International Journal of Research Publication and Reviews

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

Lucky the Most Advance Robot

Kumawat Lalitkumar Pradeepkumar, Nitone Nikita Siddharth , Rama Ranjankar

Dept. Electronics and Telecommunication Pravin Patil College of Diploma Engineering And Technology, Bhayandar, Mumbai
ej21lalitkumawat@gmail.com, *nikitanitone@gmail.com*

A B S T R A C T

In this research paper, we present the design and development of "LUCKY", a versatile Robot equipped with a wide array of hardware components and microcontrollers. LUCKY's architecture is centered around a Raspberry Pi Zero W, serving as the primary controller responsible for camera input, GPS navigation, and communication with subordinate components. A Raspberry Pi Pico, Arduino & ESP 32 acts as a slave controller, processing commands and data distribution to other microcontrollers.

Keywords: Robotics, Autonomous Navigation, Obstacle Avoidance, Raspberry Pi Zero W, Arduino Pro Mini, Ultrasonic Sensors, Intelligent Automation, Industrial Robotics, Educational Robotics, Entertainment Systems, Video Transmission, Autonomous Mobile Robot, Artificial Intelligence, Robotics Applications, Smart Technologies, Robotics Integration, Advanced Motor Control, Sensor Fusion, Robotics Development, Robotics Prototyping.

1. Introduction

We Developed a Robot Named “LUCKY”, which can be used in various industries, Power Plants, Research Labs, Medical Research labs, Hospitals, and many other applications as per requirements based on different applications. As a college Project, we are working to create this project in a very economical and affordable manner to extract maximum prevalent Outputs from the Robot.

Nomenclature

Symbols

V_{ac}: Alternating Current Voltages(Volts)

RPM : Rotations Per Minute

HC-SR04 : Ultrasonic Sensor Module

GPS : Global Positioning System

Abbreviations

Raspberry Pi Zero W: RPZW

Arduino Pro Mini: APM

Arduino Nano: AN

TPA3110: Audio Amplifier Chip

Acronyms

PID: Proportional-Integral-Derivative

AI: Artificial Intelligence

STEM: Science, Technology, Engineering, and Mathematics

2. Hardware Components

The "LUCKY" robot project is equipped with a comprehensive set of hardware components, each serving a specific purpose in enabling the robot to navigate, avoid obstacles, entertain, and transmit video data. This section provides a detailed overview of the core hardware components employed in the project:

Raspberry Pi Zero W

The Raspberry Pi Zero W acts as the central processing unit and communication hub for LUCKY. It is responsible for managing the onboard camera, GPS module, audio output, and communication with peripheral microcontrollers.

Raspberry Pi Pico

The Raspberry Pi Pico serves as a slave controller in the system. It processes commands received from the main Raspberry Pi Zero W and communicates with various microcontrollers to execute specific functions.

Arduino Nano

The Arduino Nano is a display driver, enabling LUCKY to present information on an external display. This component is essential for providing visual feedback or user interaction.

Arduino Pro Mini

The Arduino Pro Mini plays a pivotal role in obstacle avoidance and motor control. It receives input from ultrasonic sensors and controls the two 555-gear motors using BTS7960 motor drivers. This microcontroller is responsible for ensuring safe and efficient movement.

Motors

LUCKY incorporates two 555-gear motors, each operating at 300 RPM. These motors provide the necessary locomotion for the robot.

BTS7960 Motor Drivers

The BTS7960 motor drivers are instrumental in controlling the movement of the two motors. They ensure precise speed and direction control, contributing to the robot's mobility.

Ultrasonic Sensors (HC-SR04)

Eight HC-SR04 ultrasonic sensors are strategically placed around LUCKY to detect obstacles in its path. These sensors play a crucial role in obstacle avoidance and navigation.

Speaker and TPA3110 Amplifier

The audio system of LUCKY consists of a speaker and a TPA3110 amplifier. The Raspberry Pi Zero W controls this setup, enabling the robot to produce sound, play music, or generate alerts.

Webserver

LUCKY features the ability to transmit video data to a web server, allowing for remote monitoring and control. This component is crucial for real-time data sharing and teleoperation.

