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# Block Chain Based Underwater Communication Using Li-Fi and Eliminating Noise Using Machine Learning

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***Abstract*—**Underwater medium is the most difficult medium for data communication while electromagnetic waves and optical signals are some of the present modes of communication in water. Electromagnetic waves would suffer a significant loss, limiting them to short-range communication. Optical waves, on the other hand, have line-of-sight concerns. The proposed work employs a Light Fidelity (Li-Fi) data transmission technology in a water medium to address these issues. Visible light communication allows using a wide range of frequencies to send messages, and when compared to other transmission technologies, the data transfer rate is likewise relatively high. Electronic components and level converters are utilized to regulate flickering and communicate data on both the transmitter and receiver sides; but when exposed to the outer environment, they will lose the signal due to noise. To help with noise level estimate and signal reconstruction, the proposed work employs a machine learning technique that uses an encrypted block chain approach to check for data loss and a weighted Long Short-Term Memory (LSTM) algorithm to predict data from a neural network. The proposed work concludes that block chain can be the best way for data transfer in terms of minimizing errors while maintaining high accuracy.

***Keywords*—**Underwater; Block chain; Li-Fi; Machine learning; Neural network; Bit error rate; Weighted LSTM.

## 1. INTRODUCTION

A lot of studies have been going on right now in the field of underwater communication and underwater sensor networks. The major research lines are based on expanding distance and bandwidth on one hand, and reducing the energy consumption of underwater devices on the other, with the goal of improving network longevity. Radio frequency has a tiny and limited bandwidth underwater due to the amount of energy absorbed by water, and radio waves do not propagate well. For underwater wireless data transmission, Li-Fi is the best option where LEDs can send data. Data may be sent at a high frequency due to recent developments in Li-Fi. When exposed to the outer environment, a Li-fi signal, on the other hand, may degrade. Visible light communication allows using a wide range of frequencies to send the message. When compared to other transmission methods, the data transfer rate is also very high. LEDs emit light that is invisible to the naked eye. Electronic components and level converters are utilized to regulate flickering and communicate data on both the transmitter and receiver sides.

Li-Fi is a visible light connections technology that broadcasts radio internet communications at very fast rates using visible light. Using this technique, LED light bulb

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may discharge bursts of light that are imperceptible by the human eye, and data can be transmitted and received from receivers inside those emitted pulses of light. It has a bandwidth of up to 100 Gbits and frequency between 400-800 THz. Blockchain technology can provide benefits to the user's record such as tracking, security, and authorization. Further, each transaction carries the user's signature, and allows others to verify the legitimacy of user's record by looking at transaction history. As a result, data provenance on the blockchain is tightly maintained. The entire ledger is stored in a decentralized form by multiple nodes, ensuring a secure and tamper-proof storage method. This type of blockchain increases reliability and security while also acting as a network authentication system. The open-source ledger Fabric blockchain platform is used for the proposed model development. Base stations employ global blockchain technology to securely communicate with another one.

In [1], the author has compared the handling likelihoods to the network standard with an authentic base station deployment, and observed that the suggested model is suspicious while the network standard is positive, and that mutually are approximately precise. In supplement to existence that others are manageable, the suggested standard might improve the progressively resourceful and intense location of base stations in forthcoming systems. The author in [2] has perceived that in co-channel positioning approach, if femtocell wireless factors are appropriately coordinated rendering to unpredictable grid state, the Area Spectral Efficiency (ASE) improvement can be improved numerous crinkles exclusive of disturbing macro cell grid functioning. It is also exposed that, by centrally aligning the range reclaim and distributed control at each macro/femto tier, the global functioning can be enriched. The author in [3] has overviewed the nominal and professional influences for femtocells that portray the methodical tasks confronting femtocell grids and provided roughly primary concepts to overawe them. In [4], the author has indicated that with fastened admission femtocells, the augmented joint and disjoint subchannel parts afforded the maximum quantity amid all structures in light and compact femtocell grids individually. Alongside exposed approach femtocells, the improved combined subchannel distribution affords the topmost potential quantity for all femtocell densities. The author in [5] has proposed a piecewise multinomial occasion as a comprehensive standard for the nonlinear resettlement feature of the source for Optical Wireless Communications (OWC).

