Performance Comparison of Optical Wireless Communication Using Gray Relational Analysis

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Abstract. In this study, Indian Optical Wireless Communication (IOWC) is examined as a short-range method for transferring data at high rates. It is rapidly gaining popularity as an effective method, with an optical transmitter at the IOWC terminal and a receiver included. For example, it can be used in tall buildings separated by several hundred meters, where light beams propagate through the atmosphere and convey information to the recipient. IOWC has several advantages over its competitors, most notably its quick setup, free-of-charge licensing, and lightweight, high-capacity communications. However, IOWC still faces many challenges, including improving communication efficiency in adverse weather conditions or during construction. In the field of underwater acoustic communication, great progress has been made, but IOWC is still better than traditional audio communication systems due to its significantly lower power consumption and ability to provide simple computational problems for short-range wireless links. IOWC has many potential applications, including in Indian coastal waters. The gray relational analysis (GRA) method is simple in calculations and optimizations, and research shows that it is easy to extend this proposed method for problems with more than two answers. To determine the material and life strategies in a one-dimensional array, a method provides multidimensional alternatives based on Taguchi using gray correlation analysis. The optimization design is done on a top cap with a thin wall section unique to TWBs structures. The gray relational analysis method can be used to describe the alternative and evaluation parameters in optical wireless communication. As far as the optical wireless communication APM-EDM process is concerned, alternatives include Lamina Atlas NT-42C1-0484, AOP LED Corp PU-5WAS, Kingbright AADI-9090QB11Gitek/3, LGLB-313E, Toshiba TL12B01 (T30), and Lumex SML-LX1610USBC. The evaluation parameters are wavelength (nm) and luminous flux (lm). From the final result, it is seen that AOP LED Corp PU-5WAS got the first rank, whereas Toshiba TL12B01 (T30) has the lowest rank.
Key words: Optical Wireless Communication, Gray Relational Analysis

1. Introduction

Ultraviolet, infrared, and visible bands are included. An alternative is to adopt OWC technology, which offers a large unconstrained bandwidth and, in the infrared band, can provide. In the world of communication, Indian Optical Wireless Communication (IOWC) is one of the main areas that needs to be studied in more detail. IOWC uses rays of light to propagate through the atmosphere and carry information. The optical transmitter and receiver are housed in tall buildings several hundred meters apart at the IOWC terminal. Key Benefits of IOWC include no license requirements or fees for its use, no need to dig roads, and its ability to enable very high data rates while being small, lightweight, and compact. However, the problem is that changing wind loads, under the influence of thermal expansion and weak earthquakes, typical tall buildings sway. This causes vibrations of building motion transmitter beam. Based on these models, we also provide performance analytics. As water absorption increases for all three connection types, communication skills decrease dramatically, and communication efficiency drops dramatically for all three connection types. It is clear from the analysis. However, in some cases, this reduction has been mitigated by the use of diffused light. For example, networks of sensors underwater high data rate optical wireless networks for emerging applications, we conclude from the analysis that this is a possible solution. The problem formulation of electricity forecasting, Gray Correlation Analysis (GRA), data including normalization and evaluation indices introducing predecessors. Originally, the Taguchi method was designed to optimize only one performance characteristic. Gray Correlation Analysis (GRA) effectively resolves complex interactions between multiple answers. For response variables to analyze a measure of the relationship of multiple responses, a gray relative grade is calculated. Gray correlation analysis measures between factors or variables relationships belong to the pattern and type of geometrical methods of treatment. In gray contact system, an important point Gray is the relative quality, which is a measure of correlation between two factors.

