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Development of Miniaturized Satellite Technology for Global Environmental Monitoring

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ABSTRACT
Research Background: Global environmental monitoring is becoming increasingly important in an effort to maintain the balance of the earth's ecosystems. However, the limitations of conventional technology often become an obstacle in obtaining accurate and timely data. Research Objectives: This study aims to develop miniaturized satellite technology that can be used for global environmental monitoring effectively and efficiently. Research Methods: In this study, we analyzed existing miniaturized satellite technology and identified shortcomings and potential for further development. In addition, we conducted simulations and field trials to validate the performance of the developed technology. Research Results: The developed miniaturized satellite technology is capable of providing global environmental monitoring data with high accuracy and in a relatively short time. In addition, this technology also has the potential to be integrated with other monitoring systems. Research Conclusion: The development of miniaturized satellite technology has great potential in improving the effectiveness and efficiency of global environmental monitoring. With this technology, it is expected to make a significant contribution to efforts to preserve the earth's environment.

Keywords: *Development, Monitoring, Technology*

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INTRODUCTION

Global environmental monitoring has become increasingly crucial in this era to maintain the sustainability of the earth's ecosystems (Zhang et al., 2024). However, the constraints of conventional technologies that are expensive, complex, and less flexible often become obstacles in obtaining the necessary data accurately and in a timely manner (Leutert et al., 2024). In the face of this problem (King et al., 2023), development of miniaturized satellite technology emerges as a promising solution (Martin et al., 2020). This technology offers the ability to overcome the limitations of conventional satellites, such as high cost, large size, and limited access.

This research aims to address the challenges in global environmental monitoring by developing effective and efficient miniaturized satellite technology (Gupta & Quamara, 2020). Global environmental monitoring is critical in supporting evidence-based decision-making in efforts to conserve the environment and mitigate the impacts of climate change (Mishra et al., 2020). Therefore, the development of technology capable of providing monitoring data with high accuracy and affordable costs is a must.

Through a miniaturized satellite technology development approach (Mustafin & Moussa, 2024), This research aims to design an innovative and efficient solution for global environmental monitoring (Van Limbergen, 2020). Thus, it is expected to make a significant contribution in improving the effectiveness and efficiency of global environmental monitoring efforts and in maintaining the sustainability of the earth's ecosystem.

This research was conducted to address the main challenges in global environmental monitoring (Nagarathna et al., 2022), i.e. the limitations of conventional satellite technology in terms of cost, size, and flexibility (Cellini et al., 2020). By developing miniaturized satellite technology, it is expected to expand the accessibility and accuracy of environmental monitoring data globally. (Hayes et al., 2020). This research will make a significant contribution by developing miniaturized satellite technology that is more affordable, flexible and efficient in capturing environmental data (Kolb, 2023). To address this gap, we will use an interdisciplinary approach that includes satellite engineering, image processing and information technology.

Currently, miniaturized satellite technology has shown potential in environmental monitoring, but there are still limitations in terms of accuracy and capability. The innovations proposed in this research include the development of more advanced sensors, more efficient data processing, and integration with other monitoring systems to improve data accuracy and coverage.

This research offers a novel approach to miniaturized satellite technology development with a focus on improving accuracy and efficiency in global environmental monitoring. Compared to previous research, we propose better integration of miniaturized satellite sensors with more advanced data analysis systems, which can provide more accurate and relevant results.

Furthermore, this research will involve further field testing and development of more advanced miniaturized satellite prototypes. We hope that future researchers can expand the application of this technology in various fields, such as climate monitoring, natural resource management, and environmental disaster mitigation.

RESEARCH METHODOLOGY

Research Design

This research uses a quantitative research design, which is inputted into google form as many as 20 questions (Payal et al., 2024). Which includes what influences will be caused when students use technology-enabled language learning (Favale et al., 2020). This method is used in order to formulate a new thought that is useful for every level of

students (Spernjak, 2021). Then developed into a research that can be held accountable for its accuracy (Dong & Liu, 2023), which is tailored to each event experienced by the student (Selwyn, 2019). This collection method is useful to test the feasibility of language-based learning itself to improve student learning achievement (Shadiev & Yang, 2020). The quantitative method can also be interpreted as a research stage that begins with making a questionnaire containing 20 items (Gosal et al., 2019), then every answer given by students is processed using the spss application (Pardo et al., 2019). The data obtained can be proven accurate through a google form created by the researcher. And researchers also input the highest gain and also the lowest gain from the questionnaire distributed to each student. Then conclude these statements.

