability, productivity and time efficiency of the bangus aquaculture industry. It is recommended that further research and investment be directed towards refining the technology, including enhancing sensor accuracy, adding more sensors to further enhance its water quality checking, expanding data transmission or range capabilities and install actuators and pumps to not only check water quality but also add an action if needed. Also, using a better material for the structure is recommended for safety and durability reasons. Lastly, training local fish farmers in the use of this system can maximize its benefits, ensuring broader adoption and a more profound impact on the aquaculture sector (Wang Y., Chi Z. 2016).

References

Paul, B. (2018). *Sensor based water quality monitoring system (Doctoral dissertation, BRAC University).*https://dspace.bracu.ac.bd/xmlui/handle/10361/10840

Castilla Mena, M. L. (2020). *Sensor Platform for Algae Growth and Water Temperature Monitoring.* https://repositorio.comillas.edu/xmlui/handle/11531/44497

Garcia, S. M. P., Santos, C. L. B., Briones, K. M. E., Reyes, S. M. L., Macasaet, M. A. G., & Pula, R. (2020).

Automated Water Quality Monitoring and Control for Milkfish Pond. In World Congress on Engineering and Technology; Innovation and its Sustainability 2018 1 (pp. 129-139). Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-030-20904-9_10

Wang, Y., & Chi, Z. (2016, July).*System of wireless temperature and humidity monitoring based on Arduino Uno platform. In 2016 Sixth International Conference on Instrumentation & Measurement, Computer, Communication and Control (IMCCC) (pp. 770-773). IEEE.* https://ieeexplore.ieee.org/abstract/document/7774887/

McLean, K. M., Pasulka, A. L., & Bockmon, E. E. (2021). *A low-cost, accessible, and high-performing Arduino-based seawater pH control system for biological applications. HardwareX, 10, e00247.* https://www.sciencedirect.com/science/article/pi i/S2468067221000778

ALASCO, R., DOMDOMA, E. A., DORIA, K. A., RICAFRANCA, K. M., SAITO, Y. E., ARAGO, N., & Galido, E. (2018, November).

SoilMATTic: Arduino-based automated soil nutrient and pH level analyzer using digital image processing and artificial neural network. In 2018 IEEE 10th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM) (pp. 1-5). IEEE. https://ieeexplore.ieee.org/abstract/document/8666264/

Grothmann, A., Nydegger, F., Häußermann, A., & Hartung, E. (2010). *Automatic feeding system (AFS)-potential for optimisation in dairy farming. Landtechnik, 65(2), 129-131.*