2. Optical Wireless Communication

In short-distance communication, Radio Frequency (RF) is a promising complementary technology. Interest in Optical Wireless Communications (OWC) has gained new momentum due to the real-time bandwidth-intensive applications of indoor wireless access. To meet future demand, as a potential candidate, optical wireless (OW) technology has sparked interest for streaming video, music, and network-attached storage (NAS). A possible solution is in the OWC system, and research interests are growing. Two common groups of OWC are indoor and outdoor. OWC offers unlimited bandwidth, and

IR is used for communication purposes. Also, the frequency at which the bands in OWC are occupied illustrates the range of wavelengths. OWC uses IR or UV light, and this is very important in challenging situations. Also, outdoor OWC can be atmospheric or free space from a point through an unguided channel. Such defects include distortion, which is introduced into the received signal. In designing an efficient OWC system, implementation and operation, and analysis, a good understanding of optical wireless channel characteristics is also essential to combat this. Channel characteristics of OWCs depend on the type of communication environment, which leads to efficient spatial diversity. This is for multipath fading and shows high levels of immunity. A large part of this is the received power at several optical wavelengths, calculating the average, and thus related to the time variation of the channel of Rasari optical power. Only slow variation is present, which enables simple processing with low overhead. For the same physical reason, optical wireless may be more suitable in some automotive use cases. Finally, in backhaul applications, optical wireless links can be useful at short distances, while long-distance and NLOS links by mm-wave may be better served, and coherent reception is used there rather than direct detection, which is highly sensitive. OWC usually takes place in a point-to-point fashion, and compared to RF and underwater acoustic communications, it provides enhanced security. However, the enabled nature of light propagation reduces the connectivity of the network, and a more accurate pointer, acquisition, and maintenance of trusted connections, and tracking (PAT) mechanisms are required. Alternatively, with wide beam/unidirectional propagation capabilities, less secure, and at the cost of low-bandwidth communication, reduce PAT requirements. Optical transceivers can be developed. Despite its virtues, implementing IOWC systems in practice has many challenges. First, as with pre-space optical communications, usually of the sea surface random movements, variations in-depth, deep currents, and ocean turbulence occur. To mitigate attenuation effects, the spread of the light beam, absorption by the interaction of water molecules, is subject to scattering, turbulence, multipath fading, and particles containing photons. Such defects cause distortion and significantly reduce the range of communication.

3. Gray Relational Analysis

"GRA is a multivariate statistical analysis method. It evaluates the degree of correlation between factors based on their similarity or differences in development trends. As the unity between time series geometries increases, the interaction between these factors becomes more significant. Based on this principle, major and minor factors affecting the development of the organization can be determined. According to the theory of Gray texture, ecosystems with complex factor relationships and ambiguous internal policies are gray control systems. The interference of unknown and undetermined factors increases our understanding of ESs, which do not satisfy the laws of constant distribution, even for small data samples. Gray correlation analysis is appropriate for such cases. Estimates using this method generally involve the gray correlation coefficient, based on degree and order. Gray Relational Analysis (GRA) is an effective approach for considering two or more response variables concurrently. This method was first proposed by Deng and is widely used to estimate the behavior of an unknown system. A multiple-response problem can be converted to a single-response problem by developing a new single-objective problem, and an optimal combination of response parameters can be found. Previous research that has focused on multi-objective optimization has shown the effectiveness of this method. Orthogonal Arrays and Gray Relational Analysis can be used for multi-objective optimization of drilling of Al-SiC MMC. Taguchi, Adaptive Neuro-Fuzzy Inference System (ANFIS), and Gray Relational Analysis are used to study WEDM process parameters for modeling and optimization. Lu et al. combined Gray Correlation Analysis (GRA) and Primary Component Improve Analysis (PCA) for high-speed end-milling process parameters. Gray relative analysis method was used to predict USM parameters and improve the neural network approach for Ti-6Al4V Taguchi-entropy-based weight parameters for machining. Gray correlation analysis and Taguchi method were used for parametric design of friction stir welding parameters for different Al alloys to connect Al/SiC/Al2O3 metal matrix for response optimization in friction welding. Adalarasan and Sondra based their study on combined Gray Correlation Analysis and Principal Component Analysis (GT-PCA) for composites. Because it is an alternate sequence, the relationship between the reference sequence can be measured and allow engineers to be flexible. The vector array, gray relational grade (GRG) formulation of Xiong et al. extended Grays based on correlation principles for mixed number sequence, matrix sequence, fuzzy number sequence, and tensor sequence. The extended GRA method can be used to solve problems by accurately measuring the correlation. The TOPSIS method, which combines individual assessments of FMEA team members, is used for order prioritization by convergence of optimal solution. This technique provides double reference points, meaning that the best alternative should have the closest positive distance to PIS and farthest to NIS. The GRA-TOPSIS method is systematically integrated to get more accurate ranking."

