Ultra-Wide Band (UWB) Distance Measurement Device

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A solar-powered smart golf assistant with Time of Flight (ToF) sensing and club recommendation using LoRa communication and an intuitive OLED display

01. Introduction

Accurate distance measurement is vital for strategic decision-making on the golf course. This project introduces a portable, dual-unit system that leverages Ultra-Wideband Time-of-Flight ranging and barometric sensing to deliver real time, centimetre-level accuracy, even under non-line-of-sight conditions. Built around ESP32 microcontrollers with solar assisted power and wake-up protocols, the flagstick-mounted transmitter and handheld receiver collaborate to calculate 3D distances and suggest the optimal club based on your personal shot data. Field tests show average errors within ±30 cm, demonstrating the system's readiness for practical play and future commercialisation.

02. Objective

Enhancing Golf Performance with Precision Distance Measurement and Smart Club Selection.

Why a New Approach?

Conventional golf distance tools like GPS devices and laser rangefinders face key limitations:

- GPS lacks accuracy, with typical errors of ±3–5 metres and poor elevation data.
- Laser rangefinders require a clear line of sight and manual targeting, making them unreliable in obstructed or uneven terrains.

This project introduces a Time-of-Flight and LoRa-based system that overcomes both issues by delivering centimetre-level accuracy and automatic club suggestions, even under non-line-of-sight conditions.

03. Methodology

- **Designed a dual-unit system: flagstick mounted transmitter and handheld receiver**
- **Utilised UWB ToF sensor for centimetre level distance accuracy**
- **Integrated barometric sensor for elevation compensation in distance calculations**
- **Employed LoRa communication for low-power, long-range data transfer**
- **Developed custom firmware on ESP32 microcontrollers**
- **Powered handheld unit via rechargeable battery, and flagstick unit via solar power**
- **Calibrated and tested system under Line-of-Sight (LoS) and Non-Line-of-Sight (NLoS) conditions**

04. Results/Findings

Extensive testing was conducted to evaluate the system's performance in real world golfing scenarios.

- Achieved highly accurate distance measurements, with errors approximately 30 cm
- System worked reliably even when the flagstick was not visible (e.g. behind trees or hills)
- Club suggestions were accurate and adjusted for elevation changes
- The OLED display provided clear, easy to read feedback during testing
- The device remained powered all day using a combination of solar and rechargeable battery
- Field tests showed the system was easy to use, requiring no manual input from the user
- Demonstrated greater consistency and ease of use compared to traditional GPS and laser tools

These results confirm the system's potential as a practical, user friendly solution for enhancing decision-making on the golf course

05. Analysis

- Performance across all test scenarios suggests that combining Time-of-Flight UWB with barometric altitude sensing can effectively overcome the limitations of GPS and laser-based systems, especially in uneven or obstructed terrain.
- Minor deviations in accuracy were generally linked to barometric drift and environmental factors such as pressure variation or dense foliage — indicating potential areas for further refinement.
- The system's low dependency on user input and real-time feedback highlight strong potential for enhancing usability, particularly for less experienced golfers.
- Consistent functionality during non-line-of-sight testing suggests the communication and wake-up protocols were effectively implemented and robust enough for real-world course conditions.
- The success of the solar-powered design confirms that energy-efficient architecture can support continuous outdoor use without sacrificing performance.
- Overall, the project demonstrates that UWB-based solutions can fill a clear gap in existing golf tech by delivering both accuracy and autonomy, while remaining simple to operate.

06. Conclusion

"This project demonstrates that UWB technology can deliver precise, real time distance measurement and smart club selection in varied golf course conditions. While results are promising, future work will focus on reducing barometric drift, enhancing non-line-of-sight accuracy, and exploring commercial integration