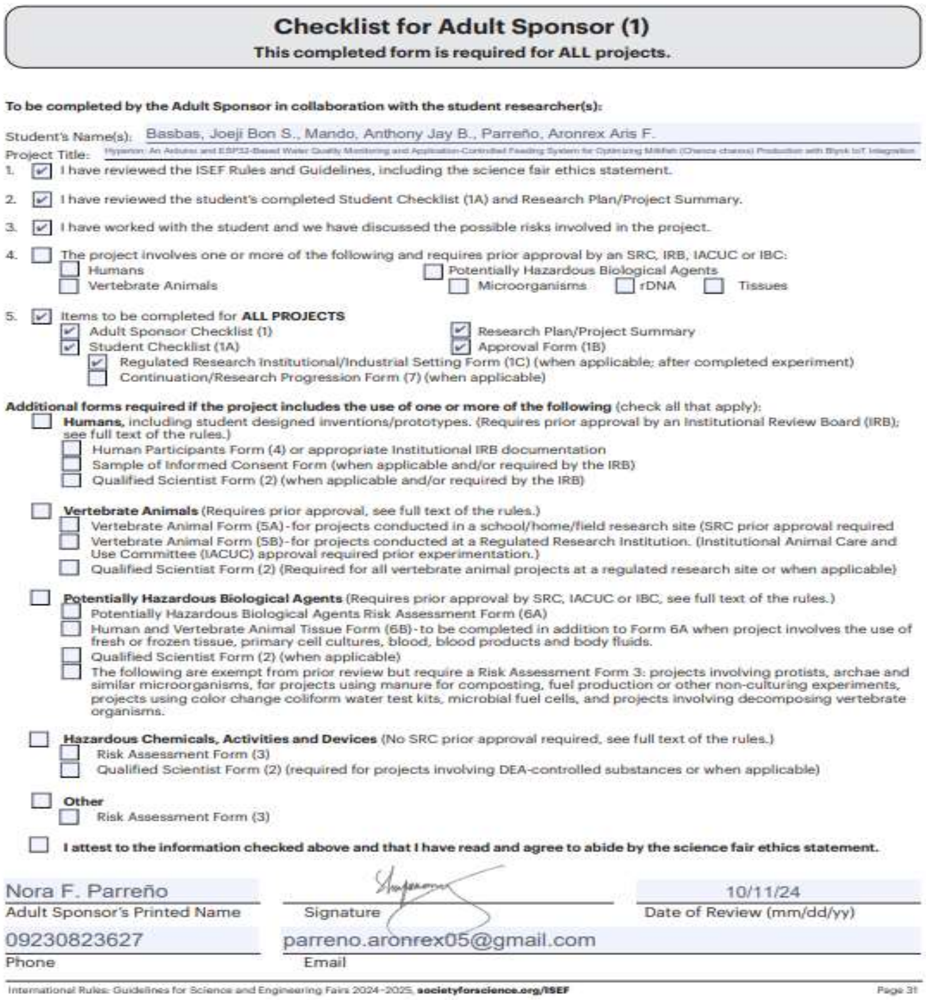
https://scholar.archive.org/work/mhbywm2nbnfmjifzw5a6jutxhe/access/wayback/https://www.landtechnik-online.eu/ojs-2.4.5/index.php/landtechnik/article/viewFile/2010-2-129-131/987

Claude E. Boyd, Ph.D. (2018). Water temperature in aquaculture. https://www.globalseafood.org/advocate/water-temperature-in-aquaculture/#:~:text=Warmwater%20species%20will%20usually%20not,temperatures%20below%2025%20degrees%2DC

Importance of Water Quality in Aquaculture. (n.d.) *pH in FishFarming.* https://www.yokogawa.com/ph/library/resources/application-notes/ph-in-fish-farming/#:~:text=A%20value%20of%207%20is,normally%20between%20pH%206.5%2D%209

Appendices:

3.1.1 Form 1 - Checklist for Adult Sponsor



Checklist for Adult Sponsor (1)

This completed form is required for ALL projects.

To be completed by the Adult Sponsor in collaboration with the student researcher(s):

Student's Name(s): Basbas, Joeji Bon S., Mando, Anthony Jay B., Parreño, Aronrex Aris F.

Project Title: Hyperion: An Arduino and ESP32-Based Water Quality Monitoring and Application-Controlled Feeding System for Optimizing Milkfish (Chanos chanos) Production with Blynk IoT Integration

1. [✓] I have reviewed the ISEF Rules and Guidelines, including the science fair ethics statement.
2. [✓] I have reviewed the student's completed Student Checklist (1A) and Research Plan/Project Summary.
3. [✓] I have worked with the student and we have discussed the possible risks involved in the project.
4. [ ] The project involves one or more of the following and requires prior approval by an SRC, IRB, IACUC or IBC:
   - [ ] Humans
   - [ ] Vertebrate Animals
   - [ ] Potentially Hazardous Biological Agents
     - [ ] Microorganisms [ ] rDNA [ ] Tissues
5. [✓] Items to be completed for **ALL PROJECTS**
   - [✓] Adult Sponsor Checklist (1)
   - [✓] Student Checklist (1A)
     - [✓] Regulated Research Institutional/Industrial Setting Form (1C) (when applicable; after completed experiment)
     - [ ] Continuation/Research Progression Form (7) (when applicable)
   - [✓] Research Plan/Project Summary
   - [✓] Approval Form (1B)