The author in [6] has presented a DistArch-SCNet that was well-organized, mountable, and blockchain-based disseminated smart-city system design inspired by the Li-Fi communication scheme. The author in [7] has projected a model application of a permissioned blockchain that would be created user-friendly beneath the GNUv3 General Public License. The author in [8] has recommended a public blockchain that supplies the nodule and communication honesty in a disseminated register that is suitable for assuring the communication distribution in a timely manner.

The author in [9] has proposed a structure that guarantees the protected interaction and verification of information across expanded networks and devices. The author in [10] has proposed a blockchain technology into the traceability administration of outcome information, and a product life cycle information traceability scheme centered on multi-blockchain to verify the feasibility and rationality of the proposed method.

The author in [11] has described HCLS usage leveraging these features of blockchain, involving persistent agreement and well-being facts conversation, outcome-based agreements, next-generation medical examinations, supply chain, overheads and dues. The author in [12] proposed a zero-knowledge proof of location (zk-PoL) protocol to improve defending the user's secrecy.

In [13], the author elicited the encounters of IoT that remained focused, and the described scheme of the blockchain-based clarifications from two evaluations, specifically information administration and object administration. In [14], the author presented a real-time videotape broadcast using Li-Fi transmitter where the aural and videotape broadcast accomplishes greatest void of 200 m.

In [15], the author has dealt with the outdoor multipath channel model for visible light communication by finding the gain. In [16], the author has used Li-Fi transmitter and receiver which have been used in combination with GSM that acts as an alert for multimodal biometric security system.

The previous work dealt independently with Neural Network for numerous applications, Block chain with Li-Fi for smart city and LSTM machine learning techniques. The proposed work has made an attempt to combine all the three phases with Li-Fi for eliminating noise using machine learning techniques

## 2. METHODOLOGY

Signals can be sent over a wide range of wavelengths via visible light communication. The Li-Fi has a comparatively high data transfer rate when compared to other transmission options. To the human eye, the light emitted by LEDs is inaudible. Electronic components and level converters are used to control flickering and convey data on both the transmitter and receiver sides. To construct the message signal, a photodetector was used to receive the light and convert it to original pulses. Its signal will be lost if it is exposed to the outside world due to noise. Visible light communication can be used for a variety of purposes. Li-Fi is a very speed, bidirectional, and power packed network light-based wireless knowledge communication system. A wireless network that made up of many bulbs is known as Li-Fi. The LED light bulb creates a stream of photons when an electrical current is supplied to it. Because it is a semiconductor device, the highly brightness of the photon source that passes through them is altered at incredibly fast rates. This demonstrates that the signal is altered at various speeds on a frequent basis. The signal is then received by a detector, which interprets the signal data strength fluctuations. When the LED is switched on, you send a digital 1 and when it is turned off, you send a digital 0. The data can be transferred to the blockchain in the form of 0s and 1s. The blockchain maintains a digital log of transaction and every time a new transaction occurs, a record is being added to ledger. Every transaction in the ledger can be easily reviewed, watched, and the output signal is then handled neutrally after being received by a photodiode detector in the receiver side in addition to the ambient noise. Because of its ability to handle many forms of transfer functions, Machine Learning (ML) is a type of Artificial Intelligence (AI) that is showing potential results in non-linear systems. The data is then predicted using a weighted LSTM algorithm and Block Chain as shown in Fig. 1.

