Combined GPS and Intensity-based Alignment of Laser Devices

Product Requirements

Track Tech

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Document History

Rev Number	Date	Modified By	Reason
1	Sep. 18, 2023	All	First Draft
2	Sep. 21, 2023	All	Initial Release

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Objective

The objective of this document is to define the requirements for enabling the fast and correct alignment of over-the-air (fiber launching) optical communication devices.

Scope

The scope of this document is to define the plan to implement and test embedded software to drive a robotic arm for optical beam alignment between two devices. There is already an initial design in place, but we can improve arm design and implementation as needed. The devices needed alignment should communicate with each other about location and attitude and use that to focus a laser signal to each other and align such signal to maximum strength.

References

Acronyms

GPS   Global Positioning System
LED   Light-Emitting Diode
POC   Proof of Concept
USB   Universal Serial Bus

Functional Requirements

User Interface Requirements
The operator shall not be required to make any decisions in order to align the devices. After beginning the program, the alignment process shall be fully automatic.

What it should do
The devices shall rotate an optical sender and receiver about two axes. They shall use a combination of GPS-determined position and signal strength to form and optimize a connection for data transfer. This alignment process shall work at a minimum distance of 6 feet.

Mechanical Requirements

Spatial Requirements
The devices shall each fit within a 1x1x1 ft cube.

Weight/Mass Requirements
The devices shall weigh fewer than 10 lbs each to ensure easy human portability and minimize load when placed on shelves or server racks.

Electrical Requirements

The devices shall receive electricity from a standard external power supply, via means such as a USB cable or electrical outlet.

Software Requirements

Functionality
Each device shall use a GPS component to determine its position. The two devices shall then communicate with each other to determine their relative positions, before rotating to face each other and finally beginning fine calibration based on signal strength.

User Interface
The program for aligning the devices shall be triggered by pressing a button. No data entry shall be required, and no user input shall be required past this point. Aborting the alignment process shall also be a single button press.

Diagnostic information, such as alignment status, shall be provided through blinking LEDs with clearly documented meaning.

Program Structure
The program shall be written in a modular style, emphasizing the usage of compartmentalization and functions. All logic central to the goal of aligning optical devices, rather than specific to the hardware or other details of the actual devices used, shall be transferable. This has the goal of enabling application to more contexts than our prototype devices, potentially at far greater distances.

After initial alignment and formation of an optical connection, already existing software provides support for maximizing signal strength across that connection. Our software shall interface with and make use of that software for fine calibration.

Cost Requirements

Prototype Cost
Cost to build a POC prototype shall not exceed $300. Our final concept will consist of improvements made to an existing prototype.

Schedule Requirements

The following are the major Project Milestones:
Fall
- Project Definition Documents   Sept. 21, 2023
- Project Plan Documents   Oct. 3, 2023
- Snapshot Day #1   Oct. 10, 2023
- Concept Design Review   Nov. 10, 2023
- Snapshot Day #2   Dec. 5, 2023
- Project Portfolio   Dec. 8, 2023

Spring
- Snapshot Day #3   March 27, 2024
- ER Review   Feb. 16, 2024
- UI Design EXPO   April 26, 2024
- Final Report / Drawings   May 4, 2024