Additional forms required if the project includes the use of one or more of the following (check all that apply):

[ ] **Humans,** including student designed inventions/prototypes. (Requires prior approval by an Institutional Review Board (IRB); see full text of the rules.)
- [ ] Human Participants Form (4) or appropriate Institutional IRB documentation
- [ ] Sample of Informed Consent Form (when applicable and/or required by the IRB)
- [ ] Qualified Scientist Form (2) (when applicable and/or required by the IRB)

[ ] **Vertebrate Animals** (Requires prior approval, see full text of the rules.)
- [ ] Vertebrate Animal Form (5A)-for projects conducted in a school/home/field research site (SRC prior approval required
- [ ] Vertebrate Animal Form (5B)-for projects conducted at a Regulated Research Institution. (Institutional Animal Care and Use Committee (IACUC) approval required prior experimentation.)
- [ ] Qualified Scientist Form (2) (Required for all vertebrate animal projects at a regulated research site or when applicable)

[ ] **Potentially Hazardous Biological Agents** (Requires prior approval by SRC, IACUC or IBC, see full text of the rules.)
- [ ] Potentially Hazardous Biological Agents Risk Assessment Form (6A)
- [ ] Human and Vertebrate Animal Tissue Form (6B)-to be completed in addition to Form 6A when project involves the use of fresh or frozen tissue, primary cell cultures, blood, blood products and body fluids.
- [ ] Qualified Scientist Form (2) (when applicable)
- [ ] The following are exempt from prior review but require a Risk Assessment Form 3: projects involving protists, archae and similar microorganisms, for projects using manure for composting, fuel production or other non-culturing experiments, projects using color change coliform water test kits, microbial fuel cells, and projects involving decomposing vertebrate organisms.

[ ] **Hazardous Chemicals, Activities and Devices** (No SRC prior approval required, see full text of the rules.)
- [ ] Risk Assessment Form (3)
- [ ] Qualified Scientist Form (2) (required for projects involving DEA-controlled substances or when applicable)

[ ] **Other**
- [ ] Risk Assessment Form (3)

[ ] **I attest to the information checked above and that I have read and agree to abide by the science fair ethics statement.**

Nora F. Parreño	[signature]	10/11/24
Adult Sponsor's Printed Name	Signature	Date of Review (mm/dd/yy)
09230823627	parreno.aronrex05@gmail.com	
Phone	Email	

International Rules: Guidelines for Science and Engineering Fairs 2024-2025, **societyforscience.org/ISEF** Page 31

3.1.2 Form 1A - Student Checklist

Student Checklist (1A)

This form is required for ALL projects.

1. a. Student/Team Leader: Basbas, Joeji Bon S. Grade: 12-Dalton

   Email: bonbonvip82@gmail.com Phone: 0994-679-1794

   b. Team Member: Mando, Anthony Jay B. c. Team Member: Parreño, Aronrex Aris F.

2. Title of Project: [illegible]

3. School: Davao City National Highschool School Phone: (082) - 227901

   (if multiple schools, list of the team leader or list all schools).

School Address: F. Torres Street 8000 Davao City, Philippines

4. Adult Sponsor: Nora F. Parreño Phone/Email: parreno.aronrex05@gmail.com

5. Does this project need SRC/IRB/IACUC or other pre-approval? ☐ Yes ☒ No Tentative start date: ________

6. Is this a continuation/progression from a previous year? ☐ Yes ☒ No

   If Yes:

   a. Attach the previous year's ☐ Abstract **and** ☐ Research Plan/Project Summary

   b. Explain how this project is new and different from previous years on ☐ Continuation/Research Progression Form (7)

7. This year's experimentation/data collection:

   09-20-24 — Actual Start Date: (mm/dd/yy)

   10-05-24 — End Date: (mm/dd/yy)

