Universal Hand Tool Handle with Real-Time Tracking

Field of Invention

The present invention relates to tool tracking and management systems, particularly within the aviation maintenance sector. Specifically, it concerns a universal hand tool handle embedded with Bluetooth Low Energy (BLE) technology. This handle is designed to accommodate various straight tools, such as screwdrivers and spanners, and integrates BLE components to provide real-time tracking and management. The innovation ensures accurate tool location and minimizes signal interference, addressing the challenges associated with tool misplacement in metal-rich environments typical of aviation maintenance. This invention enhances both the efficiency and safety of tool management for airframe technicians.

Background

In aviation maintenance, the accidental misplacement of hand tools can lead to severe safety hazards, including mechanical failures and system malfunctions. Existing solutions, such as RFID systems and shadow boards, can indicate when a tool is missing but do not provide the exact location of the missing tool. Additionally, standard operating procedures (SOPs) rely on human compliance, which is prone to errors. There is a need for a more reliable and efficient system to track and manage tools in aviation maintenance.

Effective tool control is crucial in the aviation maintenance environment. At best, lost tools result in an expensive waste of time and resources; at worst, they can cause catastrophic failures, which may be life-threatening. Proper tool management enhances workplace efficiency and safety.

In structured environments, engineers typically visit a tool store to retrieve a toolbox. Before beginning their work, they may use systems like RFID to scan each tool within the box. This system registers the tools, ensuring all are accounted for before the engineer proceeds. For very small tools, such as Allen keys, that are difficult to scan, a visual check is performed. Some toolboxes use shadow boards, making it visually obvious when a tool is missing. SOPs are in place to ensure all tools are accounted for, including multiple checks before work begins. This system is essential, especially in environments where toolboxes are shared among multiple engineers.

However, using RFID or a shadow board is not a foolproof solution. While these methods can indicate when a tool is missing, they do not provide information on the tool's location. Additionally, SOPs rely on human compliance, and human error can still occur. Some commercial aviation companies do not use such systems because each engineer typically has their own toolbox, but supplying each engineer with a personal set is impractical. Aviation toolboxes are designed to be durable and are much more expensive than standard commercial toolboxes.

Existing Solutions

1. RFID Systems: These systems are designed to track tools by scanning RFID tags. While they can indicate the presence of tools, they often face limitations in high-metal environments, where signal interference can compromise accuracy. Furthermore, RFID systems typically do not provide real-time location data for misplaced tools, making it challenging to pinpoint the exact whereabouts of a missing item.

2. Shadow Boards: Shadow boards visually represent the layout of tools, making it easier to identify missing items at a glance. However, they do not offer precise location information and rely on manual inspection. This method is inherently limited by its reliance on visual checks, which can be error-prone and may not be effective in all situations.

3. Standard Operating Procedures (SOPs): SOPs involve a series of manual checks to ensure all tools are accounted for before work begins. Although SOPs are designed to maintain tool control, their effectiveness is dependent on human accuracy and adherence. This reliance on manual processes introduces the risk of human error, which can lead to gaps in tool management and tracking.

Challenges with Current Methods

1. Signal Interference:

    1.1. High-metal environments, common in aviation maintenance settings, can disrupt signals from RFID and other tracking systems, resulting in unreliable tool tracking. This interference affects the ability to accurately locate and manage tools.

2. Tool Modifications:

    2.1. Existing tracking solutions may require modifications to the tools themselves, which can affect their functionality and usability. Such modifications can be impractical and costly, especially for specialized aviation tools.

3. Human Error:

    3.1. The effectiveness of SOPs and visual inspection methods is limited by the potential for human error. Manual checks are susceptible to inaccuracies, which can lead to missed or misplaced tools and undermine overall tool management.

4. Cost and Practicality:

    4.1. Providing each engineer with a personal toolbox, as an alternative to shared toolboxes, is often impractical due to cost and space constraints. Aviation

toolboxes are designed for durability and are significantly more expensive than standard commercial toolboxes, making individual tool management a challenging and costly solution.

In summary, while current methods like RFID systems, shadow boards, and SOPs offer some degree of tool management, they each have limitations that hinder their effectiveness in high-metal environments and in ensuring precise tool location. There is a pressing need for a more reliable, efficient, and practical solution to address these challenges and enhance tool management in aviation maintenance.

Summary of the Invention

The present invention relates to a universal hand tool handle embedded with Bluetooth Low Energy (BLE) technology, specifically designed for use in aviation maintenance. The universal handle accommodates various straight tools, such as screwdrivers and spanners, and integrates BLE components to provide real-time tracking and management.

