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B-TRAP: Bicycle Tracking Device with Integrated Anti-Theft System for Effective Theft Prevention and Tracking

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ABSTRACT

As the number of bicycle users continues to rise in modern society, so too do the challenges they face, particularly concerning safety and security. Recent statistics reveal a troubling trend: bicycle-related accidents in the Philippines surged from 1,759 in 2019 to 3,016 in 2020, highlighting the urgent need for enhanced safety measures (MMDA, 2019). Furthermore, the National Economic and Development Authority (NEDA, 2020) reports a staggering 112% increase in bicycle imports, signaling that bicycles are becoming a significant part of our daily lives. However, this growth is accompanied by a concerning rise in bike thefts, further jeopardizing cyclists' safety and convenience. In response to these critical issues, this paper proposes a GPS-based monitoring system aimed at improving bicycle security and functionality. The solution integrates cutting-edge technologies, including Arduino IDE software, a buzzer alarm, SMS notifications, and a mobile application for real-time location tracking. This project endeavors to make cycling safer and more enjoyable, addressing the pressing need for innovative solutions that support cyclists in navigating their environments and protecting their investments. This study aims to incorporate high-tech monitoring technologies into everyday cycling practices to create a safer environment for all bicycle users.

Keywords: Arduino IDE software, Buzzer Alarm, SMS Notification, Mobile Development, Bicycle Theft, GPS Monitoring, Cycling Security, Real-time Tracking, Anti-theft System, Navigation Solutions, Recovery, Cycling Safety.

INTRODUCTION

In this modern day bicycle users increase, accidents related to bicycles also increase (WHO, 2021). According to the National Economic and Development Authority (NEDA, 2020), bicycle imports saw a 112% increase to 2.1 million in 2020, compared with about 1 million units shipped to the country in 2019. These statements show that bicycles and their riders are becoming an important part of our modern society. Therefore, we must focus on their safety and create a better environment to reduce the risks they face. Based on the records of the Metropolitan Manila Development Authority (MMDA, 2019), the bike related accidents in the Philippines were 1,759 and it doubled in 2020 with 3,016.Riding a bike in heavy traffic raises the risk of accidents. Combining modern technology with scientific research and the experiences of bikers, we can find ways to reduce these risks and improve safety. For example, research by Smith and Jones (2020) highlights how real-time tracking systems can reduce accident rates by providing timely alerts to cyclists about hazardous conditions and high-traffic areas. Also according to Lee and Chen (2023) they demonstrated that integrating advanced predictive analytics with real-time data can help in identifying high-risk areas and proactively managing traffic flow to reduce accidents.

These statements show that creating a device to address multiple safety issues can make biking both safer and more efficient. Bicycle theft is a significant issue that undermines the growth of cycling as a sustainable transportation option. Research indicates that effective theft prevention measures are crucial for enhancing the safety and security of cyclists, as high theft rates can deter individuals from cycling, impacting public health and the benefits of cycling infrastructure (Smith & Jones, 2020). When cycling is perceived as safe, more people are likely to participate, leading to improved health outcomes through increased physical activity (Pucher & Buehler, 2012).

Innovative solutions like the Bicycle Tracking Device with Integrated Anti-Theft System are essential for protecting individual investments and encouraging more people to cycle, which in turn supports community economic vitality (Litman, 2013).

Additionally, implementing anti-theft systems promotes equitable access to transportation, enabling marginalized groups to cycle without the fear of losing their bikes (Dorsey & Smith, 2018). Technology, such as integrated tracking systems, enhances bicycle security and fosters a culture of cycling within communities (McCarthy & Chen, 2021). By preventing theft and facilitating the quick recovery of stolen bikes, B-TRAP aims to empower cyclists and contribute to a more bike-friendly society.

Objectives

The goals of this research are to improve bicycle safety by integrating advanced GPS tracking and anti-theft systems to address navigation and theft issues. Additionally, the study aims to enhance the overall biking experience and support better urban planning for cyclists.

Specifically this study aims to...

