Wireless Data Communication using Laser

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Introduction

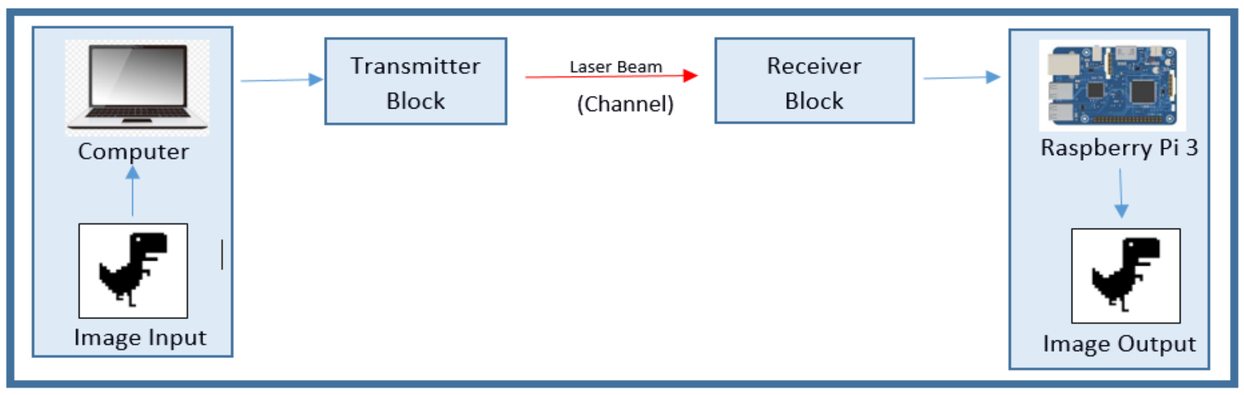
In a resource constraint scenario where a low-cost system capable of long range high-speed wireless data communication is to be built, Visible light communication (VLC) is a promising alternative to the conventional systems such as Wi-Fi, Bluetooth and Radio Frequency.

Li-Fi or "Light Fidelity" is a data communication variant which uses visible light (780–375 nm) to transmit high speed data. Laser light has low transmission loss per unit length, thus increasing the range of network.

Inspired with this concept, we propose 'Wireless Communication System using Laser'.

AIM: To develop a wireless laser based communication system, capable of efficiently transmitting data (images and text files) over few meters of distance.

Block Diagram



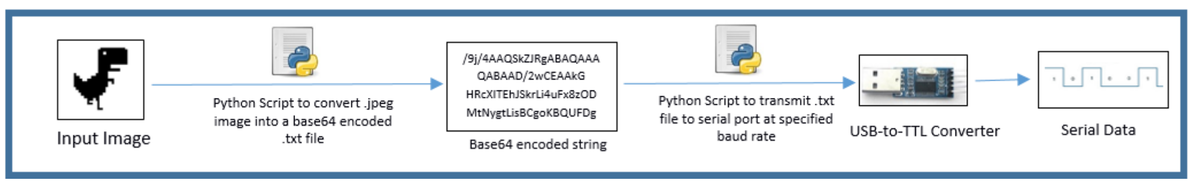
Methodology

Transmitter Design: 1. Data Encoding and Signal Acquisition-

• Communicatin protocol: UART (Universal Asynchronous Receiver/Transmitter) serial communication protocol is used to send data from host computer to the transmitter.

• Data Encoding: The image file(.jpeg) on the host computer is encoded by Base64 algorithm into a text(.txt) file with Python programming language (function- " base64.b64encode () ").

• Serial Data-to-Signal Conversion: A USB-to-TTL Converter receives the data from the USB port of the host computer and converts the stream of data bits into square wave signal with amplitude of 3.3 V.



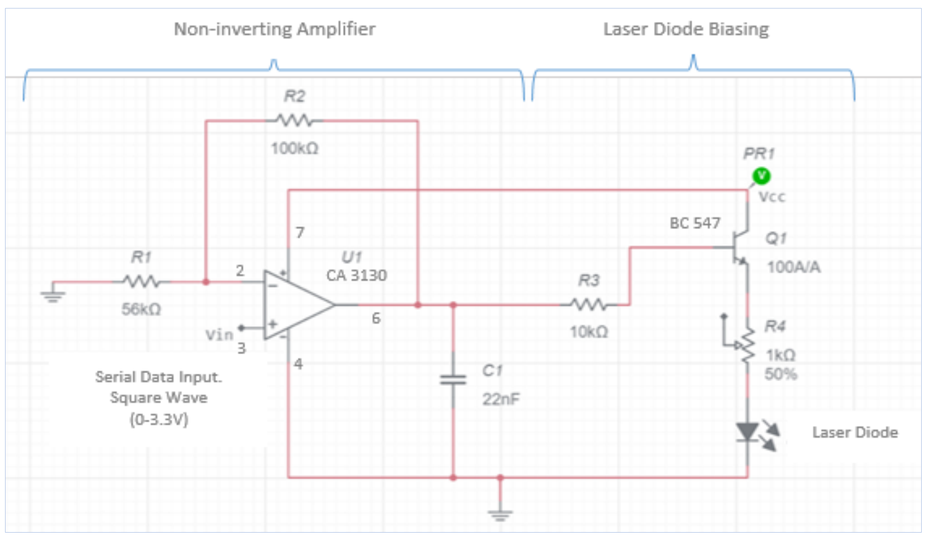
Host Block: Data Encoding and Signal Acquisition

Transmitter Design : 2. Circuit Design and Transmission-

• Non-inverting Amplifier: To properly modulate the laser diode 4.5 V is required. CA3130 Op-Amp IC (high slew rate 10V/us)is used in non-inverting amplifier configuration to modulate input signal.