TABLE 1. Optical Wireless Communication

Manufacturer	Wavelength (nm)	Luminous Flux (Im)
Lamina Atlas NT-42C1-0484	468.00	63.00
AOP LED Corp PU-5WAS	472.00	54.00
Kingbright AADI-9090QB11ZC/3	460.00	35.70
Ligitek LGLB-313E	473.00	30.60
Toshiba TL12B01(T30	460.00	6.00
Lumex SML-LX1610USBC	470.00	5.00
	B	NB

Table 1. shows the Optical Wireless Communication for Alternatives: Lamina Atlas NT-42C1-0484, AOP LED Corp PU-5WAS, King bright AADI-9090QB11ZC/3, Ligitek LGLB-313E, Toshiba TL12B01(T30), Lumex SML-LX1610USBC. Evaluation parameter: Wavelength (nm), Luminous Flux (Im).
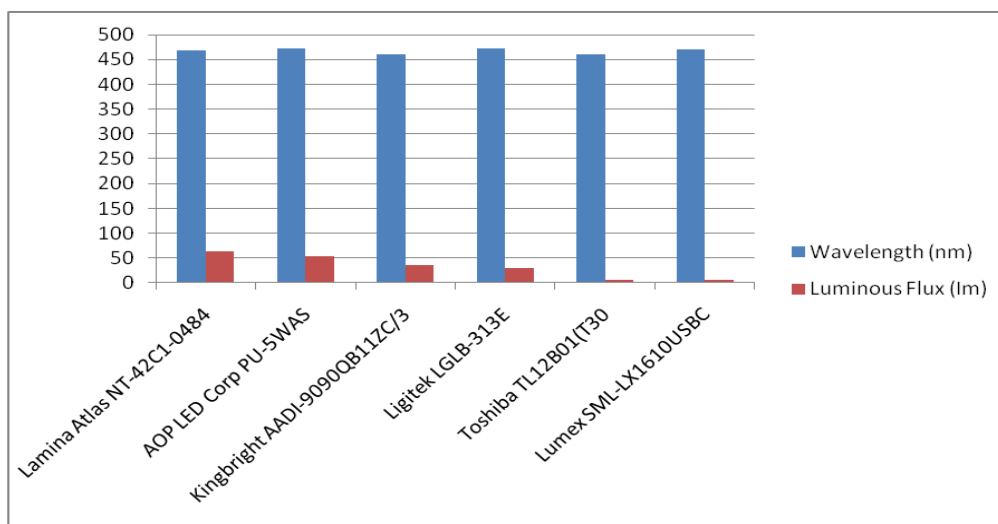
FIGURE 1. Optical Wireless Communication

Figure 1 shows the Optical Wireless Communication for Evaluation parameter: Wavelength (nm), Luminous Flux (Im). Alternatives: Lamina Atlas NT-42C1-0484, AOP LED Corp PU-5WAS, Kingbright AADI-9090QB11ZC/3, Ligitek LGLB-313E, Toshiba TL12B01(T30), Lumex SML-LX1610USBC.

TABLE 2. Normalized Data

Manufacturer	Wavelength (nm)	Luminous Flux (Im)
Lamina Atlas NT-42C1-0484	0.6154	1.0000
AOP LED Corp PU-5WAS	0.9231	0.8421
Kingbright AADI-9090QB11ZC/3	0.0000	0.5211
Ligitek LGLB-313E	1.0000	0.4316
Toshiba TL12B01(T30	0.0000	0.0000
Lumex SML-LX1610USBC	0.7692	-0.0175

Table 2 shows the Normalized data for Evaluation parameter: Wavelength (nm), Luminous Flux (Im). Alternatives: Lamina Atlas NT-42C1-0484, AOP LED Corp PU-5WAS, Kingbright AADI-9090QB11ZC/3, Ligitek LGLB-313E, Toshiba TL12B01(T30), Lumex SML-LX1610USBC it is also the Normalized value.

