SCET-MITWPU

Title of Project

Domain of Project

Industry Supported/ In-House Project

- Names of Students with ERP nos :

  1032201938 Yash Bhavsar
  1032202170 Shreyash Sontakke
  1032202209 Mrunal Dande
  1032202223 Yuvraj Khedekar

- Name of BTech Capstone Project Guide : Dr. Sanket Salvi
- Number of Time Students met the Project Guide : 5
- Are the slides approved by Project Guide YES/NO:

Contents

Introduction

A key element of display-based optical camera communication is pattern recognition. Each pattern demands significant processing resources to decode. A growing number of Internet of Things (IoT) areas are interested in using optical camera communication (OCC) to offer non-radio frequency-based communication solutions. This OCC system is based on quantum chromodynamics (QCD) concepts and can provide user-centric multiple-input multiple-output (MIMO) capabilities. In order to obtain longer communication distance and effective pattern classification, Quantum Chromodynamics Inspired 2D Multicolor LED Matrix to Camera Communication. Using nested outer and inner patterns, custom patterns are created at the transmitter based on input data. For quicker decoding on the receiver side, inner and outer patterns are subjected to multi-threaded pattern matching simultaneously. The steps involved are encoding the bit pattern and decoding the same.

Motivation

The motivation behind using a Raspberry Pi as a Li-Fi LED transmitter is to explore and implement a cost-effective and versatile solution for wireless data communication. Li-Fi (Light Fidelity) technology leverages visible light to transmit data, offering several advantages:

1. High Data Rates: Li-Fi can achieve significantly higher data transfer speeds compared to traditional Wi-Fi, making it suitable for applications where fast data transmission is crucial.

2. Security: Li-Fi is more secure since it's confined to the area illuminated by the LED, reducing the risk of eavesdropping compared to radio waves.

3. Energy Efficiency: LED lights are energy-efficient, making Li-Fi a green technology. It aligns with the growing emphasis on energy conservation.

4. Infrastructure Utilization: Li-Fi can use existing LED lighting infrastructure, reducing the need for additional hardware.

5. Interference-Free: Li-Fi operates in the visible light spectrum, which is generally free from interference, making it a valuable option in environments with high radio frequency interference.

By using a Raspberry Pi as the control unit for the Li-Fi LED transmitter, developers and hobbyists can experiment with and implement Li-Fi technology in various applications, such as smart homes, indoor navigation, secure communication, and more, in a flexible and accessible manner.

Literature Survey

- We examine the importance and possibilities of this innovative technology. This method entails creating a 2D multicolor LED matrix that uses user-centric MIMO (Multiple-Input, Multiple-Output) principles to connect with a camera.
- The 2D matrix, which is made up of different coloured LEDs, enables data to be transmitted simultaneously, greatly improving data speeds and dependability.
- User-centric MIMO offers an interactive and effective method of information exchange by customizing the communication experience to match the unique requirements and expectations of the end user.
- The system's design gains a distinctive dimension from the incorporation of quantum chromodynamics-inspired methodologies, which tackles the advantages and disadvantages of this innovative method of optical communication.
- In order to shed light on the exciting future potential in this field, this literature review explores the history, implications, and future prospects of this technology. It also covers its architecture, hardware and software requirements, alignment, calibration, security measures, performance, and user-centric applications.

Problem Statement

Design and implementation of Visible Light Communication Transceiver Pair using RPi, Camera and 8x8 LED matrix

A key element of display-based optical camera communication is pattern recognition. This OCC system is based on quantum chromodynamics (QCD) concepts and can provide user-centric multiple-input multiple-output (MIMO) capabilities.

Requirements Gathering

The H/w & S/w Requirements are as follows:

Hardware:

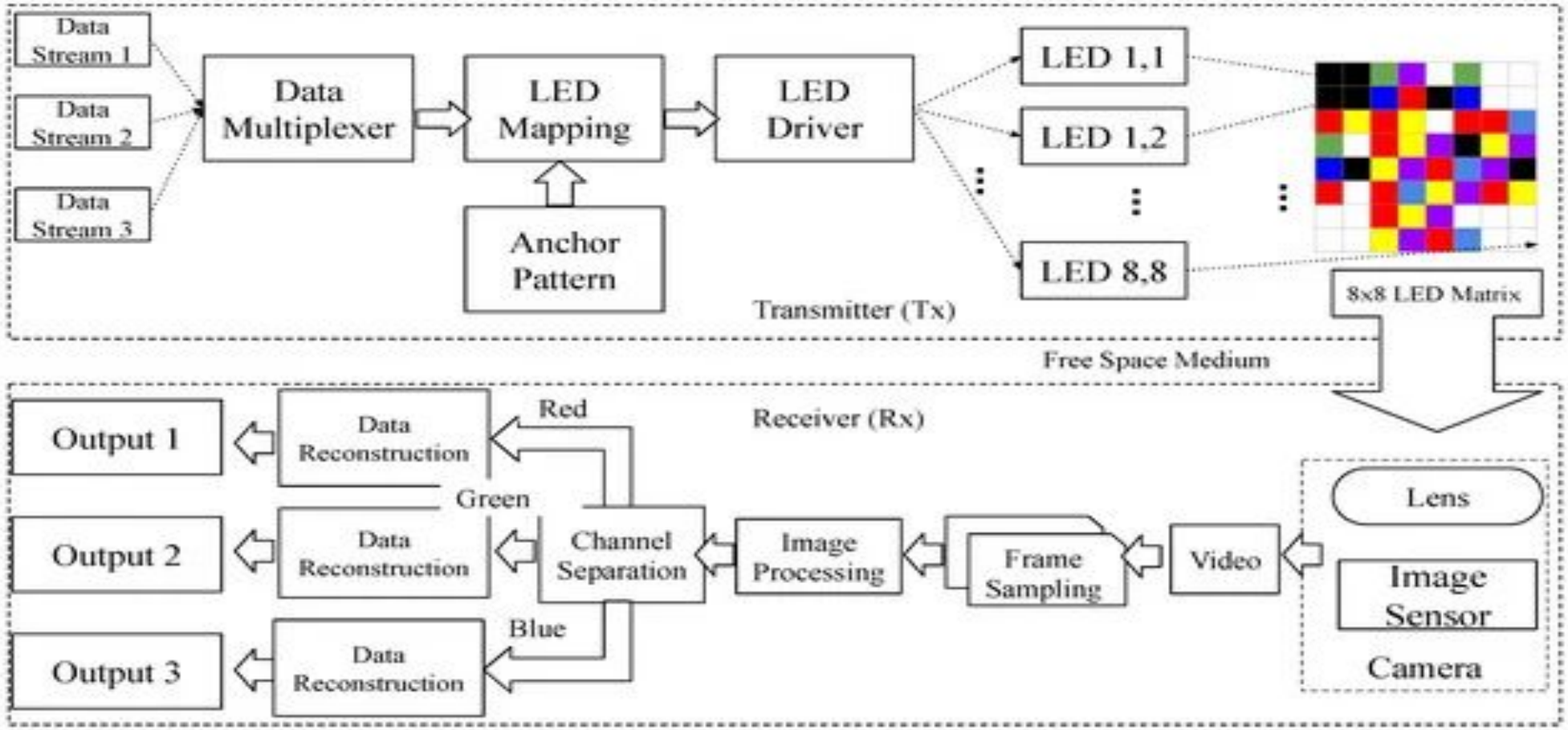
- 2 x Raspberry Pi
- 2 x 8*8 Light emitting diode (LED)
- 2 x Raspberry Pi Camera

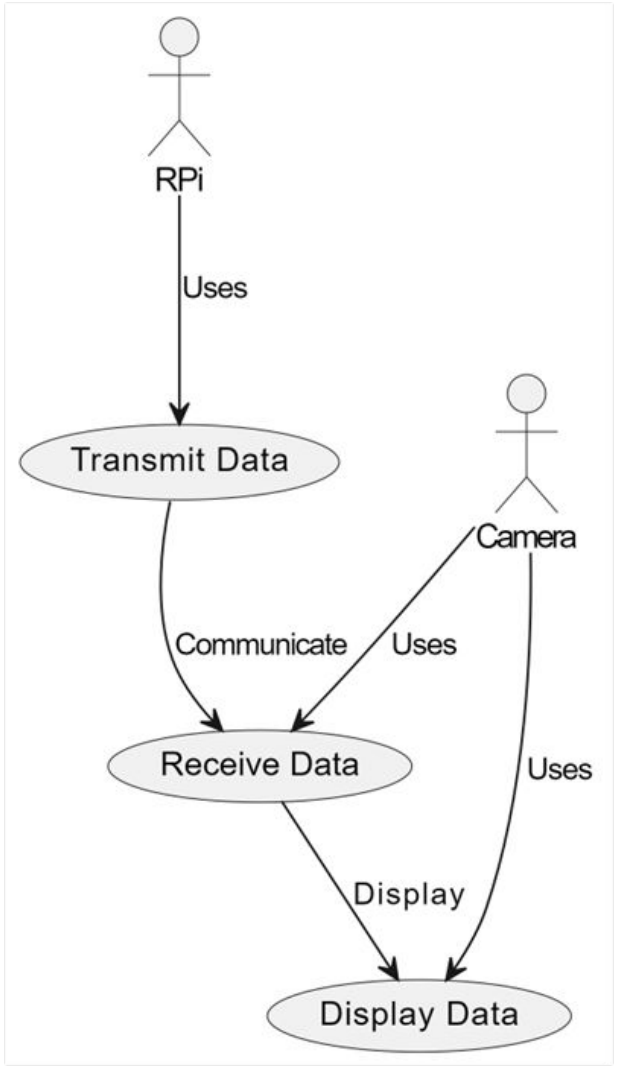
Software:

- Python
- OpenCV

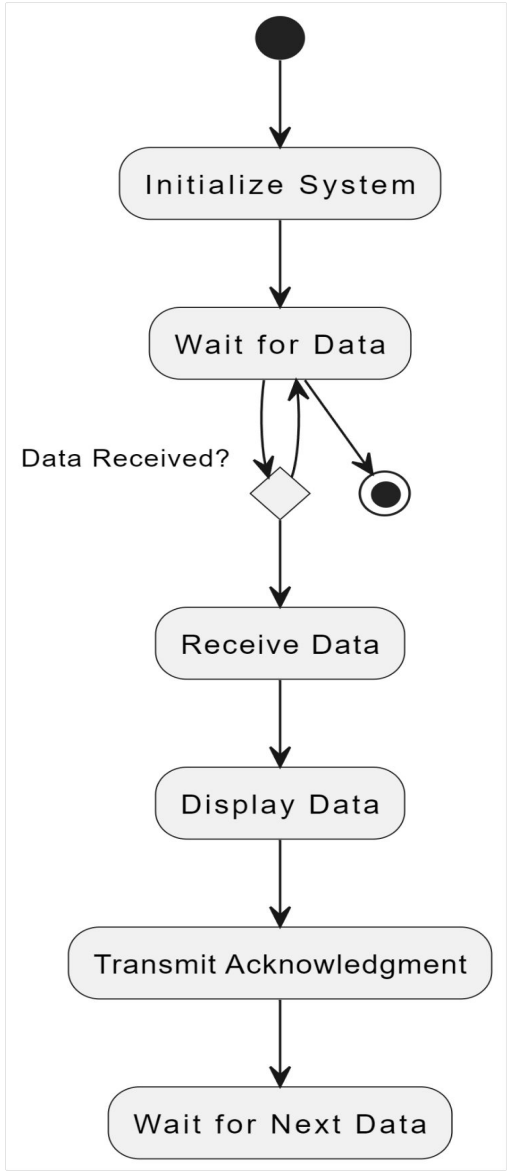
System Design

Show the System Architecture:

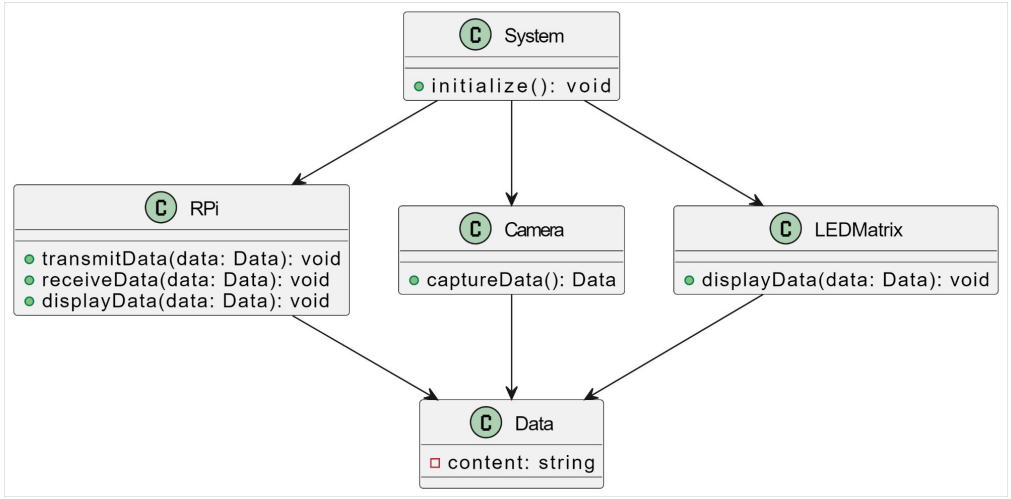




Use case



Activity Diagram



Class Diagram

Future Aspects

Explain the plan of next steps towards project completion.