• Modulation Technique: On-off keying (OOK) - The logic value zero corresponds to LOW (0 V) and the logic value one to HIGH (4.5 V).

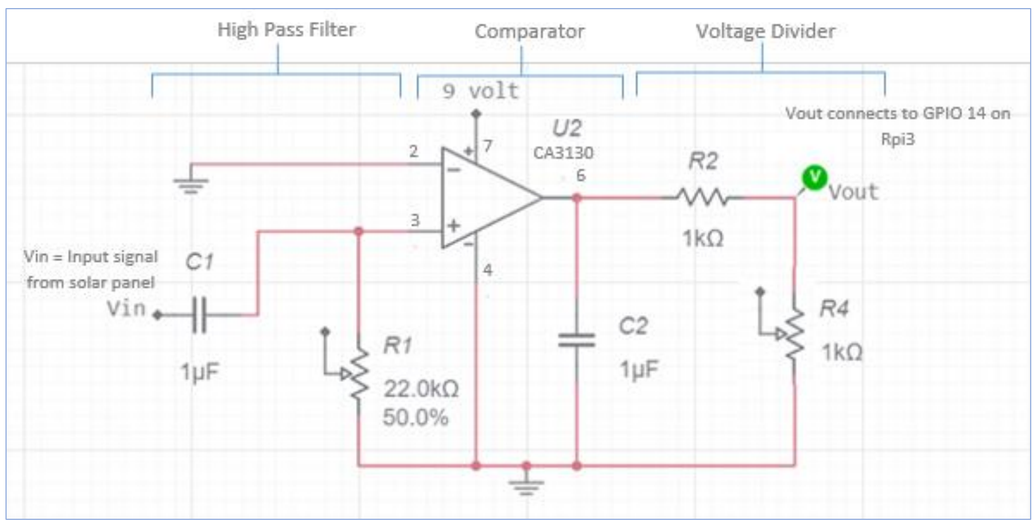
• Laser Diode Biasing: BC547 npn transistor (high gain bandwidth product 300 MHz)is used in switching configuration in order to bias the laser diode and modulate its intensity according the input serial data.



Transmitter Circuit Diagram

Methodology

Receiver Design: 1. Signal Reception and Signal-to-Serial Data Conversion-

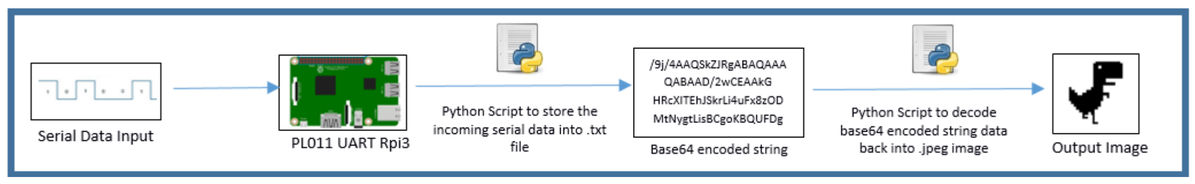


Receiver Circuit Diagram

- Solar panel : Used as optical receiver for laser light beam.
- High Pass Filter: To filter out 100 Hz noise and DC offset from the electrical signal of solar panel.
- Comparator: In order to retrieve back serial data bits from the received signal, CA3130 Op-amp was used as comparator.

Receiver Design: 2. Serial Data acquisition and data decoding-

- Serial data from the receiver circuit is stored on RPi 3 by PL011 UART.
- A Python script decodes the input string of data back into .jpeg image format.



Destination Block: Data Decoding and Output

Performance Analysis

Performance evaluation parameters: Data Rate (Baud Rate of serial data communication) and Channel length.

Error Control Mechanism: UART Protocol Parity Check

Data Type: Image (Compressed and Encoded) ,
Text (Uncompressed)

Results:

Exp. No.	Data Type	Data Rate (kbps)	Channel Length (feet)
1.	Image/Text	9.6	30
2.	Image/Text	25	30
3.	Text	30	30

Applications

- The system can function as indoor Li-Fi system for inter-device communication as well as providing internet facility to smart IoT devices and computers.
- The proposed system can be used in vehicle to vehicle communication for autonomous vehicles and traffic control architecture.
- It can be efficiently used to transmit data in remote areas (one hill top to other hill top!) where cell phone communication is not possible due to the lack of mobile operator's network.
- With data encryption, the system can be efficiently used for military zone and satellite communication applications.

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