8. Where will you conduct your experimentation? (check all that apply)

   ☐ Research Institution ☐ School ☑ Field ☐ Home ☐ Other: ________

9. Source of Data:

   ☑ Collected self/mentor ☐ Other Describe/url: ________

10. List the name and address of all non-home and non-school work site(s), whether you worked there virtually or on-site:

Name: Natures Garden Building - JohnJames Garments

Address: Palma Gil Street, Obrero, Davao City

Phone/email: 0923-082-3627

11. **Complete a Research Plan/Project Summary following the Research Plan/Project Summary instructions and attach to this form.**

12. **An abstract is required for all projects after experimentation.**

Research Plan/Project Summary Instructions

A complete Research Plan/Project Summary is required for ALL projects and must accompany Student Checklist (1A).

- All projects must have a Research Plan/Project Summary
  a. The Research Plan is to be written prior to experimentation following the instructions below to detail the rationale, research question(s), methodology, and risk assessment of the proposed research.
  b. If changes are made during the research, such changes can be added to the original research plan as an addendum, recognizing that some changes may require returning to the IRB or SRC for appropriate review and approvals. If no additional approvals are required, this addendum serves as a project summary to explain research that was conducted.
  c. If no changes are made from the original research plan, no project summary is required.
    - Some studies, such as an engineering design or mathematics projects, will be less detailed in the initial project plan and will change through the course of research. If such changes occur, a project summary that explains what was done is required and can be appended to the original research plan.
    - The Research Plan/Project Summary should include the following:
      a. **RATIONALE:** Include a brief synopsis of the background that supports your research problem and explain why this research is important and if applicable, explain any societal impact of your research.
      b. **RESEARCH QUESTION(S), HYPOTHESIS(ES), ENGINEERING GOAL(S), EXPECTED OUTCOMES:** How is this based on the rationale described above?
      c. Describe the following in detail:
        - **List of materials:**
        - **Procedures:** Detail all procedures and experimental design including methods for data collection, and when applicable, the source of data used. Describe only your project. Do not include work done by mentor or others.
        - **Risk and Safety:** Identify any potential risks and safety precautions needed.
        - **Data Analysis:** Describe the procedures you will use to analyze the data/results.
      d. **BIBLIOGRAPHY:** List major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.

Items 1–4 below are subject-specific guidelines for additional items to be included in your research plan/project summary as applicable.

1. **Human participants research:**
   a. Participants: Describe age range, gender, racial/ethnic composition of participants. Identify vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).
   b. Recruitment: Where will you find your participants? How will they be invited to participate?
   c. Methods: What will participants be asked to do? Will you use any surveys, questionnaires or tests? If yes and not your own, how did you obtain? Did it require permissions? If so, explain. What is the frequency and length of time involved for each subject?
   d. Risk Assessment: What are the risks or potential discomforts (physical, psychological, time involved, social, legal, etc.) to participants? How will you minimize risks? List any benefits to society or participants.
   e. Protection of Privacy: Will identifiable information (e.g., names, telephone numbers, birth dates, email addresses) be collected? Will data be confidential/anonymous? If anonymous, describe how the data will be collected. If not anonymous, what procedures are in place for safeguarding confidentiality? Where will data be stored? Who will have access to the data? What will you do with the data after the study?
   f. Informed Consent Process: Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary and they have the right to stop at any time.
2. **Vertebrate animal research:**
   a. Discuss potential ALTERNATIVES to vertebrate animal use and present justification for use of vertebrates.
   b. Explain potential impact or contribution of this research.
   c. Detail all procedures to be used, including methods used to minimize potential discomfort, distress, pain and injury to the animals and detailed chemical concentrations and drug dosages.
   d. Detail animal numbers, species, strain, sex, age, source, etc., include justification of the numbers planned.
   e. Describe housing and oversight of daily care.
   f. Discuss disposition of the animals at the end of the study.

- **Potentially hazardous biological agents research:**
  a. Give source of the organism and describe BSL assessment process and BSL determination.
  b. Detail safety precautions and discuss methods of disposal.