The invention's key novel aspect is the BLE configuration, which includes a sleep mode to reduce signal interference and enhance accuracy in high-metal environments. The BLE beacon is programmed to recognize only signals from a designated mobile application, ensuring secure and precise tool tracking.

This innovative handle offers several advantages: it maintains the tool's original form and function while providing effective tracking capabilities, reduces the risk of tool misplacement, and minimizes signal interference. By addressing the limitations of existing systems, such as RFID and shadow boards, the invention enhances tool management efficiency and safety in aviation maintenance environments.

Detailed Description of the Invention

Overview

The present invention is a universal hand tool handle embedded with Bluetooth Low Energy (BLE) technology, designed specifically for tracking and managing airframe technician tools in aviation maintenance, combined with a mobile application designed as a locator for assisting in finding misplaced tools. The handle is engineered to be compatible with various hand tools, including but not limited to screwdrivers, spanners, and other straight tools, allowing seamless integration without altering the tool's form or function.

Detailed Description of the Universal Handle with Integrated BLE Module

The present invention is a universal hand tool handle embedded with Bluetooth Low Energy (BLE) technology, designed specifically for tracking and managing airframe technician tools in aviation maintenance. The handle is engineered to be compatible

with various hand tools, including but not limited to screwdrivers, spanners, and other straight tools, allowing seamless integration without altering the tool's form or function. The universal handle designed for Airframe Technician tools is an advanced tool that combines ergonomic functionality with cutting-edge BLE (Bluetooth Low Energy) technology for efficient tool tracking and management. This handle is engineered with dual ends, each serving a distinct purpose to enhance usability and safety in aviation maintenance operations.

1. Structure of the Universal Handle

The universal handle comprises the following key components:

1.1. Handle Body (101): The main structure of the handle is ergonomically designed for comfortable grip, Figure 6 and efficient use. The handle is constructed from a durable, lightweight material such as reinforced plastic or composite material, capable of withstanding the rigors of aviation maintenance environments. Figure 1.

1.2. Tool Attachment Mechanism (102): The handle is designed with a built-in, secure, and non-detachable universal attachment mechanism at one end. This mechanism is factory-fitted to securely hold various tool heads, such as screwdriver bits, spanner ends, and other straight tool components. The attachment mechanism includes a locking feature that ensures the tool head is permanently secured during manufacture, preventing detachment during use. This integral design enhances safety and reliability, particularly during critical maintenance tasks, Figure 1.

1.3. Embedded BLE Module (103): The Bluetooth Low Energy (BLE) module is housed at the end of the handle. This placement securely encloses the BLE module within the handle, preserving the tool’s form and functionality while providing real-time tracking and location capabilities. The module's location ensures it is an integral part of the handle design, maintaining the tool’s durability and usability without any external attachments, Figure 1

1.4. Power Source (104): A small, high-capacity battery powers the BLE module. The battery is embedded within the handle and designed to last for extended periods without frequent recharging. The power source may also include energy-saving features, such as a low-power sleep mode, to extend battery life. Figure 1.

1.5. Antenna Placement (105): The BLE antenna is placed facing outward, away from any metal components of the tool, to reduce signal interference. The antenna placement ensures consistent and reliable communication with the mobile application.

2. Handle Design: Material: The handle is constructed from a high-strength, lightweight material, ensuring durability and ease of use in rigorous aviation environments.

2.1. Ergonomics: The handle features an ergonomic design that provides a comfortable grip, reducing hand fatigue during extended use. The surface is textured or coated to prevent slippage, ensuring secure handling even in challenging conditions.

2.2. Dual-End Structure:.

2.2.1. Front End:

2.2.1.1. Tool Attachment: The front end of the handle is designed to grip various tool heads, such as screwdrivers, spanners, or other similar tools. The gripping mechanism is versatile, allowing it to accommodate both round and flat tool bars. Figure 3

2.2.1.2. Secure Grip: The front end provides a firm grip on the tool head, ensuring it remains securely attached during use. This design is crucial for maintaining the integrity of the tool during critical maintenance tasks, where any detachment could result in operational failure. Figure 3

2.2.1.3. Non-Detachable Mechanism: Once a tool head is attached to the front end, it is locked into place, making it non-detachable. This feature prevents accidental disassembly, ensuring that the tool remains fully functional throughout its use. This Non-Detachable Mechanism is factory-fitted during manufacturing and is not an add-on. Figure 4.

2.2.2 Back End:

2.2.2.1 Round Cap with BLE Housing: The back end of the handle features a round cap that houses the BLE module and is securely fastened to the handle permanently. Figure 5

2.2.2.2 BLE Module Integration: The BLE module embedded within the round cap is responsible for the tool's tracking capabilities. The module remains in sleep mode until activated by a connected mobile app or BLE reader, preventing unnecessary signal interference.