- **What is the effectiveness of the device for both the bicycle and the user in terms of measurable outcomes?**
- **What are the numerical effects of integrating these technologies on overall cyclist satisfaction and usage frequency?**

METHODOLOGY

This part of the research paper explains the methods used to conduct the study to create a concrete and reliable result.

Procuring of Materials

Firstly, the researcher begins to ask their adviser what materials are needed to create the device. The researcher also tried to search for the said materials from their adviser to see if they were available, and if not, they could ask for an alternative. The researcher looks for shops related to robotics or electronics for them to be able to buy materials; some were bought online.

Solenoid Electromagnetic Lock

The purpose of the solenoid electromagnetic lock in our materials was to be the lock to the bicycle's disk brake. This lock will be used as an alternative lock. The researcher wished to use a wheel lock; however, due to the availability of the material, it is too difficult to be used in their research.

Arduino Kit

Arduino Kit was one of the essential materials the researcher's adviser recommended for them to be able to test things and to make things work in our own ideas while also learning how machine learning works.

Arduino Kit include component such as:

Item

5pcs White LED

5pcs Yellow LED

5pcs Blue LED

5pcs Green LED

5pcs Red LED

1pcs RGB LED

2pcs Photoresistor

1pcs Thermistor

1pcs Sound Sensor Module

1pcs LCD1602 Module

1pcs IR Receiver Module

1pcs Ultrasonic Sensor

1pcs Water Level Sensor

With these equipment the researcher are able to test some mechanisms they wanted to add in their device.

Materials Used (Not included in the Kit)

The materials used by the researcher that are not included in the Kit was:

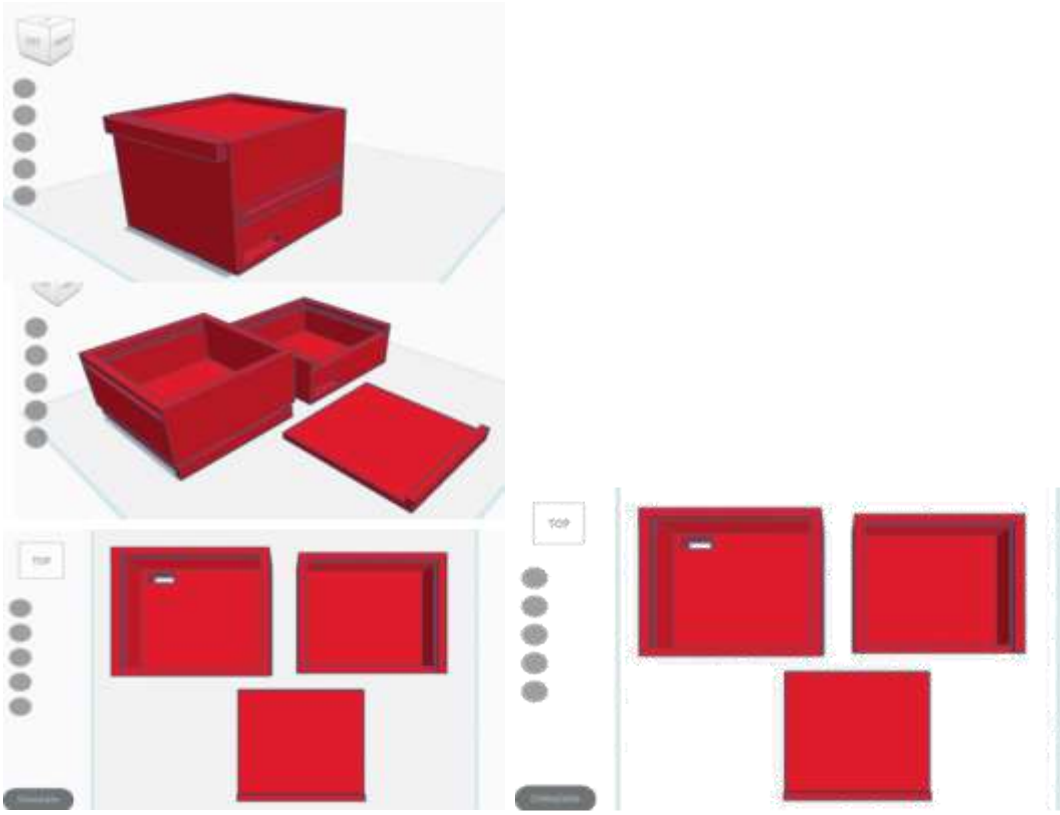
- Nodemcu V3 Wifi Module
- Additional Wires
- Single DC Relay Module
- 9V Li-ion (Lithium Ion) Battery
- (4pcs) 3.7 Lithium Battery
- Vibration Sensor
- Plug w/ Transformer
- 4 slot Battery Case
- NEO-6M GPS Module
- GPRS/GSM SMS Module