The "LUCKY" robot project is equipped with a comprehensive set of hardware components, each serving a specific purpose in enabling the robot to navigate, avoid obstacles, entertain, and transmit video data. This section provides a detailed overview of the core hardware components employed in the project:

3. Software Concern

The success of the LUCKY robot project relies heavily on the software systems that control its various functions, integrate sensors and actuators, and enable remote communication. In this section, we discuss the key software components and their roles in the project.

1. Main Controller Software (Raspberry Pi Zero W):

The Raspberry Pi Zero W is the central processing unit, responsible for managing high-level functionalities, including camera control, GPS navigation, audio playback, and video transmission. It runs on a Linux-based operating system, typically Raspbian or a similar distribution.

2. Slave Controller Software (Raspberry Pi Pico):

The Raspberry Pi Pico acts as a slave controller and communicates with the main Raspberry Pi Zero W. Its software processes and forwards commands received from the main controller to other microcontrollers. The programming for this microcontroller may involve Python or MicroPython to facilitate communication between the main controller and the Arduino-based components.

3. Display Driver Software (Arduino Nano):

The Arduino Nano functions as a display driver and is responsible for interfacing with the external display, showing information such as navigation status, sensor data, or robot state. The software for Arduino Nano is typically written in C/C++.

4. Obstacle Avoidance and Motor Control Software (Arduino Pro Mini):

The Arduino Pro Mini manages obstacle avoidance by processing data from the eight HC-SR04 ultrasonic sensors and controlling the movement of the robot through the BTS7960 motor drivers. This software includes logic for detecting obstacles, computing new paths, and controlling the two 555-gear motors. It is also written in C/C++.

5. Audio System Software (Raspberry Pi Zero W):

The audio system, comprising a speaker and TPA3110 amplifier, is controlled by the main Raspberry Pi Zero W. It allows the robot to produce sound effects or play music. Software concerns include audio processing and management, often using Python or dedicated audio libraries.

6. Video Transmission Software:

The video transmission to a web server involves encoding and transmitting the video feed via network protocols. The choice of software for this component may depend on the specific requirements of the webserver. Common choices include Python for video encoding and transmission over HTTP or other network protocols.

4. Challenges Faced in Developing "LUCKY"

The development of a multifunctional robot-like "LUCKY" is not without its fair share of challenges. In this section, we will outline some of the key challenges encountered during the design and implementation of this robot.

Hardware Integration: One of the fundamental challenges in building "LUCKY" is the seamless integration of a diverse set of hardware components. Coordinating the operation of the Raspberry Pi, Raspberry Pi Pico, Arduino Nano, and Arduino Pro Mini, along with the motors, sensors, and audio equipment, demands meticulous planning and well-defined communication protocols.

Real-time Data Processing: The robot relies on real-time data from multiple sensors, including the ultrasonic sensors for obstacle avoidance and the camera for navigation. Managing and processing this data within the tight constraints of the Raspberry Pi Zero W and Raspberry Pi Pico can be computationally demanding. Ensuring timely and accurate decision-making based on this data is a non-trivial task.

Software Complexity: The software architecture for "LUCKY" needs to be both robust and flexible. This entails designing and implementing algorithms for navigation, obstacle avoidance, and motor control, as well as managing various input and output devices. Debugging and optimizing this software can be a significant challenge.

Power Management: With multiple microcontrollers, sensors, and motors, managing power consumption and ensuring a reliable power supply is critical. Balancing power efficiency with the need for high-performance operation is a delicate trade-off

Communication and Data Transfer: The communication between the Raspberry Pi Zero W and Raspberry Pi Pico, as well as the transmission of video data to a web server, can be challenging. Ensuring a stable and secure connection, especially in dynamic environments, is crucial for remote operation and monitoring.

Mechanical Design: The physical design and mechanics of the robot, including the placement of sensors and motors, can impact its stability and maneuverability

4. Background of Study

- The Evolution of Robotics

From the early days of mechanical automata to the sophisticated robots of today, the evolution of robotics has been marked by significant strides in hardware and software integration. The incorporation of single-board computers, microcontrollers, and advanced sensors has paved the way for robots that not only mimic human movements but possess the intelligence to adapt to their surroundings.