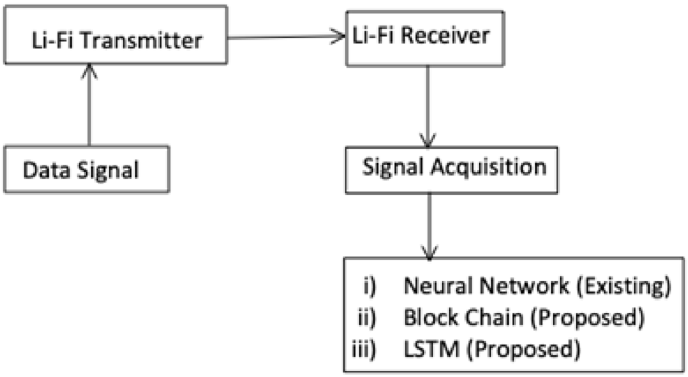


Fig. 1. Flow of the proposed work using block chain and LSTM.

## 3. SIMULATION RESULTS

The simulated output for the neural network phase obtains neural network training and validation error histogram and regression as a consequence for reconstructing the signal. Similarly for block chain phase, the simulated output is considered for input data histogram, encrypted data histogram and decrypted data histogram for data safety. Accordingly in LSTM phase, the simulated output towards training progress for loss and root mean square error (RMSE).

### 3.1. Neural Network Phase

In this case, neural network has been used to anticipate signal loss and the TRAIN-GDA algorithm, also known as Gradient descent where adaptive learning rate backpropagation algorithm has been used to reconstruct the signal. The training state (as in Fig. 2) shows the gradient, validation and learning rate captured at epoch 9. The best validation performance occurs at epoch 3 over the mean square error as shown in Fig. 3. The validation performance considers the best epoch at 3 for the test and validation of data with respect to mean square error.

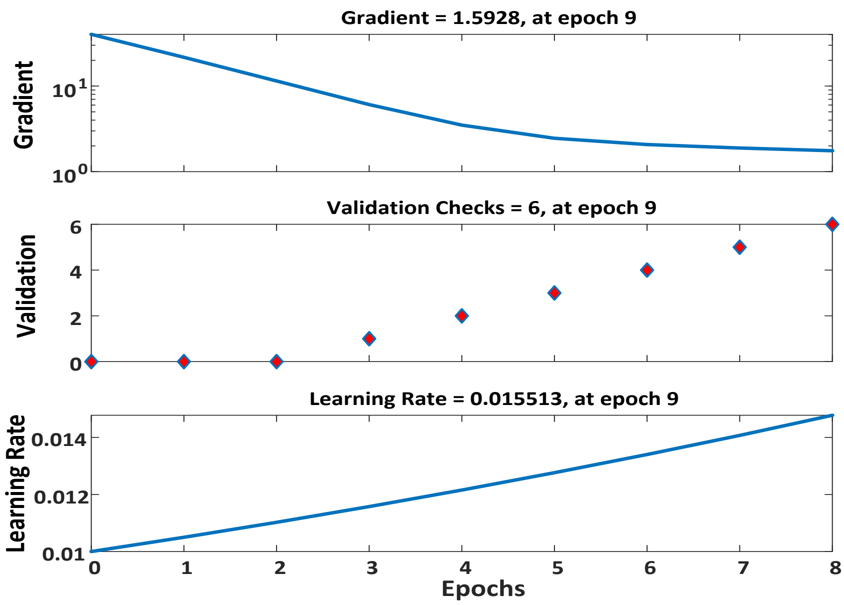


Fig. 2. The training state.

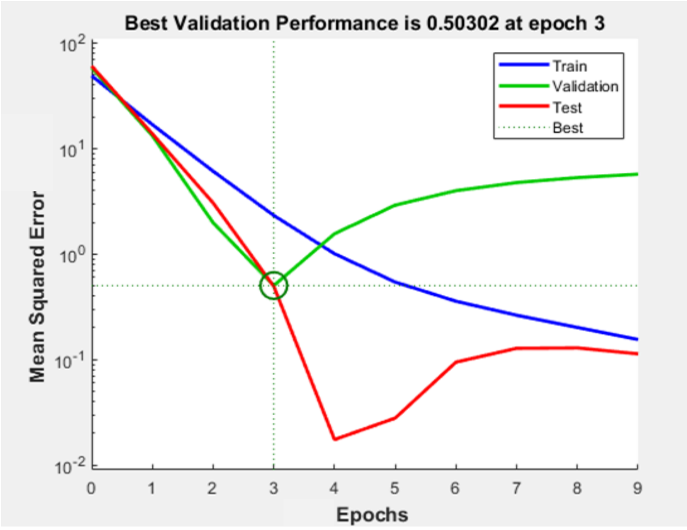

Fig. 3. Validation performance.