These materials were bought by the researcher for them to be able to add features and also some were used because it was essential inorder for the device to work.

Container of the Device

For the container of the device the researcher decided to create a 3D layout and print it in order to decide the structure of the internal design.

3D Layout of the container:



Testing of the Transmitting Modules and Sensors

These figures show the containers' decided layout in different perspectives and forms. Considering the dimensions of the used components, the researcher decided to make it 10 cm x 10 cm for the device to also be effective and it will not affect the bicycle's balance.

Process

This part tackles the process of making the device. This part also tackles the making of the app for the monitoring of the bicycle and the device itself.

The testing of the components began in the bought modules such as GPRS/GSM SMS Module and NEO-6M GPS Module. These are the materials who were tested first because they're the most vulnerable and prone to being faulty.

Mostly the materials that's too vulnerable or less durable and can easily be faulty. These modules can also be called transmitting modules since these were used to transmit the user's data to the device and vice versa.

GPRS/GSM SIM800L Module - The purpose of this module, or the reason it is included by the researcher in their study, is for the device to be able to notify the user of the device in a long range via SMS text or call.

NEO-6M GPS Module - The purpose of this module was for the users to be able to track their bicycle via APP. It could also help for the user's navigation.

Vibration Sensor - The purpose of this sensor was to be the one who determines if the bicycle was touched or was shaken.

Arduino Software Development

```
#include <ESP8266WiFi.h>
#include <ESP8266WebServer.h>
#include <neo6mGPS.h>
#include <GSM.h>
```

The researcher use these libraries to enhance the functionality and performance of the project. The `ESP8266WiFi` library allows for seamless Wi-Fi connectivity, enabling the device to communicate over the internet. The `ESP8266WebServer` library supports the creation of a web server, making it easier to manage user interactions and control the device remotely or via App. The `neo6mGPS` library facilitates GPS tracking, ensuring accurate location data for the bicycle. Lastly, the `GSM` library provides cellular communication capabilities, allowing the device to send alerts and notifications even in areas without Wi-Fi. Together, these libraries enable the development of a robust and efficient anti-theft and tracking system.

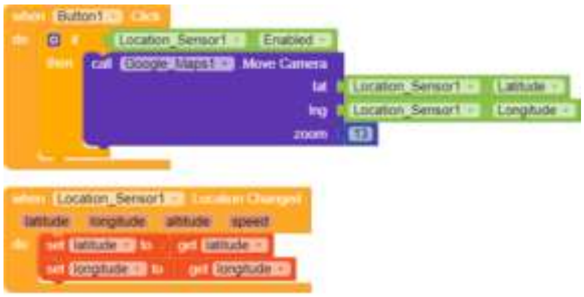
Mobile App Development

The researcher used Kodular Creator. AppInventor to create a dedicated app for BTRAP. Kodular was baked from MIT AppInventor in conjunction with Google to help novices and beginner programmers quickly become more advanced. App Inventor is a free cloud-based service that allows users to make their mobile apps using a block-based programming language (Edwards, 2022).