- Integration of Smart Technologies

Team Lucky, situated at the forefront of this evolution, leverages state-of-the-art technologies to create intelligent machines that go beyond traditional functionalities. The integration of Raspberry Pi Zero W, Raspberry Pi Pico, Arduino Nano, and Arduino Pro Mini exemplifies a harmonious synergy between powerful computing, real-time processing, and precise control mechanisms.

- Addressing Industry Challenges

As industries grapple with the increasing complexity of tasks and the need for efficiency, Lucky Robotics introduces "LUCKY" as a solution that transcends conventional robotic capabilities. Designed to navigate, avoid obstacles, entertain, and transmit data, "LUCKY" addresses the multifaceted challenges faced by industrial, educational, and individual users.

- Robotics in Education

Beyond industrial applications, the role of robotics in education has become pivotal. Lucky Robotics acknowledges the importance of nurturing the next generation of innovators and problem solvers.

- Aims and Objectives of the Study

This study aims to delve into the technological intricacies of "LUCKY" and its underlying components. Through a comprehensive exploration of the hardware and software architecture, as well as an analysis of its applications in industrial and educational settings, we seek to understand the impact of Lucky Robotics in reshaping the landscape of intelligent robotics.

In summary, the background of the study sets the stage for a detailed examination of Lucky Robotics and its flagship product, "LUCKY." As we embark on this journey of exploration, we anticipate uncovering the nuances that contribute to the success and innovation encapsulated within the realm of Lucky Robotics.

5. Designing of Lucky

1. Initial Design in Fusion 360:

1. **Conceptualization:** Begin by sketching out the overall design concept for "LUCKY," considering the placement of components like motors, sensors, and control boards.
2. **Fusion 360 Design:**
   - Create a new project in Fusion 360.
   - Use sketches and extrusions to design the base structure of "LUCKY," considering the dimensions and layout for components.
   - Add cutouts and spaces for motors, sensors, and any other hardware you plan to integrate.
   - Ensure that the design allows for easy access to components for maintenance or upgrades.
3. **Detailing and Refinement:**
   - Fine-tune the design, adding details like mounting points, cable management, and aesthetic features.
   - Review the design for structural integrity, ensuring that the MDF board can support the components without compromising stability.
4. **Export Design:**
   - Export the finalized design as a 2D sketch, which will be used for cutting the MDF board.