The error histograms with 20 bins over instances are better observed for zero error as shown in Fig. 4. The regression operating characteristic simulation data are obtained as shown in Fig. 5. The dotted line indicates the training data shown in the legend as Y=T, while circle indicates the data and the blue line indicates the Fit for the regression obtained at R=0.85911 for the neural network training.

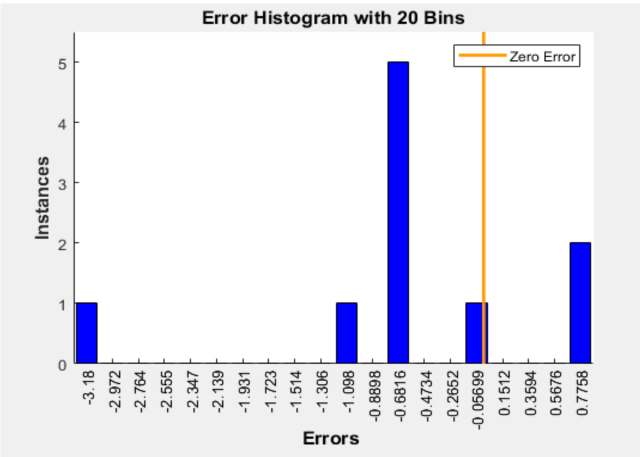

Fig. 4. Error histogram.

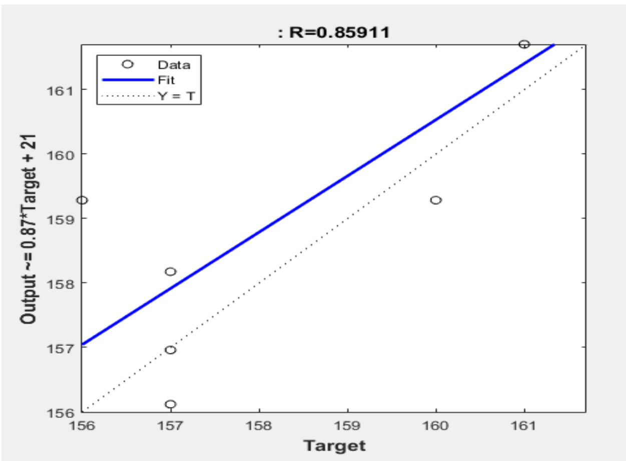

Fig. 5. Regression.

### 3.2. Block Chain Phase

For the data safety, encrypted data has been used to avoid data loss and tune the data using neural network. As a result, simulation results for input data histogram, encrypted data histogram, and decrypted data histogram have been obtained as shown in Figs. 6, 7, and 8, respectively.

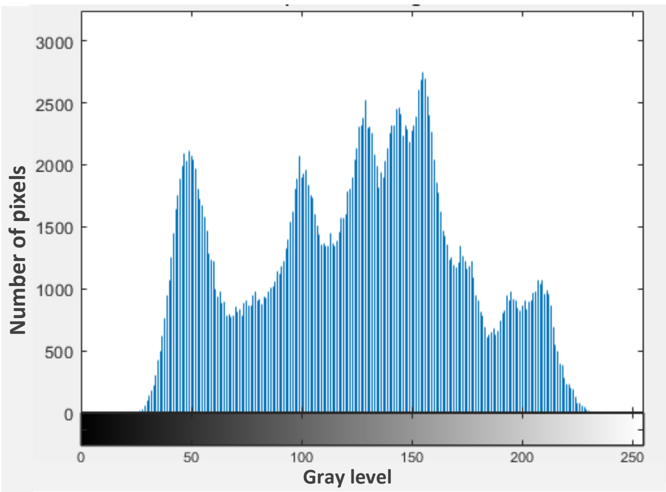


Fig. 6. Input data histogram .