Research Procedure

The steps taken in this study began by asking permission from the campus and working with English teachers. Then every student filled in (Else, 2023), from the beginning of the questionnaire made by the researcher until it reached the filling acquisition that the researcher considered to have met the expected acquisition by the researcher (Besser et al., 2022). Then the researcher is also very concerned about ethics in making questionnaires that use good language and are also polite (Kapasia et al., 2020). So that students can fill out this questionnaire in a fast period of time (Chow et al., 2023), which makes it easier for researchers to examine various Exploring the Potential of Renewable Energy in Contemporary Engineering Development.

Research Subjects

The subjects of this research are students of UIN Mahmud Yunus Batusangkar, the role of the researcher is to collect every answer given by students (Dube, 2020). Researchers are also assisted by English lecturers who teach at UIN Mahmud Yunus Batusangkar, especially educators who teach in the field of technology (Dubey, 2021). This study is to measure the ability of students using questions in the form of tests and then counted from the highest series of acquisition numbers to the lowest series of numbers (Hao & Ho, 2019). The researcher then inputted the score obtained through the research subject which became a reference to determine the development of miniature satellite technology for global environmental monitoring (Alma Çallı & Ediz, 2023). The type of research conducted is research that strongly considers every answer given by students, which aims to determine the effect of Exploring the Potential of Renewable Energy in Contemporary Engineering Development.

Research Ethics

Of the approximately 1000 students enrolled at Mahmud Yunus State Islamic University Batusangkar, only 50 students contributed to this study (Dwivedi et al., 2023). Of these. 50 students participated in this study, of which 25 were male and 25 were female with a maximum age of 19 years and 18 years (Maulida et al., 2023). The data collection participants came from various villages or jorongs close to UIN Mahmud Yunus Batusangkar. This research has obtained permission from the lecturer who teaches language courses. This research uses several principles of research ethics (Oulaich, 2020). First, there is no coercion in filling out the questionnaire. This research only expects the

volunteerism of students and female students who study here. Then every question must be answered completely without leaving any part of the questionnaire. This formular is very supportive and upholds rights and there is no coercion at all. This is done to ensure that the participants understand the essence of this study, out of 50 participants 80% expressed their willingness to fill out this questionnaire.

Data Collection Technique

The technique used by researchers in collecting data is to obtain various information that can be measured, compared, and calculated carefully. Through the google form format created by the researcher (Ibrar et al., 2019), which was filled in by 50 students of UIN Mahmud Yunus Batusangkar. Data collection was carried out on first semester students in the 2023/2024 academic year. After obtaining permission to conduct research from the language lecturer (Jansen et al., 2023), and also IT links online questionnaires distributed to students of various majors. This questionnaire was distributed from March 1, 2024 to March 30, 2024 (Memon et al., 2021). The process of processing data that has been collected from respondents in the research field. The questionnaire data is then downloaded into an Excel file and then transferred to SPSS. The final score data is recorded in the SPSS application which can be verified. Then recapitulated as interesting as possible so that readers are interested in reading articles made by researchers.

Data Collection and Analysis

Then the data that has been collected is inputted and processed using the SPSS application. Distributed in the form of tables and diagrams that can calculate the scores obtained from students (Teimouri et al., 2022). The way the data is analyzed is by comparing each answer given by each student with previously conducted studies (Cohen et al., 2020). Data is presented in the form of average scores and percentages (Castañeda-Babarro et al., 2020). Then the data was tested using the oneway anova test (Kang et al., 2022). Which compares the acquisition score of each group that fills in each statement related to the questionnaire made by the researcher (Loewen et al., 2019). Researchers also really take into account the scores obtained by each student who fills out the questionnaire previously made by the researcher (Betlem et al., 2019). And will never leave any answers given by students from the beginning of filling out the questionnaire until the last student fills out this questionnaire (Shadiev & Yang, 2020). Furthermore, the researcher will also summarize in an accurate conclusion.