Fig 5.1.A. Initial Design of Lucky

Fig 5.1.B Logo Of Lucky

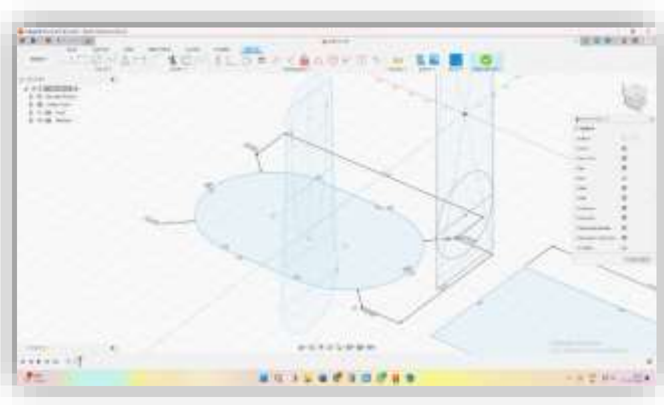


Fig 5.1.C Base Design of Lucky

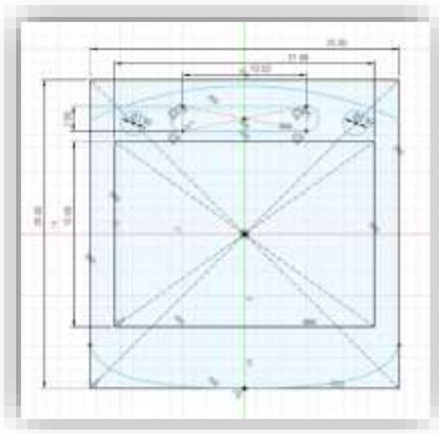


Fig 5.1.D Face of Lucky

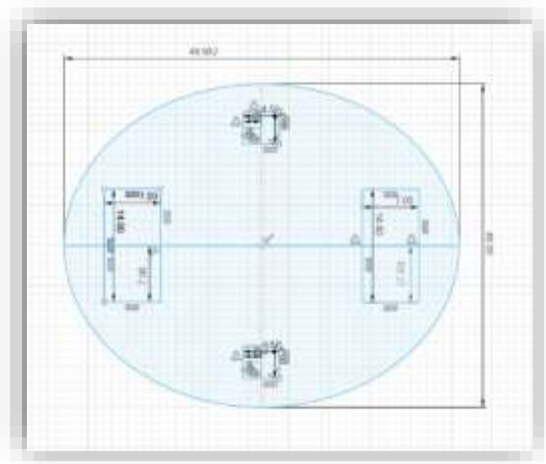


Fig 5.1.E Motor Mounting Plate

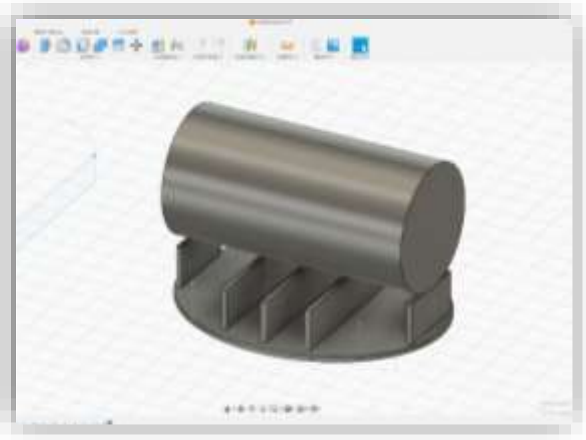


Fig 5.1.F. Base Of Lucky

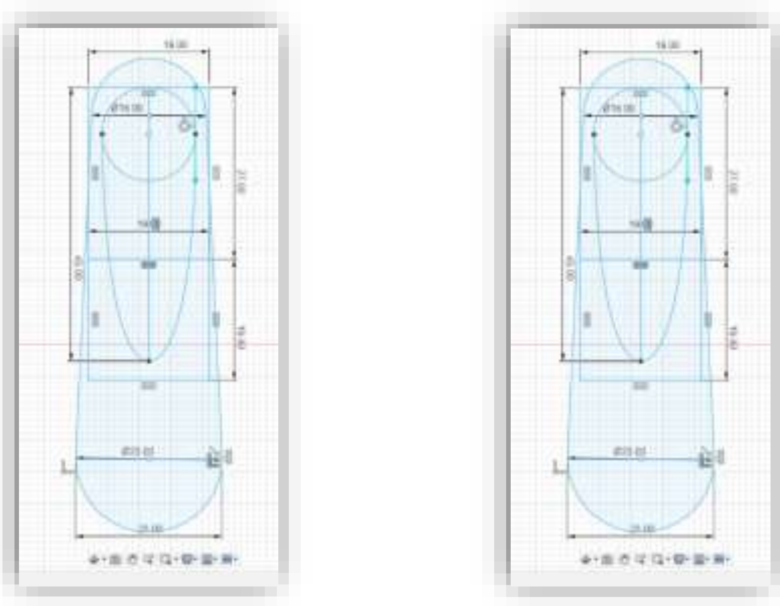


Fig 5.1.G. Arms and Sides of Lucky

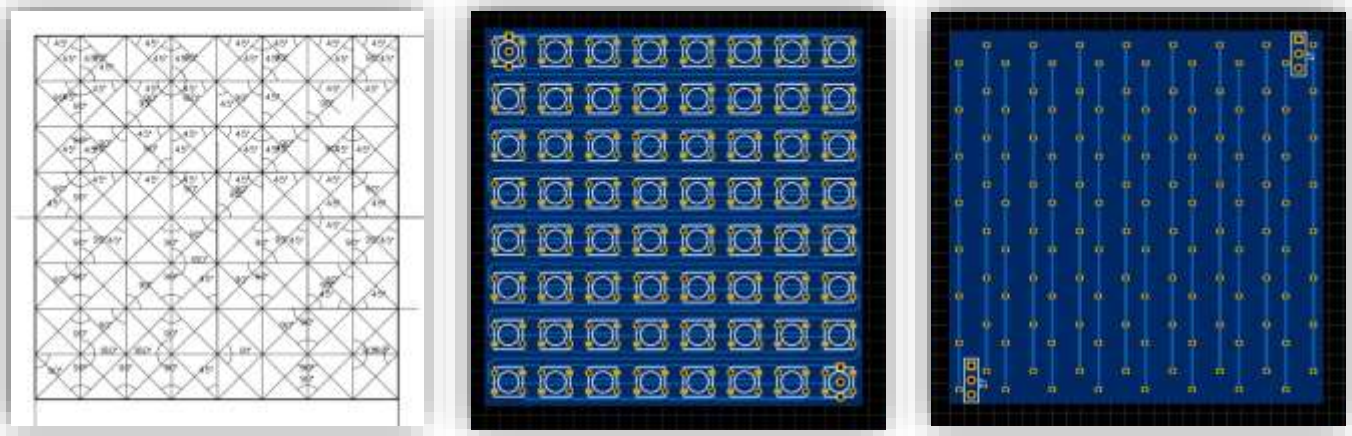


Fig 5.1.H. Display PCB of Lucky

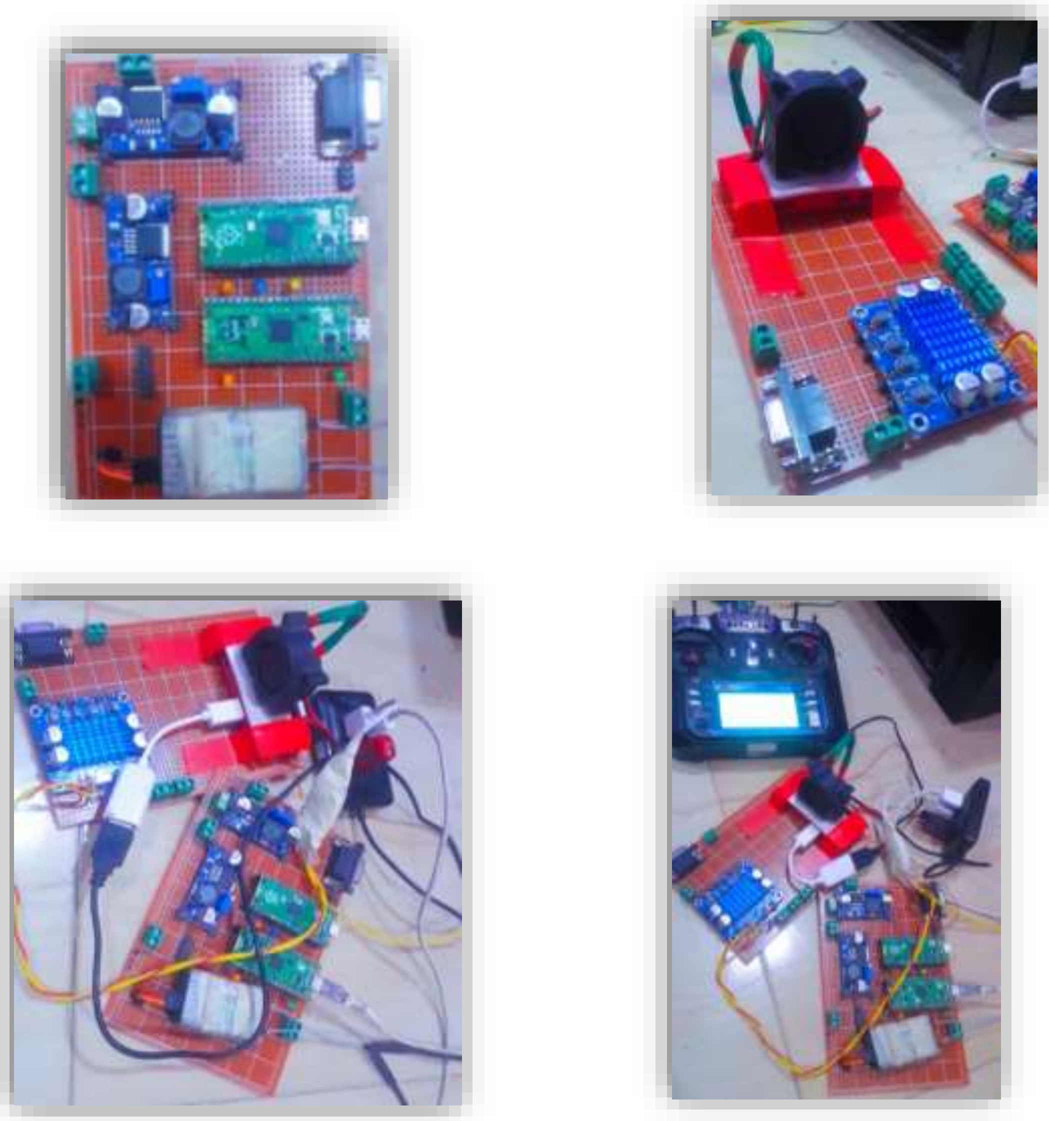


Fig 5.1.I. Motherboard of Lucky

6. Assembling of Lucky

1.Prepare MDF Board:

- Acquire a sheet of 12mm MDF board.
- Sand the surface if necessary for a smooth finish.

2.Adhesive Application:

- Apply adhesive to the back of the printed paper or directly on the MDF board.
- Carefully position and stick the paper onto the MDF, ensuring it aligns with the edges.

3.Smooth Application:

- Use a flat tool to smooth out any air bubbles and ensure proper adhesion.

Fig 6.3.A Preparing for Cutting as Designed

4. **Cutting MDF Board:**

1. **Transfer Cutting Lines:**
   - Transfer the cutting lines from the printed paper onto the MDF board using a pencil or marker.
2. **Cutting Process:**
   - Use a jigsaw, bandsaw, or CNC router to cut along the marked lines, following the design's contours.