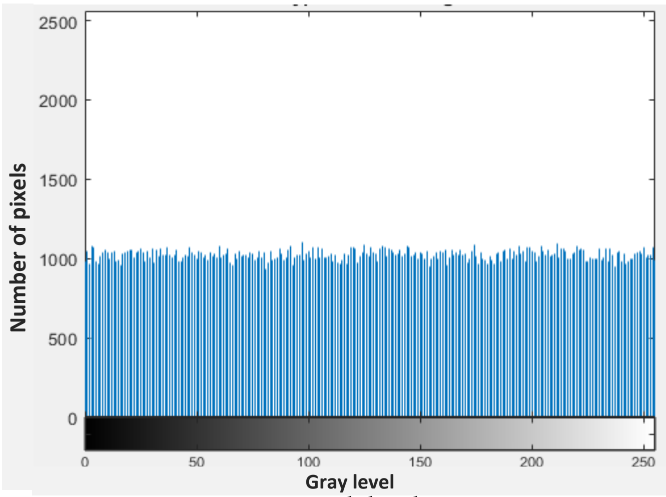


Fig. 7. Encrypted data histogram.

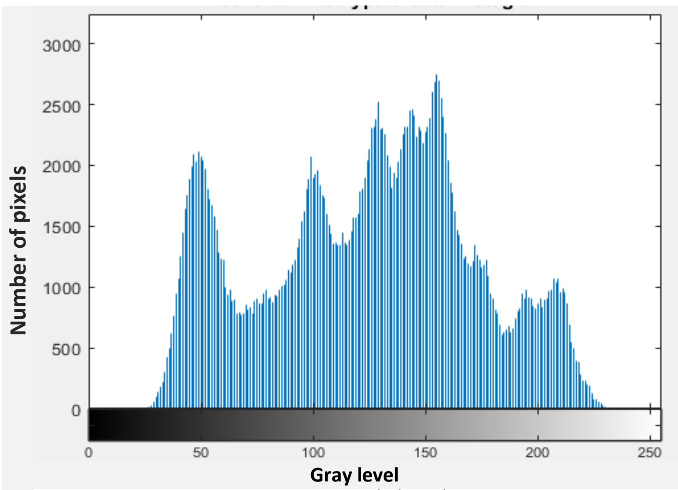


Fig. 8. Decrypted data histogram.

### 3.3. LSTM Phase

A neural network, to perform the LSTM method, has been employed to predict data (as shown in Fig. 9) towards simulation of training progress for Loss and RMSE. The learning rate considered is 0.001 for training with maximum iterations. It is observed that the RMSE gradually decreases for the increase in iteration to obtain the reduced RMSE for prediction. Similarly, the loss also gets reduced as iteration increases and almost reaches zero.