4. **Hazardous chemicals, activities & devices:**
   a. Describe Risk Assessment process, supervision, safety precautions and methods of disposal.
   b. Material Safety Data Sheets are not necessary to submit with paperwork.

International Rules: Guidelines for Science and Engineering Fairs 2024-2025, **societyforscience.org/ISEF** Page 33

3.1.3 Form 1B - Approval Form

Approval Form (1B)

A completed form is required for each student, including all team members.

1. To Be Completed by Student and Parent

a. Student Acknowledgment:

- I understand the risks and possible dangers to me of the proposed research plan.
- I have read the ISEF Rules and Guidelines and will adhere to all International Rules when conducting this research.
- I have read and will abide by the science fair ethics statement.

Student researchers are expected to maintain the highest standards of honesty and integrity. Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include but are not limited to plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and ISEF.

Aronrex Aris F. Parreño	[signature]	09-17-24
Student's Printed Name	Signature	Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

b. Parent/Guardian Approval: I have read and understand the risks and possible dangers involved in the **Research Plan/Project Summary**. I consent to my child participating in this research.

Nora F. Parreño	[signature]	09-17-24
Parent/Guardian's Printed Name	Signature	Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

2. To be completed by the local or affiliated Fair SRC

(Required for projects requiring prior SRC/IRB APPROVAL. Sign 2a or 2b as appropriate.)

a. Required for projects that need prior SRC/IRB approval BEFORE experimentation (humans, vertebrates or potentially hazardous biological agents).

The SRC/IRB has carefully studied this project's **Research Plan/ Project Summary** and all the required forms are included. My signature indicates approval of the **Research Plan/Project Summary** before the student begins experimentation.

Christian S. Englisa

SRC/IRB Chair's Printed Name

[signature] 09-18-24

Signature — Date of Approval (mm/dd/yy) (Must be prior to experimentation.)

OR

b. Required for research conducted at all Regulated Research Institutions with no prior fair SRC/IRB approval.

This project was conducted at a regulated research institution (**not home or high school, etc.**), was reviewed and approved by the proper institutional board before experimentation and complies with the ISEF Rules. **Attach (1C) and any required institutional approvals (e.g. IACUC, IRB).**

Christian S. Englisa

SRC Chair's Printed Name

[signature] 09-18-24

Signature — Date of Signature (mm/dd/yy) (May be after experimentation)

3. Final ISEF Affiliated Fair SRC Approval (Required for ALL Projects)

SRC Approval After Experimentation and Before Competition at Regional/State/National Fair

I certify that this project adheres to the approved **Research Plan/Project Summary** and complies with all ISEF Rules.

Regional SRC Chair's Printed Name	Signature	Date of Approval (mm/dd/yy)
State/National SRC Chair's Printed Name *(where applicable)*	Signature	Date of Approval (mm/dd/yy)

Page 34 International Rules: Guidelines for Science and Engineering Fairs 2024–2025, **societyforscience.org/ISEF**

Approval Form (1B)

A completed form is required for each student, including all team members.

1. To Be Completed by Student and Parent

a. Student Acknowledgment:

- I understand the risks and possible dangers to me of the proposed research plan.
- I have read the ISEF Rules and Guidelines and will adhere to all International Rules when conducting this research.
- I have read and will abide by the science fair ethics statement.

Student researchers are expected to maintain the highest standards of honesty and integrity. Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include but are not limited to plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and ISEF.

Jorji Bon S. Barbas — Student's Printed Name

Signature

9-17-24 — Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

b. Parent/Guardian Approval: I have read and understand the risks and possible dangers involved in the **Research Plan/Project Summary**. I consent to my child participating in this research.

Jill S. Barbas — Parent/Guardian's Printed Name

Signature

9-17-24 — Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

2. To be completed by the local or affiliated Fair SRC

(Required for projects requiring prior SRC/IRB APPROVAL. Sign 2a or 2b as appropriate.)

a. Required for projects that need prior SRC/IRB approval BEFORE experimentation (humans, vertebrates or potentially hazardous biological agents).