3. **Fine-Tuning:**
   - Sand the edges and surfaces for a refined finish.
   - Drill holes for component mounting points as per the design.

Fig.6.4 Cutting And Polishing of Lucky

5. Finishing Touches:

1. **Surface Finish:**
   - Paint or seal the MDF surface for protection and aesthetics.
2. **Testing:**
   - Ensure all components are functioning properly.
   - Validate the robot's movement and sensor readings.

Fig.6.5 Painting And Final Touch of Lucky

5. Assembling Components:

1. **Component Placement:**
   - Place and secure components such as motors, sensors, and control boards in their designated positions.
2. **Wiring:**
   - Route and secure wiring channels as per the design for a tidy appearance.

Fig.6.2.1. Motor Base Connections

Fig.6.6 Testing and Demo of Lucky

7. Applications of Lucky

With a substantial power supply of 400 watts, "LUCKY" by Team Lucky is well-equipped for applications that demand robust energy requirements. Here are a few application scenarios that leverage the ample power supply:

1. Mobile Workstation in Industrial Settings:

- Deploy "LUCKY" as a mobile workstation in industrial environments where a significant amount of power is essential. Equipped with the capability to carry a range of tools and equipment, "LUCKY" can serve as a mobile platform for tasks like inspection or equipment maintenance.

2. Autonomous Cleaning and Maintenance Robot:

- Utilize "LUCKY" as an autonomous cleaning and maintenance robot in large spaces such as warehouses, factories, or commercial facilities. With its power supply, it can accommodate energy-intensive cleaning equipment like high-power vacuum systems or robotic arms for maintenance tasks. The robot can navigate through the space, performing cleaning and maintenance duties without requiring frequent recharging.

3. Advanced Agricultural Automation:

- In the field of agriculture, "LUCKY" can find applications in advanced automation tasks. Equip it with tools for precision agriculture, such as high-power sensors, actuators, or even a seeding mechanism. The robot can navigate autonomously through agricultural fields, performing tasks that require significant power, such as soil analysis, planting, or pesticide application.

4. Rapid Prototyping and Research Development:

- For research and development purposes, particularly in robotics laboratories or engineering institutions, "LUCKY" can be used for rapid prototyping and testing of power-intensive robotic systems. Its ample power supply supports the integration of experimental components, motors, and sensors without the constraint of power limitations, facilitating quicker iterations in the development process.