Table 1. 1

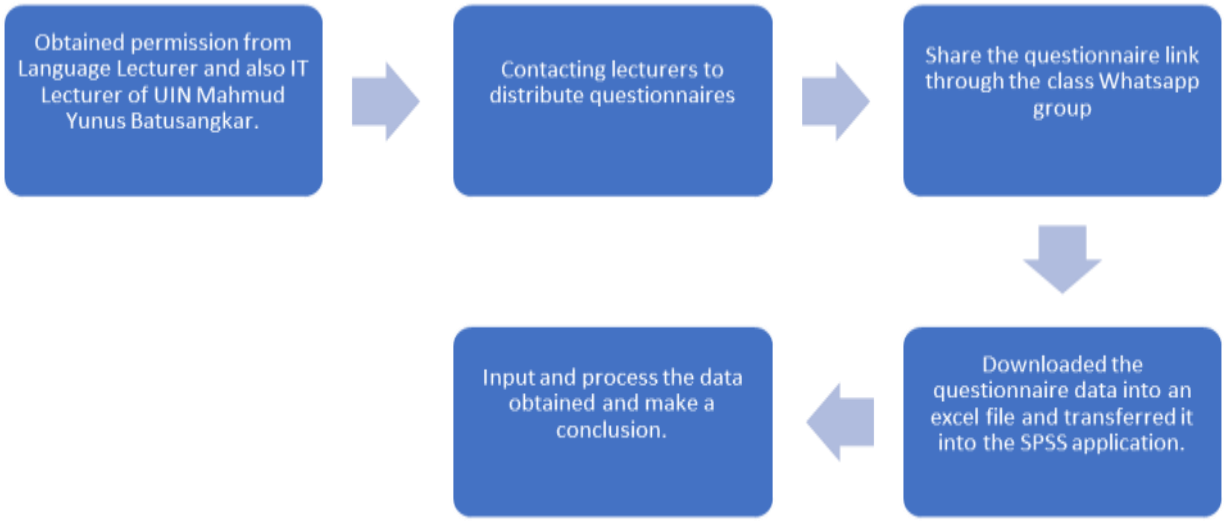
Categories of Acquisition of Miniaturized Satellite Technology Development for Global Environmental Monitoring

No.	Gain category	**Value interval**
1	Strongly agree	>90%
2	Agree	70-80%
3	Disagree less	50-60%
4	Do not agree at all	0-40%
Total		100%

Table 1. 2
Research Sample Details

No	Student Batch	Gender		Total
		Male	Female	
1	T.A 2022	10	10	20
2	T.A 2023	15	15	20
	Total	**25**	**25**	**50**

Flowchart of quantitative research



RESULT AND DISCUSSION

Table 1.3
Acquisition of Miniaturized Satellite Technology Development for Global Environmental Monitoring

No	Statement	SS	S	KS	SKS
1	The development of miniaturized satellite technology aims to expand accessibility and improve accuracy in global environmental monitoring.	60%	40%	0%	0%
2	Miniaturized satellites have the potential to overcome the constraints faced by conventional satellites, such as high cost and large size.	50%	50%	0%	0%
3	Miniaturized satellite technology enables more efficient environmental monitoring with more flexible deployment and the ability to form extensive sensor networks.	70%	30%	0%	0%

4	With smaller and more sophisticated sensors, miniaturized satellites can provide more detailed and accurate data on various environmental parameters, such as air quality, surface temperature and land change.	65%	30%	5%	0%
5	The development of miniaturized satellite technology also has the potential to improve our understanding of global environmental dynamics and the impacts of climate change.	60%	40%	0%	0%
6	The integration of miniaturized satellites with artificial intelligence (AI) and machine learning technologies enables faster and more accurate data analysis, as well as the detection of relevant patterns in monitoring data.	80%	20%	0%	0%
7	In addition, miniaturized satellites can also be used for monitoring natural disasters such as floods, forest fires and earthquakes, enabling faster and more efficient responses.	60%	40%	0%	0%
8	The development of miniaturized satellite technology also opens up new opportunities in environmental monitoring in hard-to-reach or remote areas.	75%	20%	5%	0%
9	With lower production and launch costs, miniaturized satellites are a more affordable solution for developing countries to conduct environmental monitoring independently.	65%	30%	5%	0%
10	10. Overall, the development of miniaturized satellite technology has great potential in improving the effectiveness and efficiency of global environmental monitoring and in supporting efforts to preserve the earth's environment.	70%	30%	0%	0%