The researcher meticulously designed the app with a dual purpose: to locate the bicycle and authenticate it in case of a critical identity loss. These features were carefully laid out to achieve the implementation objectives effectively. The app connects with the transmitting modules using the Nodemcu V3 (ESP8266) WiFi Module. Additionally, location tracking is facilitated by integrating the GSM SIM800L module, enabling real-time monitoring of the device’s whereabouts.

These figure shows the blockings and front-end design for creating the login and sign-up system for the device, ensuring that only one person—the authorized user—can access and use the device.

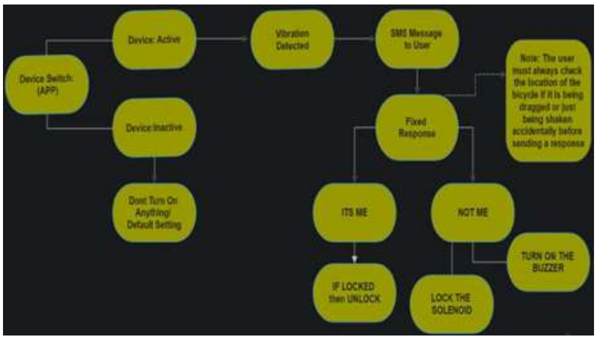
These figures also show the blockings and front-end design for creating the status checking, response to the SMS, and also the button to proceed to tracking.



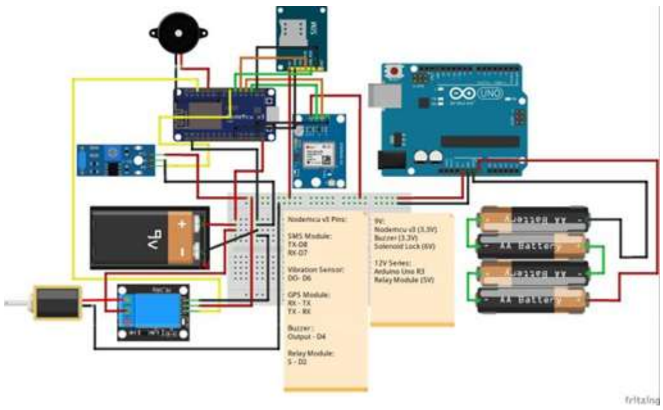
These figure also shows the blockings and front-end design for creating the tracking system.

Device Flow and Functionalities

This phase shows the final flow of the device and functionalities. The app was also included in the device because it was made for the user to monitor their bicycle and device status.



Schematic Diagram of the whole Device



This figure shows the entire assembly of the device, including the wiring connections and pin assignments of the components. The schematic diagram provides a detailed overview of how each component is interconnected, highlighting the flow of signals between the sensors, microcontroller, and peripheral devices. It also illustrates the power supply distribution and the communication links between the main control unit and external modules, offering a clear visual representation of the overall system architecture.

Data Collection by Testing the Device in Selected Environments

The researcher conducted data collection in various environments, including Alley, Parking Lot, At Home, and Pathways, to assess the transmission speeds of the Data Transmission of the device. This investigation aimed to understand how different settings impact the module's performance and communication efficiency

Environment	**Trial**	**Transmission Speed (kbps)**
Alley	1	30
Alley	2	28
Alley	3	32
Alley	4	29
Alley	5	31
Parking Lot	1	40
Parking Lot	2	42
Parking Lot	3	39
Parking Lot	4	41
Parking Lot	5	43
At Home	1	20
At Home	2	18
At Home	3	22
At Home	4	19
At Home	5	21

Pathways	1	35
Pathways	2	36
Pathways	3	34
Pathways	4	37
Pathways	5	38

Based on the researcher's data, the transmission speeds vary significantly across different environments. The highest mean transmission speed was observed in the parking lot (41 kbps), followed closely by the pathways (36 kbps) and the alley (30 kbps). These environments demonstrated relatively low variability, as indicated by their small coefficients of variation: 3.9% for the parking lot, 4.4% for pathways, and 5.3% for the alley.

