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Lens Cleaning Solution Efficiency on Optical Survey Accuracy among Fourth-Year Geodetic Engineering Students at Batangas State University-Alangilan

Zamuel Jan P. Agarap[1], Nathalie Nicole A. Arellano[2], Kent Vincent F. Arojado[3], Althea Sheemae D. Atienza[4], Arjohn P. Atienza[5], Nicholas Eduard P. Bagsit[6], Donatello F. Berana[7], Dustin Andrei I. Wong[8], Bryle A. Armeza[9]
Bachelor of Science in Geodetic Engineering, Batangas State University, The National Engineering University, Batangas City, Philippines

Abstract: ***The study examines the limitations of current practices in maintaining and ensuring the optimal condition of surveying instruments, with a particular focus on lens cleanliness and its impact on measurement accuracy. It aims to understand these limitations and evaluate the effectiveness of informative infographics as a proposed tool for improving lens maintenance, accuracy, and efficiency in surveying tasks. The use of a quantitative research approach with a descriptive-developmental design allowed for a thorough analysis of the current shortcomings in instrument care and the potential of infographic-based guidance to address these issues. Conducted at Batangas State University – The National Engineering University - Alangilan, the research involved geodetic engineering students with firsthand experience in field surveying, using purposive-convenience sampling with 50 respondents. A researcher-developed questionnaire, divided into sections covering experience in lens maintenance, assessment of infographic effectiveness, benefits, and challenges in application, was used for data collection. Statistical tools, such as the mean and composite mean, aided in data analysis, enabling a quantitative assessment of the respondents' perceptions. The key findings highlighted concerns about improper lens care potentially affecting survey accuracy, while also emphasizing the positive reception of the infographic tool, which was praised for its clarity, ease of use, adaptability, and applicability in both laboratory and field settings. However, some challenges were noted, such as respondents' initial unfamiliarity with proper procedures and the need for additional training to maximize the infographic's effectiveness. Overall, the infographic has emerged as an innovative tool aimed at improving lens maintenance practices, enhancing survey accuracy, and fostering responsible instrument handling. This study contributes to the advancement of geodetic engineering education and practice by systematically evaluating an effective approach to address current gaps in optical survey instrument care.***

Keywords: Lens Cleaning, Optical Survey Accuracy, Informative Infographics, Geodetic Engineering

I. INTRODUCTION

Optical lenses are integral to various engineering applications, including photonics, instrumentation, and imaging systems. Tudor & Băbușanu (2024) highlight that the manufacturing of these lenses involves intricate processes that ensure precision and functionality. Lens contamination is a significant factor affecting the accuracy and efficiency of optical survey instruments. Consequently, advancements in lens manufacturing have led to significant improvements in precision, performance, and cost-effectiveness. The accumulation of dust, fingerprints, and moisture on the lenses of total stations and theodolites obstructs light transmission, causing optical aberrations that reduce image clarity and measurement accuracy (Baseline Equipment, 2025; Gerhard et al., 2020). To address this, specialized optical cleaning agents are formulated with mild solvents and surfactants to remove residues and dust without damaging the protective coating (Tudor & Băbușanu, 2024). Proper and consistent use of these solutions can improve optical transmittance by 12–18% and extend instrument service life by up to 20%, enhancing the reliability of surveying data. In geodetic and civil engineering education, the accuracy of surveying measurements depends greatly on proper maintenance of optical instruments, especially lenses. International curricula emphasize both correct operation and systematic care to prevent measurement errors (Ogundare, 2015); nevertheless, studies reveal inconsistent maintenance practices among students (Ustinova et al., 2017).

The Washington State Department of Transportation (WSDT) also notes that poor instrument care can reduce survey efficiency and accuracy. In the Philippines, government initiatives such as Department Order No. 2007-29 highlight the importance of calibration and maintenance to ensure precision and improve land survey quality (Lopez, 2025).

Despite the presence of international and national guidelines emphasizing proper lens care for surveying instruments, existing studies reveal inconsistencies in their practical application among engineering students and professionals. Moreover, there is a noticeable lack of focused research examining how various lens cleaning solutions affect the performance, accuracy, and longevity of surveying instruments, particularly within academic and field settings.