TABLE 3. Deviation sequence

Manufacturer	Wavelength (nm)	Luminous Flux (Im)
Lamina Atlas NT-42C1-0484	0.3846	0.0000
AOP LED Corp PU-5WAS	0.0769	0.1579
Kingbright AADI-9090QB11ZC/3	1.0000	0.4789
Ligitek LGLB-313E	0.0000	0.5684
Toshiba TL12B01(T30	1.0000	1.0000
Lumex SML-LX1610USBC	0.2308	1.0175

Table 3 shows the Deviation sequence for Evaluation parameter: Wavelength (nm), Luminous Flux (lm). Alternatives: Lamina Atlas NT-42C1-0484, AOP LED Corp PU-5WAS, Kingbright AADI-9090QB11ZC/3, Ligitek LGLB-313E, Toshiba TL12B01(T30), Lumex SML-LX1610USBC it is also the Maximum or Deviation sequence value.

TABLE 4. Grey relation coefficient

Manufacturer	Wavelength (nm)	Luminous Flux (lm)
Lamina Atlas NT-42C1-0484	0.5652	1.0000
AOP LED Corp PU-5WAS	0.8667	0.7600
Kingbright AADI-9090QB11ZC/3	0.3333	0.5108
Ligitek LGLB-313E	1.0000	0.4680
Toshiba TL12B01(T30	0.3333	0.3333
Lumex SML-LX1610USBC	0.6842	0.3295

Table 4 shows the Grey relation coefficient for Wavelength (nm), Luminous Flux (lm). Alternatives: Lamina Atlas NT-42C1-0484, AOP LED Corp PU-5WAS, Kingbright AADI-9090QB11ZC/3, Ligitek LGLB-313E, Toshiba TL12B01(T30), Lumex SML-LX1610USBC it is also Calculated the Maximum and minimum Value.

TABLE 5. GRG and Rank

Manufacturer	GRG	Rank
Lamina Atlas NT-42C1-0484	0.7826	2
AOP LED Corp PU-5WAS	0.8133	1
Kingbright AADI-9090QB11ZC/3	0.4220	5
Ligitek LGLB-313E	0.7340	3
Toshiba TL12B01(T30	0.3333	6
Lumex SML-LX1610USBC	0.5068	4

Table 5 shows the GRG, Rank of the final result of this paper the Lamina Atlas NT-42C1-0484 is in 2rd rank, the AOP LED Corp PU-5WAS is in 1st rank, the Kingbright AADI-9090QB11ZC/3 is in 5th Rank, the Ligitek LGLB-313E is in 3rd rank, the Toshiba TL12B01(T30) is in 6th rank and the Lumex SML-LX1610USBC is in 4th rank. The final result is done by using the GRA method.
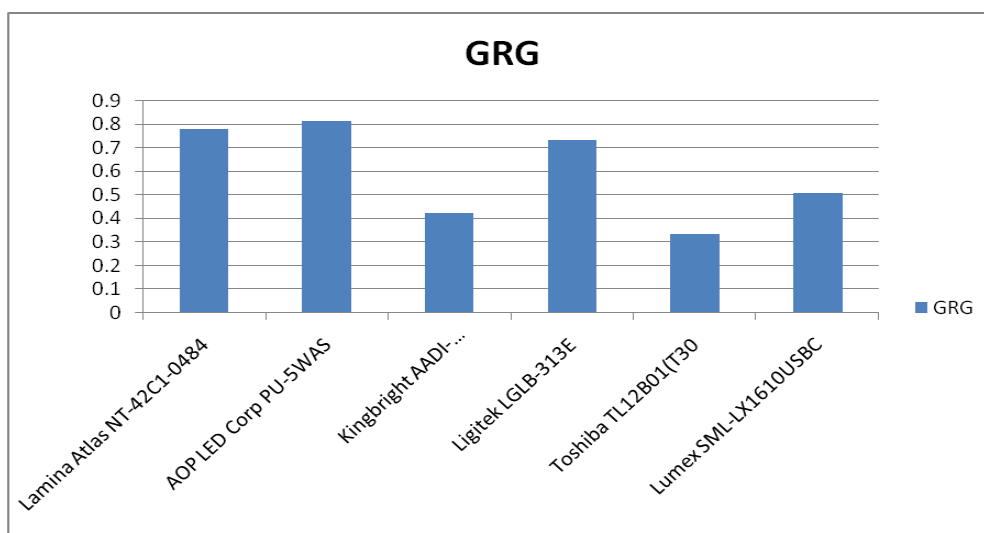
FIGURE 2. GRG