In contrast, the at-home environment exhibited the lowest mean transmission speed (1.58 kbps), with a notably high coefficient of variation (44.94%), suggesting that transmission speeds at home were both low and highly inconsistent. The high variability at home could be due to factors such as signal interference or obstructions.

Overall, it can be concluded that outdoor environments or much open areas like the parking lot, pathways, and alley generally provide higher and more stable transmission speeds compared to the home environment, where speeds are slower and more unpredictable.

Data Collection by Testing how long the batteries will took before it runs out

Battery Setup	**Components Powered**	**Total Current Draw (mA)**	**Battery Capacity (mAh)**
9V (650 mAh)	NodeMCU (idle) + Piezo Buzzer	90 mA	650 mAh
9V (650 mAh)	NodeMCU (transmitting) + Piezo Buzzer	190 mA	650 mAh
12V (1200	Relay, Vibration	665 mA	1200 mAh

mAh)	Sensor, GPS SMS Module		

Costing of Materials

This section shows the expenses in procuring the materials and the prices of the materials themselves.

Cost	**Item**
Arduino Kit	₱1,499
Nodemcu V3 Wifi Module	₱270
Additional Wires	₱100
Single DC Relay Module	₱110
9V Li-ion (Lithium Ion) Battery Rechargeable	₱370
(4pcs) 3.7 Lithium Battery	₱840
Vibration Sensor	₱52
4 slot Battery Case	₱90
NEO-6M GPS Module	₱250
GPRS/GSM SMS Module	₱380
Transportation Expenses	₱150

3D Printed Container	1,000
Total	₱5,681

RESULT AND DISCUSSION

Based on the process made by the researcher the results that have been obtained indicate that it is better for the device to use a strong material or durable material to cover the internal of the device.The researcher also found that it is beneficial to use sensors that can accurately detect whether the bicycle is being stolen or simply shaken.

Data Analysis for Transmission speed

Environment	N	Mean (kbps)	SD	SE	Coefficient of Variation (%)
Alley	5	30	1.58	0.71	5.3
Parking Lot	5	41	1.58	0.71	3.9
At Home	20	1.58	0.71	7.9	44.94
Pathways	5	36	1.58	0.71	4.4

This study used ANOVA and Post HOC Tests to evaluate the B-TRAP device performance in depth. The choice of this statistical 19 procedure yields a dependable mean and is consistent with the study's experimental design.

Based on the researcher's data the transmission speeds vary significantly across different environments. The highest mean transmission speed was observed in the parking lot (41 kbps), followed closely by the pathways (36 kbps) and the alley (30 kbps). These environments demonstrated relatively low variability, as indicated by their small coefficients of variation: 3.9% for the parking lot, 4.4% for pathways, and 5.3% for the alley.

In contrast, the at-home environment exhibited the lowest mean transmission speed (1.58 kbps), with a notably high coefficient of variation (44.94%), suggesting that transmission speeds at home were both low and highly inconsistent. The high variability at home could be due to factors such as signal interference or obstructions.

It also shows that outdoor environments like the parking lot, pathways, and alley generally provide higher and more stable transmission speeds compared to the home environment, where speeds are slower and more unpredictable.

Overall, the device works more stably in open areas due to fewer physical obstructions, reduced interference from walls and household electronics, and generally better line-of-sight connectivity with signal sources. Environments like the parking lot, pathways, and alley show higher and more consistent transmission speeds, likely because open areas allow for stronger and uninterrupted signal reception.

Battery Setup	**Components Powered**	**Total Current Draw (mA)**	**Battery Capacity (mAh)**	**Estimated Runtime (hours)**
9V (650 mAh)	Node MCU (idle) + Piezo Buzzer	90 mA	650 mAh	~ 7.2 hours
9V (650 mAh)	Node MCU (transmitting) + Piezo Buzzer	190 mA	650 mAh	~ 3.4 hours
12V (1200 mAh)	Relay, Vibration Sensor, GPSSMS Module	665 mA	1200 mAh	~ 1.8 hours

$$\text{Battery Life} = \frac{\text{Battery Capacity (mAh)}}{\text{Total Current Draw (mA)}}$$