Based on the researchers' observation, despite the continuous advancements in surveying measurement tools, certain limitations remain evident in practice. Environmental irregularities, such as temperature variations, humidity, and atmospheric disturbances, can still affect the precision of measurements obtained from optical instruments. It has been observed that traditional total stations often exhibit slight inaccuracies when exposed to such external factors. This suggests that while technological innovations have enhanced efficiency, the accuracy of measurements in actual field conditions is still influenced by environmental factors beyond the operator's control.

The accuracy of geodetic measurements depends on the condition of optical surveying instruments. Environmental contaminants like dust, dirt, and humidity can affect lens clarity and cause measurement errors. Proper cleaning is therefore vital to maintain precision and data integrity. As noted by Tudor and Băbușanu (2024), using unsuitable cleaning products can damage lens surfaces and reduce performance. This highlights the need for Geodetic Engineering students to use appropriate cleaning solutions to ensure accuracy, discipline, and reliability in their fieldwork.

The common presence of dust, dirt, and pollution in field environments highlights the need for proper maintenance and cleaning of surveying instruments to ensure measurement reliability. According to the Noll et al. (2020), regular inspection and cleaning prevent contamination that can compromise accuracy. For Geodetic Engineering students, these practices are essential in maintaining instrument performance and achieving precise survey results.

This study is significant as it highlights the importance of selecting effective lens cleaning solutions to maintain the accuracy and performance of optical surveying instruments. The findings benefit Geodetic Engineering students by promoting proper maintenance practices and precision in fieldwork, assisting instructors in integrating standardized cleaning methods in training, and supporting the university's efforts in preserving laboratory equipment. Moreover, it contributes to professional and institutional practices by emphasizing the value of well-maintained instruments, ultimately enhancing data reliability in surveying applications.

This research paper aims to analyze the efficiency of cleaning solutions on optical survey accuracy by conducting various tests to accurately assess said solutions. By comparing different cleaning solutions and techniques, the proponents would determine, based on the results, and systematically figure out the most effective for cleaning lenses. This will help find the most optimal cleaning solution and techniques for fourth-year Geodetic Engineering Students of BatstateU. It would ensure a result backed up by accurate data, proof, and unbiased truth, considering every factor.

Overall, this means that lens maintenance and quality affect surveying precision and accuracy, showing the importance of an efficient cleaning solution to produce the best results. A Cleaning Solution should be able to erase external factors such as dirt, dust, and humidity to properly maintain and enhance the longevity of tools or instruments.

II. OBJECTIVES

This study aims to analyze the effect of various lens cleaning solutions on the accuracy and performance of optical survey instruments used by Geodetic Engineering students at Batangas State University. The researchers sought to provide answers to the following questions:

1) Identify the current cleaning practices of the respondents in maintaining their optical survey instruments.

2) Analyze the respondents' perception of the lens cleaning solutions in terms of:
   2.1 Optical Clarity;
   2.2 Measurement Accuracy;
   2.3 Ease of Application

3) Determine the effectiveness of lens cleaning solutions through the use of an informative infographic as a tool in maintaining survey accuracy.

4) Assess the respondents' satisfaction and perceived effectiveness of the infographic in improving lens cleaning practices

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III. MATERIALS AND METHODS

A. *Research Design*

The researchers used a descriptive developmental research design to study the experiences of fourth-year geodetic engineering students. This research design looks at the characteristics of the population and identifies the gaps that exist within an organization, and allows for adequate interpretation of gathered facts using questionnaires. It was chosen because it best suited the objectives of the study.

B. *Subjects of the Study*

This study used fourth-year BS Geodetic Engineering students from Batangas State University – Alangilan Campus as respondents. They are reliable sources of data because they have already taken the course during the 3rd Year of College. The distribution of respondents per campus is presented in Table 1.