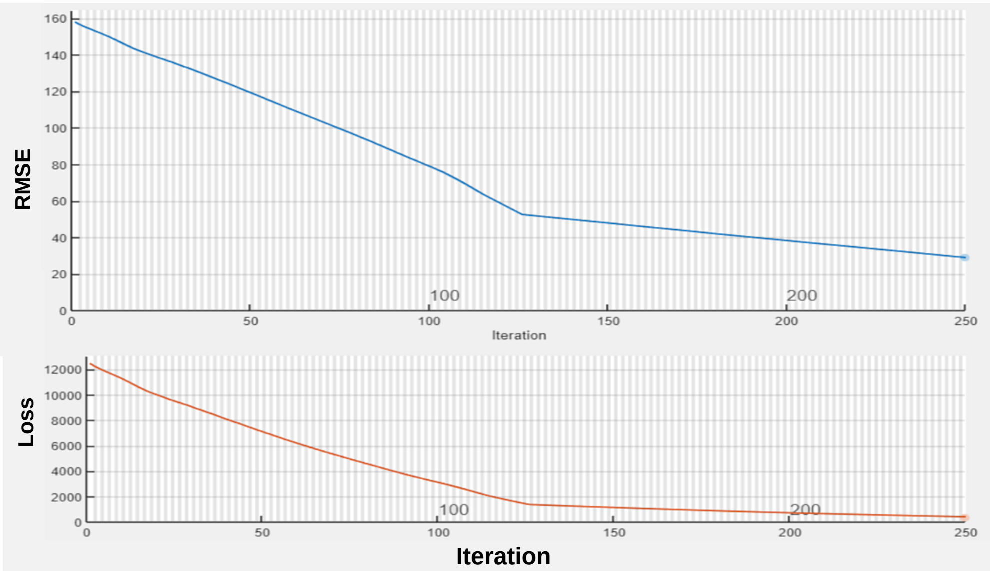


Fig. 9. Training progress.

### 3.4. Comparison of Neural Network, Block Chain and LSTM using Bit Error Rate / Neural Network BER

A neural network has been used to demodulate a signal with noise, the BER vs Eb/No to obtain values for both transmitted and received BER. The following steps are carried out by the main processing loop: create digital data and convert it to ARY symbols, QAM-modulate and use it as data symbols. Using the BER AWGN function, the obtained curve can be figured. Plotting the BER data that was transferred and received (as shown in Fig. 10), it can be seen that the points of BER data transmitted are perfectly matched with the points of BER data received.

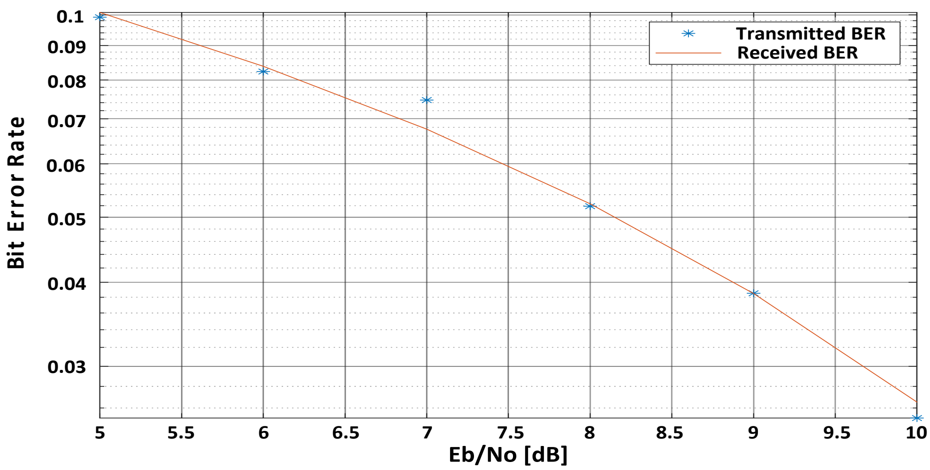


Fig. 10. Neural network BER.

A blockchain has been used to demodulate a signal with noise, the BER vs Eb/No values using a neural network. The simulated output (as in Fig. 11) shows that the points of BER data transmitted are perfectly matched with the points of BER data received.