Data Analysis for the Battery consumption and Battery Life

By using the Battery Life formula, the researchers estimated the performance of both the 9V and 12V batteries. The **9V battery**, powering the NodeMCU V3 and piezo buzzer, is expected to last approximately **7.2 hours** when the NodeMCU operates in idle mode, drawing around 90 mA. However, during active transmission, the current increases to 190 mA, reducing the battery life to about **3.4 hours**. On the other hand, the **12V battery**, powering the relay module, vibration sensor, GPS NEO-6m, and SMS module, is expected to last around **1.8 hours** due to its higher current draw, particularly from the SMS module. This data suggests that while the 9V battery offers moderate endurance for lighter tasks, the 12V system may need higher-capacity batteries or power-saving optimizations for longer operational periods.

RECOMMENDATION

Based on the data results, it is recommended that the bicycle anti-theft and tracking system should be used primarily in open areas, such as parking lots, pathways, or alleys, where transmission speeds are higher and more stable. These environments provide better performance for real-time tracking and notifications due to stronger and more consistent signal reception.

For home environments, where transmission speeds are slower and less reliable, additional measures such as signal boosters or alternative communication methods could improve performance. This would ensure that the device remains effective in all locations, allowing timely notifications and accurate tracking in both indoor and outdoor settings.

The researcher also recommends using higher-quality transmitting devices to improve speed and efficiency when using the system. Upgrading to more advanced communication modules can enhance the reliability of real-time notifications and tracking, especially in areas with weaker signals. This would ensure the device performs optimally across different environments, providing faster response times and a more seamless user experience.

The researcher recommended using a tire wheel lock for the bicycle in combination with the solenoid lock system. This added layer of security would provide a stronger physical deterrent, making it harder for thieves to move the bicycle even if they attempt to bypass the electronic system. The tire wheel lock ensures that the bicycle remains securely in place, offering greater protection alongside the tracking and alarm features.

Based on the battery life analysis, the researchers recommend considering higher-capacity batteries or implementing power-saving strategies to extend the device's operational time. For the **9V battery**, which powers the NodeMCU and piezo buzzer, switching the NodeMCU to low-power modes during idle periods could improve battery life. Additionally, for the **12V battery**, which supports the relay, vibration sensor, GPS, and SMS module, opting for a larger-capacity battery would ensure longer usage, especially under high-power conditions such as SMS transmissions. Using efficient power management techniques or alternative low-power components could also enhance overall battery performance, allowing the system to remain functional for extended periods without frequent recharging.

CONCLUSION

The implementation of a bicycle anti-theft and tracking system presents a promising solution to enhance bike security, especially in outdoor environments. The data indicate that the system performs best in open areas like parking lots, pathways, or alleys, where transmission speeds are faster and more stable. For indoor environments with weaker signal strength, enhancements such as signal boosters or alternative communication methods could ensure reliable real-time tracking and notifications. To further improve the system, upgrading to higher-quality transmission devices and using advanced communication modules would enhance its efficiency, particularly in low-signal areas.

Additionally, integrating a tire wheel lock with the existing solenoid lock system would provide an extra layer of security, making it harder for thieves to move the bicycle even if they bypass the electronic components. This physical deterrent adds value to the system's protective features.

In terms of power management, the research suggests the need for higher-capacity batteries or power-saving strategies to extend battery life. Switching the NodeMCU to low-power modes and using larger-capacity batteries for components like the GPS and SMS module would ensure longer operational time, particularly during high-power activities like SMS transmissions. By employing these strategies, the system can remain functional for extended periods, minimizing the need for frequent recharging and improving the overall user experience.

In conclusion, while the bicycle anti-theft and tracking system is effective in outdoor settings, further improvements in transmission, power management, and physical deterrence will enhance its performance across different environments, making cycling safer and more secure.