Table 1. Distribution of Respondents

Fourth-year BS Geodetic Engineer	Population of Students
4101	45
4102	51
Total	96

C. *Data Gathering Instrument*

A questionnaire made by the researcher was the main way that information was gathered for this study.

Researcher-made questionnaires. It consists of four components, which are based on the statement of the problem. The first components of this survey are about the respondents' experiences in current maintenance and cleaning practices. The second components are divided into four subparts. It consists of statements that will analyze the respondents' perception of the lens cleaning solutions in terms of: optical clarity, measurement accuracy, and ease of application. The third component of this survey is to identify the effectiveness of the informative infographics as a tool in maintaining survey accuracy. The last component of this survey is about satisfaction and perceived effectiveness of the infographics.

Scoring of the Responses. The questionnaire was assessed using a 4-point scale with 1 being the lowest score and 4 being the highest score. The scale is represented below. The following range and verbal interpretations were utilized to answer each item in the survey questionnaire:

Option	Scale Range	Adjectival Rating
4	3.50 – 4.00	Strongly Agree
3	2.50 – 3.49	Agree
2	1.50 – 2.49	Disagree
1	1.00 – 1.49	Strongly Disagree

D. *Data Gathering Procedure*

Researchers write a formal request letter to the research adviser at Batangas State University, and distribute survey questionnaires using an electronic survey method. Results are tabulated, tallied, and the data is analysed and interpreted for presentation.

IV. RESULTS AND DISCUSSION

A. *Current Maintenance and Cleaning Practices*

This section presents data on the respondents' experiences with current maintenance and cleaning practices. Table 2 presents the geodetic engineers' experiences with current lens cleaning, maintenance, and practices.

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Table 2. Current Maintenance and Cleaning Practices

Statement	M	VI	AR
1. Instruments are checked for proper functionality before and after each use.	3.68	Strongly Agree	Very Strong
2. Adequate knowledge and experience are demonstrated in performing proper maintenance and cleaning of surveying instruments.	3.68	Strongly Agree	Very Strong
3.Proper maintenance and cleaning of surveying instruments are consistently performed after use to ensure efficiency and reliability in fieldwork.	3.48	Agree	Strong
4. All components of the instruments are kept free from dust, oil residues, and moisture after each operation.	3.50	Strongly Agree	Very Strong
5. Instruments are promptly cleaned and inspected after exposure to dirt, rain, or other adverse environmental conditions.	3.56	Strongly Agree	Very Strong
6. Regular inspections are conducted to identify signs of corrosion, wear, or functional issues that may affect accuracy in land surveys.	3.28	Agree	Strong
7. Appropriate cleaning materials are used to safeguard both the instruments.	3.36	Agree	Strong
8. The long-term environmental impact of cleaning methods is considered during maintenance.	3.46	Agree	Strong
9. Surveying instruments are stored in a clean, secure, and temperature-stable environment to preserve their quality.	3.66	Strongly Agree	Very Strong
10. Safety and cleanliness are observed in the working area to prevent contamination or unnecessary exposure of instruments to harmful elements.	3.56	Strongly Agree	Very Strong
Composite Mean	3.51	Strongly Agree	Very Strong

The result revealed that signifies that Geodetic Engineering students at Batangas State University strongly agree with the Current Maintenance and Cleaning Practices. This score reflects a generally positive perception of Maintenance and Cleaning Practices. The value suggests consistent satisfaction and acknowledgement that the Current Maintenance and Cleaning Practices should be done continuously to prolong the instruments. Based on the study of Nzisa (2021), proper care in the method by which equipment is used, stored, transported, and adjusted is a major factor in the successful completion of the survey. Lack of good maintenance practices not only causes unjustified replacement costs but also can seriously affect the efficiency and accuracy of the entire survey. The findings imply that although some practices of cleaning and maintenance of instruments are being done by Batangas State University Geodetic Engineering students, and a few practices are not done or regularly, their lower score states that they are not conducting some cleaning practices, or maybe they lack the knowledge to apply that cleaning practices. In relation to the course, this warning is reasonable because, as supported by the literature, the lack of good maintenance practices not only causes unjustified replacement costs but also can seriously affect the efficiency and accuracy of the entire survey. This result highlights the need for additional hands-on practice or training, such as instructor-led demonstrations, ensuring that students not only apply what they know but also gain more knowledge on how to maintain and clean the instrument properly.