To think about as future steps are these:

- System Development and Prototyping: Using the design and architecture you've described, start by creating a functional prototype of the 2D multicolor LED matrix and camera communication system. Development of hardware and software will be required for this.

- Testing and Validation: To verify the functionality of the system, thoroughly test the prototype. Check the latency, signal quality, and data transmission speeds. Find and fix any problems or places that need work.

- Alignment and Calibration: To guarantee the system performs at its best, adjust the alignment and calibration processes. This could entail changing the settings for the hardware or software.

- Security Implementation: To safeguard data sent through the LED matrix, put strong security procedures in place. Mechanisms for access control, authentication, and encryption ought to be combined.

- Performance Optimization: Make constant efforts to improve the system's performance, paying particular attention to error correction algorithms, modulation strategies, and data encoding techniques. Find the bottlenecks and deal with them.

Publication Details: Literature Review

Sr. No.	Publication Title with authors [mention whether Journal or Conference paper]	Publication Year	Positive points of the Publication	Gaps in publication work
1.	LiCamIoT: An 8x8 LED Matrix Pattern to Camera Communication for LiFi-IoT Applications	2022	IoT systems based on visible light communication can offer inexpensive, short-range indoor connectivity, which helps to relieve spectrum saturation. This study proposes, implements, and evaluates an Internet of Things application based on optical camera communication.	Radio Frequency(RF) Saturation cannot be reduced if the distance between the communicating devices is more.
2.	A Novel 2D LED Matrix and Aztec Pattern Inspired Optical Camera Communication for Industrial IoT	2022	The purpose of this work is to give an alternative communication method without sacrificing the number of linked devices in a typical industrial setting. To that end, an optical camera communication system inspired by the Aztec design is proposed.	Congestion is brought on by the growing number of smart devices linked to the network, while spectrum saturation is the result of heavy use of radio frequency (RF)-based communication channels.

3.	A Nested Texture Inspired Novel Image Pattern Based Optical Camera Communication	2022	Giving an alternate communication mechanism without reducing the number of linked devices in an industrial context is the aim of this effort. In order to do this, a suggested optical camera communication system with Aztec design inspiration is presented.	IoT applications that require low data rate consumption and long-distance communication can employ under-sampled rolling shutter-based OCC or global shutter for communication.
4.	Quantum-Chromodynamics-Inspired 2D Multicolor LED Matrix to Camera Communication for User-Centric MIMO	2022	This work presents an OCC system that is loosely based on notions from quantum chromodynamics (QCD) that can enable user-centric multiple-input multiple-output (MIMO).	There aren't many natural phenomena that exhibit colour shifts directly related to alterations in their fundamental makeup.
5.	Optical Camera Communications for IoT-Rolling-Shutter Based MIMO Scheme with Grouped LED Array Transmitter	2020	A streamlined multi-channel transmitter (Tx) design is suggested for flicker-free transmission, utilising a 7.2 x 7.2 cm2 tiny 88 dispersed light emitting diode (LED) array based on grouping of LEDs.	The OCC data rate is restricted by the image sensors' (ISs) frame rate. However data rates can be increased by using higher frame rate cameras which is very costly gradually increasing the cost.

Future planning for Implementation Paper:

- It presents a methodical way to move this idea from theory to practical implementation. The creation and prototyping of a working system are the next steps, which are then rigorously tested and validated to make sure the system satisfies performance standards.
- Strict security measures will be put in place to protect sent data, and alignment and calibration procedures will be fine-tuned to optimize data transfer. Interactive applications and improved user interfaces will improve the user-centric experience.
- Error correction, modulation, and data encoding techniques will continue to be the key priorities in performance optimization. We'll investigate how this technology integrates with the Internet of Things and smart surroundings, opening up new possibilities for automation and connectivity.
- In order to guarantee conformity to industry standards, regulatory compliance will be handled. The system will be continuously tested and refined with user feedback, and transparency and knowledge sharing will be guaranteed by the project's reporting and documentation.
- As the project moves forward, it will be crucial to assess results, efficiently manage resources and the budget, and deal with any new hazards that may arise. The project will be completed, with an assessment of the findings and possible directions for further study and advancement, at the end of the article.
- With the potential to bring forth significant breakthroughs in optical communication, this comprehensive plan lays the groundwork for the successful application of this transformative technology.

References

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5. https://www.researchgate.net/publication/342170425_Optical_Camera_Communications_for_IoT-Rolling-Shutter_Based_MIMO_Scheme_with_Grouped_LED_Array_Transmitter
6. https://www.ijert.org/research/a-review-paper-on-li-fi-technology-IJERTCONV5IS23003.pdf?shem=iosie

Thank you!!