The SRC/IRB has carefully studied this project's **Research Plan/Project Summary** and all the required forms are included. My signature indicates approval of the **Research Plan/Project Summary** before the student begins experimentation.

Christian S. Englisa — SRC/IRB Chair's Printed Name

Signature

09-18-24 — Date of Approval (mm/dd/yy) (Must be prior to experimentation.)

OR

b. Required for research conducted at all Regulated Research Institutions with no prior fair SRC/IRB approval.

This project was conducted at a regulated research institution (**not home or high school, etc.**), was reviewed and approved by the proper institutional board before experimentation and complies with the ISEF Rules. **Attach (1C) and any required institutional approvals (e.g. IACUC, IRB).**

Christian S. Englisa — SRC Chair's Printed Name

Signature

09-18-24 — Date of Signature (mm/dd/yy) (May be after experimentation)

3. Final ISEF Affiliated Fair SRC Approval (Required for ALL Projects)

SRC Approval After Experimentation and Before Competition at Regional/State/National Fair

I certify that this project adheres to the approved **Research Plan/Project Summary** and complies with all ISEF Rules.

Regional SRC Chair's Printed Name — Signature — Date of Approval (mm/dd/yy)

State/National SRC Chair's Printed Name *(where applicable)* — Signature — Date of Approval (mm/dd/yy)

Page 34 — International Rules: Guidelines for Science and Engineering Fairs 2024–2025, **societyforscience.org/ISEF**

Approval Form (1B)

A completed form is required for each student, including all team members.

1. To Be Completed by Student and Parent

a. Student Acknowledgment:

- I understand the risks and possible dangers to me of the proposed research plan.
- I have read the ISEF Rules and Guidelines and will adhere to all International Rules when conducting this research.
- I have read and will abide by the science fair ethics statement.

Student researchers are expected to maintain the highest standards of honesty and integrity. Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include but are not limited to plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and ISEF.

Anthony Jay B. Nando — Student's Printed Name

Signature

9-17-24 — Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

b. Parent/Guardian Approval: I have read and understand the risks and possible dangers involved in the **Research Plan/Project Summary**. I consent to my child participating in this research.

Anna Joyce B. Nando — Parent/Guardian's Printed Name

Signature

9-17-24 — Date Acknowledged (mm/dd/yy) (Must be prior to experimentation.)

2. To be completed by the local or affiliated Fair SRC

(Required for projects requiring prior SRC/IRB APPROVAL. Sign 2a or 2b as appropriate.)

a. Required for projects that need prior SRC/IRB approval BEFORE experimentation (humans, vertebrates or potentially hazardous biological agents).

The SRC/IRB has carefully studied this project's **Research Plan/Project Summary** and all the required forms are included. My signature indicates approval of the **Research Plan/Project Summary** before the student begins experimentation.

Christian S. Englisa — SRC/IRB Chair's Printed Name

Signature

09-18-24 — Date of Approval (mm/dd/yy) (Must be prior to experimentation.)

OR

b. Required for research conducted at all Regulated Research Institutions with no prior fair SRC/IRB approval.

This project was conducted at a regulated research institution (**not home or high school, etc.**), was reviewed and approved by the proper institutional board before experimentation and complies with the ISEF Rules. **Attach (1C) and any required institutional approvals (e.g. IACUC, IRB).**

Christian S. Englisa — SRC Chair's Printed Name

Signature

09-18-24 — Date of Signature (mm/dd/yy) (May be after experimentation)

3. Final ISEF Affiliated Fair SRC Approval (Required for ALL Projects)

SRC Approval After Experimentation and Before Competition at Regional/State/National Fair

I certify that this project adheres to the approved **Research Plan/Project Summary** and complies with all ISEF Rules.

Regional SRC Chair's Printed Name — Signature — Date of Approval (mm/dd/yy)

State/National SRC Chair's Printed Name *(where applicable)* — Signature — Date of Approval (mm/dd/yy)