B. Perception Towards Lens Cleaning Solution

1) Optical Clarity

Table 3 presents an analysis of the weighted and composite mean concerning the assessment of the lens cleaning solution efficiency on optical survey accuracy as to its optical clarity. The operational performance is indicated as the accuracy and consistency with which lens cleaning solutions are effectively integrated.

Table 3. Optical Clarity

Statement	WM	VI	AR
1. The cleaning solution removes small particles that obstruct the light passing through the lens.	3.40	Agree	Strong
2. It restores the natural brightness and transparency of the lens surface.	3.38	Agree	Strong
3. The solution prevents the formation of smudges or fog after cleaning.	3.36	Agree	Strong
4. It maintains the lens's reflective quality, ensuring a clear optical view.	3.38	Agree	Strong
5. It maintains the lens's reflective quality, ensuring a clear optical view.	3.52	Strongly Agree	Very Strong
Composite Mean	3.48	Agree	Strong

The analysis of the results shows that the respondents generally agree that the solution effectively contributes to accurate optical instruments. Semeniuta (2016) showed that advanced camera calibration techniques are required to reduce errors in lens surfaces. When lenses are maintained clean and without distortion, the accuracy of measurement for 3D reconstruction of objects significantly improves. The findings further suggest that maintaining lens clarity is crucial in preventing systematic errors that could compromise data precision. Clean and properly calibrated lenses allow optical instruments to capture more reliable measurements, which is essential in fields such as surveying, engineering, and scientific imaging. Additionally, the results imply that users recognize the importance of regular maintenance as a preventive measure rather than a corrective one, reinforcing the value of the proposed cleaning solution in prolonging instrument lifespan

C. Perception Towards Lens Cleaning Solution

1) Measurement Accuracy

Table 4 presents an analysis of the weighted and composite mean concerning the assessment of the lens cleaning solution efficiency on optical survey accuracy, as to its measurement accuracy. The operational performance is indicated as the accuracy and consistency with which lens cleaning solutions are effectively integrated.

Table 4. Measurement Accuracy

Statement	WM	VI	AR
1. The cleaning solution ensures that light is transmitted evenly through the lens during measurement.	3.42	Agree	Strong
2. It minimizes distortion or scattering that may affect optical readings.	3.38	Agree	Strong
3. The solution prevents buildup that could alter calibration or precision.	3.40	Agree	Strong
4. Measurements remain stable even after several cleaning cycles.	3.40	Agree	Strong
5. It helps maintain the integrity of optical instruments during data collection.	3.52	Strongly Agree	Very Strong
Composite Mean	3.44	Agree	Strong

The survey results indicate that Geodetic Engineering students strongly agree with the usefulness of cleaning solutions in terms of optical clarity, measurement accuracy, and ease of application. According to Tudor and Băbușanu (2024), to achieve optimal visual fidelity, highlight the positive impact of using purpose-built cleaning products. Other than ease of use, it also promotes better visual quality, accuracy, and longevity. Cleaning solutions allow users to maintain a pristine, scratch-free surface that supports high-precision measurement and viewing, avoiding the degradation often associated with harsher cleaning alternatives. In conclusion, between Geodetic Engineering students about the usefulness of the cleaning solution. These students recognize that optical clarity is not merely an aesthetic preference but a fundamental requirement for data integrity and reducing the risk of failure through preventable problems.

D. Perception Towards Lens Cleaning Solution

1) Ease of Application

Table 5 presents an analysis of the weighted and composite mean concerning the assessment of the lens cleaning solution efficiency on optical survey accuracy, as to its ease of application. The operational performance is indicated as the accuracy and consistency with which lens cleaning solutions are effectively integrated.