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APPENDICES

ISEF FORMS

FORM 1

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): James Cedrick P. Dalumbar

Project Title: B-TRAP: Bicycle Tracking Device with Integrated Anti-Theft System for Effective Theft Prevention and Tracking

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)
☑ Research Plan/Project Summary
☑ Approval Form (1B)
☑ Regulated Research Institutional/Industrial Setting Form (1C) (when applicable; after completed expe
Continuation/Research Progression Form (7) (when applicable)

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 Rev
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 ap
Vertebrate Animal Form (5B) - for projects conducted at a Regulated Research Institution. (Institutional A
Use Committee (IACUC) approval required prior experimentation.)
Qualified Scientist Form (2) (Required for all vertebrate animal projects at a regulated research site or w

Potentially Hazardous Biological Agents (Requires prior approval by SRC, IACUC or IBC, see full text of
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 i
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 pro
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 applicab

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**

Joy P. Dalumbar	[signature]	10/10/24
Adult Sponsor's Printed Name	Signature	Date of Review (mm/dd/yy)
09056063658	joydalumbar05@gmail.com	
Phone	Email	

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FORM 1A

Student Checklist (1A)

This form is required for ALL projects.

1. a. Student/Team Leader: James Cedrick P. Dalumbar Grade: 12

   Email: cedrickdalumbar@gmail.com Phone: 09056063658

   b. Team Member: ______ c. Team Member: ______

2. Title of Project: B-TRAP: Bicycle Tracking Device with Integrated Anti-Theft System for Effective Theft Prevention and Tracking

3. School: Davao City National High School School Phone: (082) 227 9102
   (if multiple schools, list of the team leader or list all schools).

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

4. Adult Sponsor: Joy P. Dalumbar Phone/Email: 09056063658

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:

   09/21/24 — Actual Start Date: (mm/dd/yy)

   10/12/24 — 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 ______ ______

    Address: ______ ______

    Phone/email ______ ______

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.**

FORM 1B

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.

James Cedrick P. Dalumbar		09/21/24
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.

Joy P. Dalumbar		09/21/24
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.

Arnold P. Remulta

SRC/IRB Chair's Printed Name

	09/21/24
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).**

SRC Chair's Printed Name

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)

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FORM 1C

Revised–Regulated Research Institutional/Industrial Setting Form (1C)

This form must be completed AFTER experimentation by the adult supervising the student research either virtually or on site, conducted in a regulated research institution, industrial setting or any work site other than home, school or field.

Student's Name(s) James Cedrick P. Dalumbar

Title of Project B-TRAP: Bicycle Tracking Device with Integrated Anti-Theft System for Effective Theft Prevention and Tracking

To be completed by the Supervising Adult in the Setting (NOT the Student(s)) after experimentation:

(Responses must be on the form as it is required to be displayed at student's project booth; please do not print double-sided.)

Research was supported at my work site:

1. Describe the student experience at your work site (check all that apply):

• Used Equipment	Yes	/ No
• Minimal interaction with our group	Yes	/ No
• Mentored by me or someone else from our group	Yes	/ No
• Worked as a sub-set of our ongoing research	Yes	/ No
• Had an independent project from our group	/ Yes	No

2. Please describe the independent and/or creative work done by the student in any phase of the project, but particularly in developing the hypotheses or engineering goals of the project

   The student showed a lot of independent and creative work during different phases of the project, especially in developing the hypotheses and engineering goals. In the initial research phase, they looked at existing anti-theft technologies and bicycle tracking systems.

3. Detail the student's role in conducting the research (e.g. data collection, specific procedures performed). Differentiate what the student observed and the student actually did.

   The student played an active role in conducting the research by engaging in both observational and hands-on activities. Specifically, they visited various locations to test the device in real-world conditions, allowing them to gather valuable data on its performance.

4. Did the student(s) work on the project as part of a group? / Yes No
   Were there other high school students present? If yes, please list the students names and describe how their work was related or different from the work of this projecct.

   Neil Young Bamboo C. Padang gathered materials and looked for shops where the materials were available. Gian Jedric S. Galagar contributed by being an assistant for the researcher's paper.