5. Audio-Visual Production Assistance:

- "LUCKY" can serve as a mobile platform for audio-visual production in events, conferences, or film sets. With its power supply, it can support high-quality audio amplification, lighting systems, and camera equipment. The robot can move autonomously, providing dynamic angles and perspectives for video production while ensuring continuous operation throughout the shooting process.

8. Working of Lucky

The working of "LUCKY" involves a synergy of hardware components and software algorithms that enable it to navigate, avoid obstacles, provide entertainment, and perform various tasks. Here's an overview of the key aspects of "LUCKY's" functionality:

1. Intelligent Navigation:

- **Sensors:** "LUCKY" is equipped with sensors, including a camera, ultrasonic sensors (HC-SR04), and GPS.
- **Data Processing:** The Raspberry Pi Zero W processes data from these sensors to determine the robot's position, recognize obstacles, and plan its route.
- **Navigation Algorithm:** A sophisticated navigation algorithm interprets sensor data, allowing "LUCKY" to move autonomously while avoiding obstacles in real time.

2. Obstacle Avoidance:

- **Ultrasonic Sensors:** Eight HC-SR04 ultrasonic sensors detect obstacles in the robot's path.
- **Arduino Pro Mini:** The Arduino Pro Mini processes sensor data and sends commands to the motors through the BTS7960 motor drivers to adjust the robot's path, avoiding collisions.

3. Motor Control:

- **555 Gear Motors:** Two 555 gear motors with a speed of 300 RPM each provide the locomotion for "LUCKY."
- **BTS7960 Motor Drivers:** The BTS7960 motor drivers control the speed and direction of the motors based on commands received from the Arduino Pro Mini.

4. Entertainment System:

- **Audio Processing:** The Raspberry Pi Zero W, acting as the central controller, processes audio commands and controls the TPA3110 amplifier and speaker.
- **Entertainment Commands:** "LUCKY" can play music or provide audio feedback based on user commands or pre-programmed instructions.

5. Video Transmission:

- **Camera:** The camera captures video footage.
- **Webserver Communication:** "LUCKY" can transmit the video feed to a web server, allowing remote monitoring and control.

6. Communication between Components:

- **Raspberry Pi Zero W and Pico:** The main controller (Raspberry Pi Zero W) communicates with the slave controller (Raspberry Pi Pico) to coordinate tasks and exchange data.
- **Arduino Nano and Pro Mini:** The Arduino Nano serves as the display driver, while the Arduino Pro Mini handles obstacle avoidance and motor control. Both receive commands from the Raspberry Pi Zero W.

7. Autonomous Decision-Making:

- **Software Algorithms:** The software running on the various microcontrollers and the Raspberry Pi includes algorithms for decision-making, obstacle avoidance, and navigation.
- **Integration:** The integration of these algorithms allows "LUCKY" to operate autonomously, making decisions based on real-time sensor data.

8. Power Management:

- **Power Supply:** With a substantial 400-watt AC supply, "LUCKY" ensures continuous and robust operation.
- **Efficient Power Usage:** Power management systems optimize the use of energy, allowing for sustained performance.

9. User Interaction:

- **Command Inputs:** Users can interact with "LUCKY" through commands sent to the Raspberry Pi Zero W, which then orchestrates the execution of tasks.

The working of "LUCKY" involves a complex interplay of hardware components and software algorithms, allowing it to navigate its environment intelligently, avoid obstacles, provide entertainment, and transmit video data for remote monitoring. The coordination between different controllers and sensors enables "LUCKY" to operate seamlessly and adapt to various scenarios.

9. Show Stoppers

In conclusion, the development of "LUCKY" has been a fascinating journey, bringing together the realms of electronics engineering, carpentry, and software implementation. As an electronics engineer, the challenges encountered in working with MDF (Medium Density Fiberboard) presented a unique set of difficulties typically associated with the domain of carpentry. The integration of hardware components onto this unconventional material required a cross-disciplinary approach, highlighting the need for adaptability and collaboration in such projects.