Table 5. Ease of Application

Statement	WM	VI	AR
1. The cleaning solution spreads smoothly across the lens surface with minimal wiping.	3.38	Agree	Strong
2. It does not leave sticky or oily residue that requires extra cleaning.	3.34	Agree	Strong
3. The solution works effectively with gentle motion, reducing the need for pressure.	3.44	Agree	Strong
4. It can be applied quickly, making the process efficient for repeated use.	3.44	Agree	Strong
5. The steps for cleaning are straightforward to follow, even without technical skill.	3.48	Agree	Strong
Composite Mean	3.42	Agree	Strong

This indicates that respondents agree with the statement. A mean of this magnitude implies that the cleaning solution is considered effective in preventing disruptions to the light path, an essential factor in achieving stable, accurate, and high-quality optical readings during field measurements. The result is consistent with literature emphasizing that optical clarity and even light transmission depend heavily on residue-free and properly maintained lens surfaces. Feng et al. (2023) demonstrated that contaminants such as dust, oil, and fog significantly reduce light transmittance and optical precision, stressing that effective cleaning restores uniform light flow and enhances overall clarity. Their findings reinforce the idea that appropriate cleaning agents are necessary to maintain even transmission in precision instruments such as surveying optics. This implies that the respondents perceive the cleaning solution to be effective in maintaining even transmission of light through the lens.

E. Effectiveness of the Informative Infographics

Table 6 shows an analysis of the weighted mean regarding the effectiveness of the informative infographics among the respondents. It shows how geodetic engineers have improved and enhanced the efficiency, productivity, and accuracy, using the implemented informative infographics.

Table 6. Effectiveness of the Informative Infographics

Statement	WM	VI	AR
1. The infographics present accurate and relevant information about lens cleaning.	3.56	Strongly Agree	Very Strong
2. The infographic clearly explains the proper steps in cleaning optical survey instruments.	3.58	Strongly Agree	Very Strong
3. Content is easy to understand and follow.	3.58	Strongly Agree	Very Strong
4. Visuals help illustrate proper cleaning techniques effectively.	3.56	Strongly Agree	Very Strong
5. It raises awareness of how lens cleaning affects survey accuracy.	3.54	Strongly Agree	Very Strong
6. The guide encourages correct and consistent application of cleaning methods.	3.60	Strongly Agree	Strong
7. The layout and design make the information more engaging.	3.46	Agree	Strong
8. After reading the infographics, do you feel confident in your ability to properly clean optical survey instruments	3.44	Agree	Strong
9. It serves as a reliable reference for lens cleaning procedures.	3.50	Strongly Agree	Very Strong
10. The infographic is an effective tool for promoting accurate and well-maintained survey instruments.	3.62	Strongly Agree	Very Strong
Composite Mean	3.54	Strongly Agree	Very Strong

The result revealed that Geodetic Engineering students at Batangas State University strongly agree on the effectiveness of lens cleaning solution on survey accuracy using a visual presentation. This score reflects a generally positive perception toward the infographic's clarity, relevance, and usefulness in improving understanding of lens cleaning and survey accuracy. The value suggests consistent satisfaction and acknowledgement that the infographics contributed to improved awareness of proper optical maintenance practices. Wagner et al. (2016) emphasized the importance of maintaining optical clarity in total stations, stating that contaminated lenses reduce measurement reliability. Infographics help visualize these consequences effectively. The composite mean suggests that the infographic successfully functioned as an educational intervention. Students generally recognized its value in improving their understanding of lens cleaning procedures and its connection to survey accuracy.

F. Satisfaction and Perceived Effectiveness of the Infographics

Table 7 shows an analysis of the weighted mean regarding the effectiveness of the informative infographics among the respondents. It shows how geodetic engineers have improved and enhanced the efficiency, productivity, and accuracy, using the implemented informative infographics.