5. If this project is under a grant and needs to be acknolwedged, please list the grant statement here.

I attest that the student has conducted the work as indicated above and that any required review and approval by institutional regulatory board (IRB/IACUC/IBC) has been obtained. Copies are attached if applicable. I further acknowledge that the student will be presenting this work publicly in competition and I have communicated with the student research regarding any requirements for my review and/or restrictions of what is publicized.

Lemuel M. Espinar	Lemuel Espinar	Master in Engineering Program major in Electronics and Communications Engineering
Direct Supervisor's Printed Name	Signature	Title
Davao City National High School		10/12/24
Institution		Date Signed (must be after experimentation) (mm/dd/yy)
F. Torres Street 8000 Davao City, Philippines		lemuel.espinar@deped.gov.ph
Address		Email/Phone

FORM 3

Risk Assessment Form (3)

Must be completed before experimentation; recommended for all projects. May be required for projects involving Human Participants, Hazardous Chemicals, Materials or Devices or Potentially Hazardous Biological Agents.

Student's Name(s) James Cedrick P. Dalumbar

Title of Project B-TRAP: Bicycle Tracking Device with Integrated Anti-Theft System for Effective Theft Prevention and Tracking

To be completed by the Student Researcher(s) in collaboration with Direct Supervisor/Qualified Scientist: (All questions must be answered; additional page(s) may be attached.)

1. Identify and assess the risks and hazards involved in this project.

   The possible risk and hazard the researcher encounters were, Electronic dangers, Usage of Sharp Materials.

2. a) List all hazardous chemicals, activities or devices to be used; b) identify and list all microorganisms to be used that are exempt from pre-approval (see Potentially Hazardous Biological Agent rules).

   a). Short circuit, sharp materials, and any Electrical-related hazards and activities

   b). None

3. Describe the safety precautions and procedures that will be used to reduce the risks.

   Electrical Safety: Ensure proper insulation of wires and avoid exposure to moisture while the system is powered. Power off all components before any adjustments are made. Physical Safety: Use protective gloves and goggles when handling sharp tools, digging, or working with electrical components. Keep a first-aid kit available in case of injury. Fire Safety: Work in well-ventilated areas when soldering to avoid inhaling fumes and ensure no flammable materials are nearby. Weather Precautions: If the system is tested outdoors, waterproof the equipment and use coverings to protect from rain or extreme weather conditions. Use proper grounding to avoid electrical hazards. Battery Handling: Store batteries in a dry, cool place and ensure they are charged correctly to avoid leaks or explosions.

4. Describe the specific disposal procedures that will be used (when applicable).

   Electronic Components: Batteries, damaged sensors, and other electronic parts should be disposed of following electronic waste disposal guidelines, ensuring they are not mixed with regular trash to avoid environmental contamination. Chemical Disposal: If any soldering materials or adhesives are used, dispose of the chemical waste in accordance with hazardous waste disposal regulations, using designated bins for such waste.

5. List the source(s) of safety information.

   Material Safety Data Sheets (MSDS): For any chemicals or soldering materials used during assembly. Device Manuals: Safety guidelines provided in the manuals for Arduino UNO, NodeMCU, sensors, and battery components. Local Guidelines: Follow the local waste management guidelines for electronic waste disposal. General Safety Guidelines: Reference safety standards for handling electrical equipment and conducting outdoor experiments safely.

To be completed and signed by the Direct Supervisor (or Qualified Scientist, when applicable):

I agree with the risk assessment and safety precautions and procedures described above. I certify that I have reviewed the Research Plan/Project Summary and the International Rules, including the science fair ethics statement and will provide direct supervision.

Lemuel M. Espinar	Lemuel Espinar	10/11/24
Direct Supervisor's Printed Name	Signature	Date of Review (mm/dd/yy)

Master in Engineering Program major in Electronics and Communications Engineering

Experience/Training as relates to the student's area of research

Research Adviser	lemuel.espinar@deped.gov.ph
Position/Institution	Phone or email contact information

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