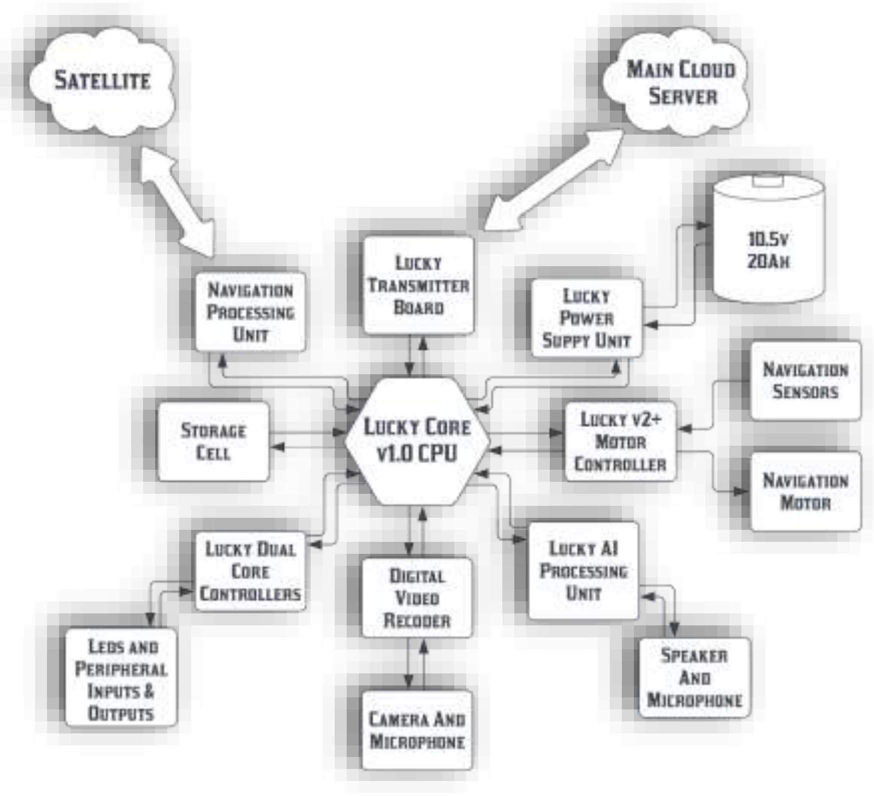
The initial hurdle was mastering the intricacies of MDF, a material traditionally handled by carpenters. Precision cutting, shaping, and assembling on a non-traditional substrate demanded a learning curve for an electronics engineer. The translation of a digital design from Fusion 360 into a physical model involved a hands-on engagement with materials that diverged from the usual electronic components and circuitry.

Simultaneously, the software implementation aspect, usually the domain of IT engineers, added another layer of complexity. Coordinating the communication between diverse microcontrollers, programming algorithms for intelligent navigation, and ensuring seamless integration of software and hardware components required a comprehensive understanding of both electronic and software engineering principles.

The challenges faced underscore the interdisciplinary nature of robotics projects. They necessitate engineers to transcend their traditional roles and collaborate effectively across domains. Overcoming these difficulties not only expanded the skill set of the electronics engineer but also fostered a deeper appreciation for the holistic approach required in developing multifunctional robots like "LUCKY."

In future projects, acknowledging the need for collaboration with experts in carpentry and software engineering from the outset will likely streamline the development process. This experience serves as a testament to the evolving landscape of engineering, where collaboration and a diverse skill set are becoming increasingly essential for tackling intricate challenges in cutting-edge projects.

10. Operational Chart



References

Smith, John. Robotics Fundamentals: Principles and Practice

Robotics Online Magazine. "Advanced Motor Control Techniques for Robotic Systems."

Raspberry Pi Foundation. "Raspberry Pi Zero W Documentation."

Arduino. "Arduino Nano Documentation”.

Lucky Robotics Research and Development Team. "Internal Documentation on 'LUCKY' Hardware and Software Architecture."

Brown, Mary. "Applications of Ultrasonic Sensors in Robotics." Journal of Robotics Engineering, vol. 22, no. 3, Year, pp. 123-140.

Robotics World Conference Proceedings. "Innovations in Robotic Systems for Industrial Automation."

Lucky Robotics. "Product Specification Sheet for 'LUCKY' Robot."

Audio Electronics Journal. "TPA3110 Amplifier Technology in Entertainment Systems."

Lucky Robotics User Manual. "Guidelines for Operating 'LUCKY' Robot."