Project #48:

Sunlink II- Light Based Wireless Communication Using Sunlight

Problem Space & Background

- Wireless IoT sensors demand **ultra-low-power communication** for remote, battery-free operation.
- RF unfeasible due to **spectrum congestion** and **high power** requirements. [1]
- Traditional visible light communication relies on **active light,** consuming significant energy.
- Need for a **passive system** that utilises **ambient sunlight** to transmit data [2].

This problem space resulted in a project set out to *design* and *implement* a reliable, ***sun-light*** based ***wireless communication*** system, where ***sun-tracking*** **technology** is used alongside ***scalable system-to-system*** transmission.

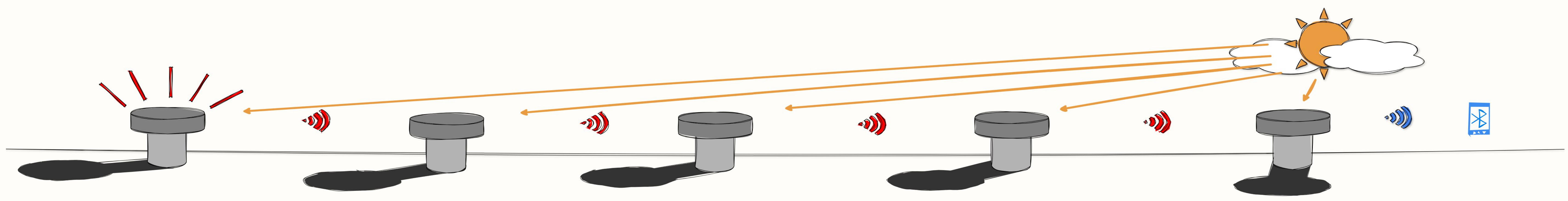
Research Outcomes & Goal

Several research approaches existed but we settled on

- Designing a **multi-node communication network**.
- An optimized **sun-tracking subsystem** to enhance data link performance.
- A comparative analysis to the system's **feasibility** and **scalability** relative to existing communication technologies.

Direction & Plan

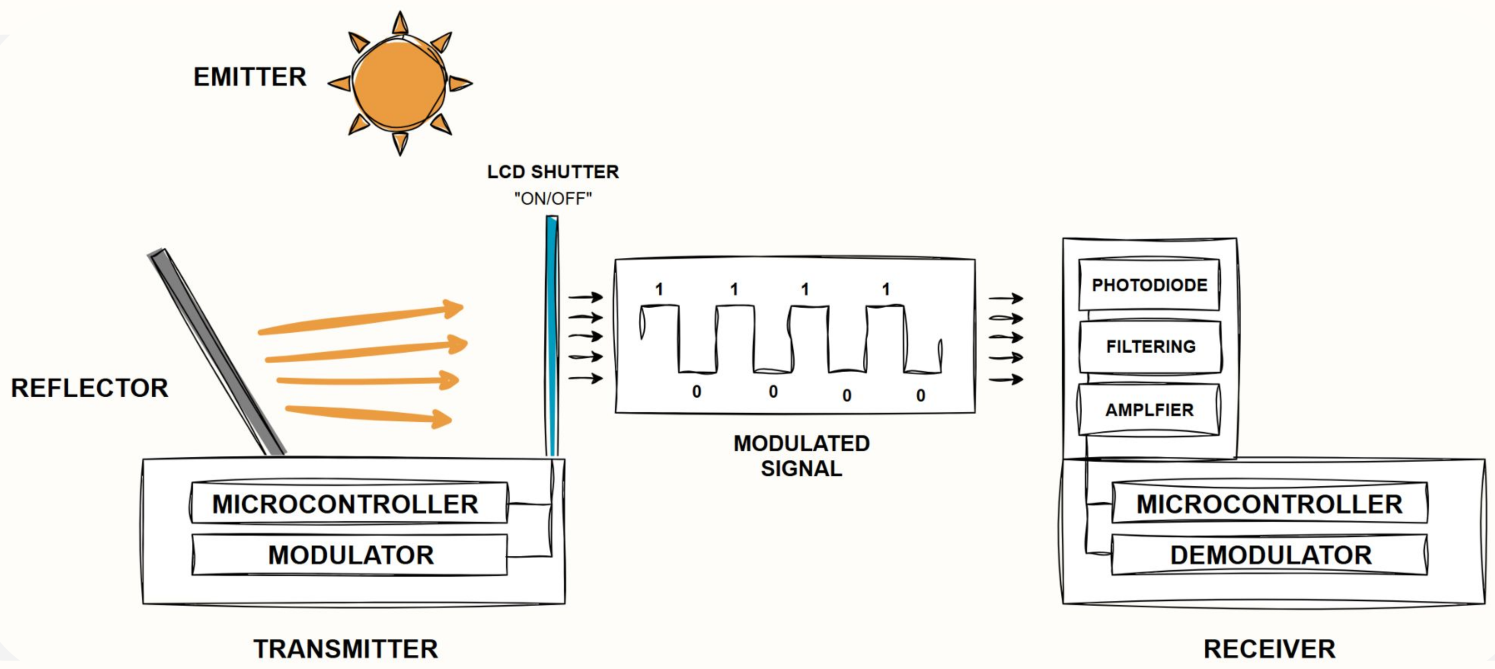
1. Develop ***sun tracking*** subsystem
2. *Develop* ***multi-nodal*** *communication* subsystem.
3. Test system to evaluate feasibility.



System Design

Our approach set out to combine *two elements* of subsystems a **multi-nodal system** & a **sun-light tracking** system.

- A ***sunlight detection array*** composed of photodiodes and LDRs arranged in an equidistant grid enabling accurate light sensing, while a ***dual-axis*** motor control system adjusts the tracker's orientation to maintain optimal alignment with the sun.
- For the ***multi-nodal*** communication subsystem, a torch served as the primary light source, with an LCD controlled by a microcontroller to modulate the light, and a photodiode circuit detecting light intensity changes for signal decoding.



Results

- While the dual-axis ***sun-tracking subsystem*** enhanced light collection efficiency, the corresponding increase in ***motor power consumption*** negated the benefits, indicating that full tracking is unsuitable for ultra-low-power system designs.
- The multi-nodal communication subsystem successfully transmits and receives data, but the ***operational range*** is ***severely limited.***

Recommendations

Based on our findings further development should investigate ***alternative*** tracking strategies, such as lightweight single-axis control or passive optical alignment, to ***enhance light collection*** while preserving the system's ***ultra-low-power operation***.

The implementation of the communication system is very primitive, so ***further development*** and ***improved decoding algorithms*** could significantly improve operational range.

References

[1]. Radio Spectrum Management, "Radio Spectrum Allocation Chart - New Zealand," https://www.rsm.govt.nz, 2024, (accessed May.3, 2024)

[2] R. Bloom, M. Z. Zamalloa, and C. Pai, "Luxlink: Creating a wireless link from ambient light," in Proc. ACM SenSys, 2019

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