Table 7. Satisfaction and Perceived Effectiveness of the Infographics

Statement	WM	VI	AR
1. The infographics provided a clear and easy-to-understand visual guide on how to properly apply the lens cleaning solution.	3.58	Strongly Agree	Very Strong
2. I am highly satisfied with the level of detail the infographics provided regarding the correct frequency of lens cleaning.	3.46	Agree	Strong
3. The infographics were visually appealing and held my attention, encouraging me to read the information thoroughly.	3.44	Agree	Strong
4. The infographics motivated me to clean the optical lenses of our surveying instruments more frequently than before.	3.42	Agree	Strong
5. I believe the infographics improved the correctness of my lens cleaning technique, reducing the risk of scratching the optics.	3.52	Strongly Agree	Very Strong
6. The infographics clearly explained the direct link between clean optical lenses and improved precision in distance measurements.	3.48	Agree	Strong
7. I now have a better understanding of how a dirty lens can introduce a systematic error that affects overall survey accuracy.	3.54	Strongly Agree	Very Strong

8. I am confident that the cleaning protocol presented in the infographics will contribute to higher-quality data collection in our field work.	3.54	Strongly Agree	Very Strong
9. I would recommend these informative infographics to other Geodetic Engineering students or professionals.	3.42	Agree	Strong
10. The use of the cleaning solution, guided by the infographics, is a necessary and effective practice for maintaining high survey accuracy.	3.60	Strongly Agree	Very Strong
Composite Mean	3.50	Strongly Agree	Very Strong

A composite mean of 3.50 indicates that the respondents collectively agree that the lens cleaning solution and accompanying infographic are useful, relevant, and effective for improving lens maintenance practices and ensuring accurate surveying outputs. Infographics in engineering education provide a pedagogically sound approach to communicate such technical procedures (Almazova et al., 2019; Wongjinda & Mekpayom, 2022). This supports the notion that combining technical cleaning with guided visual instructions enhances comprehension and encourages correct application, reinforcing the respondents' overall agreement. The overall agreement indicates that students perceive the lens cleaning solution and infographics as useful and effective for maintaining surveying instruments. This aligns with the findings that combining practical tools with visual guidance enhances comprehension and correct application. The survey suggests that this approach fosters systematic, precise, and professional maintenance practices among students.

V. CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:

1) Respondents' surveying experiences highlight the essential role of proper lens care in ensuring accurate and reliable measurement results.
2) The informative infographics were viewed as effective tools for improving understanding of lens cleaning procedures, enhancing optical clarity, and supporting accurate survey work.
3) Respondents recognized the infographics as valuable resources that promote efficiency, reinforce correct maintenance practices, and contribute to improved surveying performance.
4) No significant barriers were identified in implementing the infographic tool, as respondents showed strong willingness to use it due to its clarity, relevance, and practicality.
5) The use of informative infographics ultimately enhances lens maintenance knowledge, reduces errors related to improper cleaning, and supports more precise and sustainable surveying practices.

VI. RECOMMENDATIONS

Based on the results and conclusions of the study, the following recommendations are offered.

1) The researchers recommend that University Departments and Program Administrators promote the integration of the informative infographic into survey-related laboratory and field activities. Implementing this tool as part of standard instrument-handling guidelines will support sustainable practices, improve measurement accuracy, and strengthen the preservation of optical surveying equipment.
2) The researchers recommend that Geodetic Engineering Students and Practitioners utilize the infographic as a guide for proper lens cleaning procedures. Doing so will enhance optical clarity, reduce human error in data collection, and improve the efficiency and reliability of surveying operations.
3) The researchers recommend that Professional Engineers, Surveyors, and Related Technical Personnel apply the study's findings to maintain high standards of instrument care. Proper lens maintenance not only ensures accurate survey outputs but also promotes safety, reduces the risk of equipment damage, and reinforces professional accountability in fieldwork.
4) The researchers recommend that Academic Institutions, Training Centers, and Professional Organizations incorporate the infographic into instruction, seminars, and technical training programs. Using this resource can standardize maintenance practices, increase awareness about the importance of instrument care, and foster consistent, high-quality surveying performance across various levels of practice.

5) The researchers recommend that Future Researchers replicate this study with a larger sample size to strengthen the generalizability of the findings. Further studies may also explore the effectiveness of different visual learning materials, compare various lens cleaning solutions, or investigate additional factors affecting optical clarity and measurement precision. Researchers may likewise investigate the long-term impact of infographic-based training on field accuracy and instrument longevity.