2.2.2.3 Power Supply: The BLE module is powered by a compact, long-lasting battery located within the cap. The cap design allows for easy access to the battery compartment when replacement is

necessary, without compromising the integrity of the tool. Figure 5

3. Functionality:

    3.1. Tool Tracking**:** The integrated BLE module allows for precise tracking of the tool's location within the work environment. This feature is particularly useful in aviation maintenance, where the accurate accounting of tools is essential for safety and efficiency.

    3.2. Easy Activation**:** The BLE module can be activated via a mobile app or a BLE reader, enabling real-time location tracking. This functionality helps prevent tools from being misplaced or left behind, significantly reducing the risk of foreign object damage (FOD) in aircraft.

    3.3. Durable and Secure: The combination of a secure, non-detachable tool head and a robust BLE housing ensures that the tool is both durable and reliable. The cap design of the BLE housing protects the electronic components while allowing for easy maintenance, Figure 4.

4. BLE Configuration and Operation

    4.1. The BLE module is configured to operate primarily in a low-power sleep mode to minimize energy consumption and prevent unnecessary signal emissions in sensitive aviation environments. The module is programmed to wake up or enter active mode only when it receives a specific signal from the associated mobile application.

    4.2. Sleep Mode: In its default state, the BLE module remains in sleep mode, consuming minimal power. This mode is critical for preserving battery life and reducing signal interference within the high-metal environment of aviation maintenance.

    4.3. Wake-Up Protocol : The BLE module includes a wake-up protocol triggered by a unique signal from the mobile application. When the application initiates a handshake, the BLE module transitions from sleep mode to active mode, enabling real-time tracking and location of the tool.

    4.4. Secure Communication: The BLE module is configured to recognize and respond only to signals from the designated mobile application. This ensures secure communication, preventing unauthorized devices from interacting with the tool’s BLE module

5. Mobile Application:

    5.1. User Interface: The mobile application features an intuitive user interface, allowing technicians to easily search for and locate missing tools. The interface displays the real-time location of the tool, along with signal strength indicators to assist in the retrieval process.

5.2. Tool Management: The application allows users to register multiple tools, assign unique identifiers, and track their status. The tool management system helps technicians keep an organized inventory of their tools, reducing the risk of misplacement. The mobile application is an integral part of the tool tracking system. It is designed to facilitate the detection, location, and retrieval of tools equipped with the BLE-embedded universal handle.

5.3. Proximity Detection: The application includes a proximity detection feature, which alerts the user when they are within a specified range of the missing tool. This feature is particularly useful in large maintenance areas where tools can be easily misplaced.

5.4. Compatibility**:** The mobile app is compatible with various smartphones and tablets, ensuring widespread usability across different devices used by aviation maintenance personnel.

6. Operation Process:

6.1. Hand-tool: The universal handle is an integral part of the product design, permanently fitted during manufacturing, Figure 2.

6.2. Tool Misplacement: If the tool is accidentally left behind or misplaced, the technician can use the mobile app to locate it. The app communicates with the BLE module, awakening it and guiding the technician to the tool's location.

6.3. Tool Recovery: The app provides precise location data, helping the technician recover the tool quickly, thereby preventing potential safety hazards or delays in operations.

Claims

What is claimed:

1. A tool tracking system for aviation maintenance, comprising:

    1.1. A plurality of tools, each integrated with a Bluetooth Low Energy (BLE) component embedded within the tool in a manner that does not alter its original form, design, or usability as shown in Figure 1

    1.2. A mobile application configured to detect BLE signals from the embedded components in outdoor environments, activate the BLE components, and provide real-time location data, including directional guidance to locate misplaced tools.

    1.3. An indoor detection system comprising a network of BLE readers configured to continuously scan for BLE signals from the embedded components, providing precise location data within an indoor environment and ensuring comprehensive coverage.

    1.4. A real-time alert system configured to notify maintenance personnel if a tool is misplaced or not returned to its designated storage area.

2. The system of claim 1, wherein the BLE components are securely embedded within the tool's structure, ensuring they are protected from environmental factors and mechanical stress while maintaining the tool's original functionality.

3. The system of claim 1, wherein the indoor detection system addresses BLE signal limitations by:

    3.1. Strategically positioning BLE readers to ensure optimal coverage, particularly in areas with common metal obstructions.

    3.2. Employing BLE signal repeaters to extend the detection range and enhance performance in challenging environments.

    3.3. Designing tool storage areas to minimize signal obstruction, using materials that do not interfere with BLE signals.