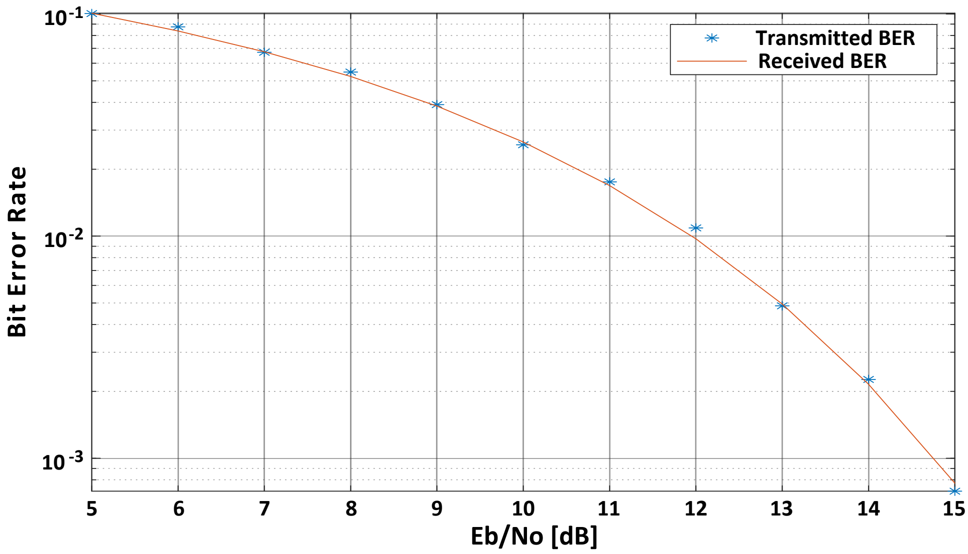


Fig. 11. Block chain BER.

LSTM has been used to demodulate a signal with noise, the BER vs Eb/No values using a neural network. As shown in Fig. 12, the points of BER data transmitted are perfectly matched with the points of BER data received.

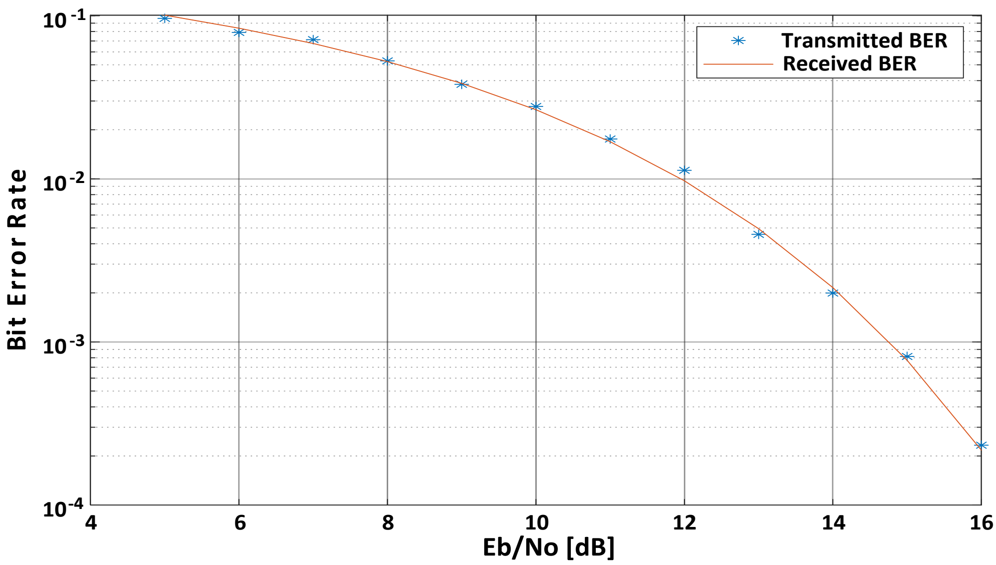


Fig. 12. LSTM BER.

## 4. CONCLUSIONS

As the electromagnetic spectrum becomes increasingly congested, Li-Fi technology promises to bring a quicker, safer, greener, better and healthful wireless future. Li-Fi may be used to power any device large enough to accommodate LED and a light sensor. Data was successfully transferred and received in this experiment with little distortion due to ambient light and noise produced in the transmission and receiver circuits. The proposed work employs a machine learning approach to help with noise level estimation and signal reconstruction. This type of approach uses an encrypted block chain approach to check for data loss and a weighted LSTM algorithm to predict data from a neural network. Using Bit Error Rate to compare the three modules, we conclude that block chain can be the best way for data transfer in terms of minimizing errors while maintaining high accuracy.

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