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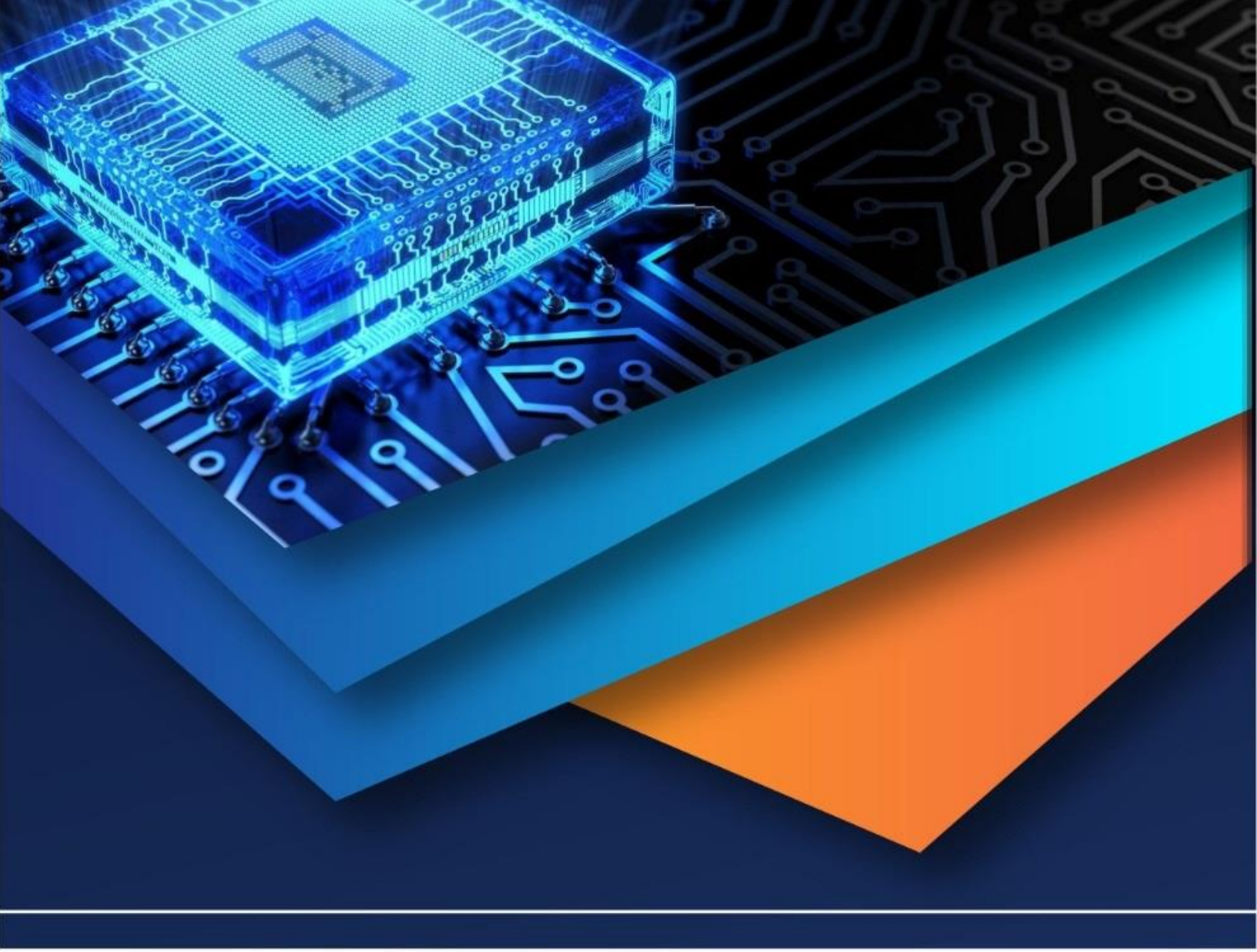

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