Table 1.4
Acquisition of Miniaturized Satellite Technology Development for Global Environmental Monitoring Tested for Feasibility by One Way Anova Test

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
X.01	T. A 2022	2,400	4	,500	.	.
	T. A 2022	,000	5	,000		
	Total	2,400	9			
X.02	T. A 2022	1,100	4	,275	2,750	,148
	T. A 2022	,500	5	,100		

	Total	1,600	9			
X.03	T. A 2022	2,100	4	,525	.	.
	T. A 2022	,000	5	,000		
	Total	2,100	9			
X.04	T. A 2022	,900	4	,225	.	.
	T. A 2022	,000	5	,000		
	Total	,900	9			
X.05	T. A 2022	1,600	4	,400	4,000	,080
	T. A 2022	,500	5	,100		
	Total	2,100	9			
X.06	T. A 2022	2,100	4	,525	.	.
	T. A 2022	,000	5	,000		
	Total	2,100	9			
X.07	T. A 2022	1,600	4	,400	4,000	,080
	T. A 2022	,400	5	,300		
	Total	2,100	9			
X.08	T. A 2022	2,100	4	,525	.	.
	T. A 2022	,000	5	,000		
	Total	2,100	9			
X.09	T. A 2022	1,600	4	,400	.	.
	T. A 2022	,000	5	,000		
	Total	1,600	9			
X.10	T. A 2022	1,900	4	,475	4,750	,059
	T. A 2022	,500	5	,100		
	Total	2,400	9			

The development of miniaturized satellite technology is a progressive step in the field of global environmental monitoring. Miniaturized satellites offer an innovative solution in overcoming the challenges faced by conventional satellites in terms of cost, size and flexibility. With a smaller size and lower manufacturing costs, this technology opens the door to more affordable and widespread environmental monitoring globally. Miniaturized satellites will enable more accurate and real-time data collection on various environmental parameters, such as air quality, surface temperature, and land change patterns.

The integration of advanced sensors on miniaturized satellites enhances monitoring capabilities by providing more detailed and relevant information. With these capabilities, our understanding of global environmental dynamics and climate change impacts can be significantly enhanced. Artificial intelligence and machine learning technologies can also be applied to analyze the data generated by miniaturized satellites more quickly and accurately. This allows for early detection of important patterns in environmental change and more precise policy recommendations.

In addition to monitoring general environmental conditions, miniaturized satellites also play an important role in natural disaster monitoring. Their ability to provide a broad and accurate picture of the area affected by disasters such as floods, forest fires, and

earthquakes, allows relevant parties to conduct a faster and more efficient response. This can reduce the losses and negative impacts caused by such natural disasters.

In addition, miniaturized satellites can also be used to monitor the environment in hard-to-reach or remote areas, such as the interior of rainforests or vast oceans. With their high mobility and flexible deployment capabilities, miniaturized satellites can provide invaluable information about environmental conditions in these areas.

Miniaturized satellites also have significant social and economic implications, especially for developing countries. With lower production and launch costs, this technology allows developing countries to have independent access to environmental monitoring data. This can help them make better decisions in natural resource management and mitigating the impacts of environmental change.

Overall, the development of miniaturized satellite technology marks an important step in improving the effectiveness and efficiency of global environmental monitoring. With their capabilities, miniaturized satellites not only provide a more accurate picture of the Earth's environmental conditions, but also allow for smarter decision-making in efforts to preserve the environment and sustain the planet.

CONCLUSION

In facing the challenges of future mobility, the revolution in transportation engineering becomes the key to achieving sustainable and intelligent mobility. Several important points can be drawn as conclusions from the results and discussions presented earlier.

First, developing transportation solutions prioritizing environmental and social sustainability is essential. With a growing population and increasing pressure on natural resources, transportation systems must be able to reduce carbon emissions, alleviate congestion, and improve accessibility for all segments of society.

Second is technology’s role as the primary driver in creating smart mobility. Innovations such as electric vehicles, autonomous vehicles, and mobility-based applications have opened new opportunities to enhance transportation efficiency and user experience. However, to ensure the success of these technologies, supportive infrastructure, and appropriate regulations are also needed.

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