Figure 2 shows the GRG of the Lamina Atlas NT-42C1-0484=0.7826, AOP LED Corp PU-5WAS= 0.8133, Kingbright AADI-9090QB11ZC/3=0.4220, Ligitek LGLB-313E=0.7340, Toshiba TL12B01 (T30) =0.3333, Lumex SML-LX1610USBC= 0.5068. AOP LED Corp PU-5WAS is showing the highest value while Toshiba TL12B01 (T30) is showing the lowest value.
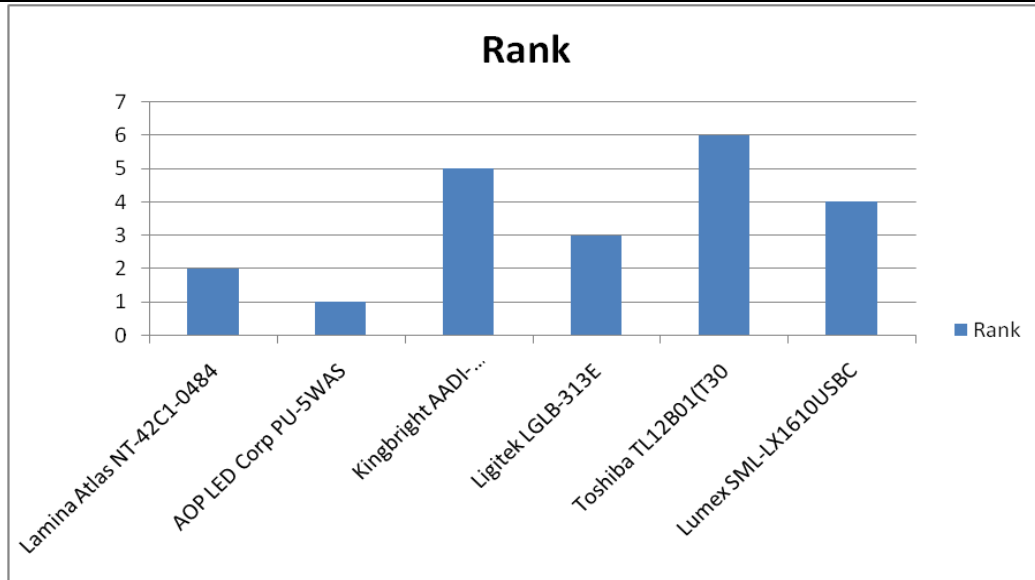
FIGURE 3. Rank

Figure 3 shows the optical wireless communication view of the Lamina Atlas NT-42C1-0484 is in Second rank, the AOP LED Corp PU-5WAS is in First rank, the Kingbright AADI-9090QB11ZC/3 is in Fifth Rank, the Ligitek LGLB-313E is in Third rank, the Toshiba TL12B01(T30) is in Sixth rank and the Lumex SML-LX1610USBC is in Fourth rank.

4. Conclusion

Grey relational analysis is a significant method that can be used effectively to detect the influence of individual input parameters on output performance properties. Specifically, it can be used to determine the material removal rate for improved laser-assisted jet in an electrochemical machine micro boring of Inconel-718. The method is straightforward and simple. Moreover, the gray relational analysis method can be applied to evaluate and analyze customer satisfaction of some brand automobile 4S companies in Wuhan over the last three years. It is a convenient function that requires less data and produces clearer results. Regarding the optical wireless communication view of various products, the AOP LED Corp PU-5WAS ranks first, followed by the Lamina Atlas NT-42C1-0484 in second place. The Ligitek LGLB-313E ranks third, and the Lumex SML-LX1610USBC is in fourth place. The Kingbright AADI-9090QB11ZC/3 is in fifth place, and the Toshiba TL12B01(T30) is in sixth place.

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