International Journal of Research In Vocational Studies (IJRVOCAS)
Vol. 2 No. 4 (2023): IJRVOCAS – Special Issues – INCOSTIG – PP. 77~85
Print ISSN 2777-0168| Online ISSN 2777-0141| DOI prefix: 10.53893
https://journal.gpp.or.id/index.php/ijrvocas/index

System of Carbon Dioxide (Co2) Detection Using Sim7600 Communication Module in Palm Oil Plantations

Febrin Aulia Batubara, Bakti Viyata Sundawa* & Tuti Adi Tama Nasution
Telecommunication Network and Technology Engineering, Medan State Polytechnic, Indonesia

ABSTRACT

The problem of environmental damage caused by the palm oil industry has become a global issue. This often becomes an obstacle to the development of the palm oil industry in Indonesia. In fact, millions of Indonesians work in the palm oil sector and are a source of non-oil and gas state revenue. For this reason, efforts to support a sustainable palm oil industry need to be carried out. One of them is the implementation of a smart system in the form of a carbon dioxide (CO2) level detection system. It is important to know these parameters because they are affected by the expansion of oil palm plantations. The measurement results can be accessed and displayed in real-time web-based using the SIM7600 communication module. It is hoped that this CO2 detector will be a solution to environmental problems and related parties can determine mitigation actions in the most extreme conditions.

Keywords:

Smart System
Co2 detector
Sim7600
Oil Palm Plantation

Corresponding Author:

Bakti Viyata Sundawa,
Telecommunication Network and Technology Engineering,
PoliteknikNegeri Medan,
Almamater Road No 1, Padang Bulan, Medan, North Sumatera, Indonesia.
Email: baktisundawa@polmed.ac.id

1. INTRODUCTION

1.1 Background

The palm oil commodity is increasingly showing its existence and has become the backbone of the Indonesian economy. Exports of palm oil in the form of CPO and its derivatives reached 36.17 million tons in 2019 [1-3]. This figure increased by 4.2% from exports in 2018. North Sumatra is one of the largest palm oil producers in Indonesia with plantation area expansion reaching 1.49% per year, namely an area of 1,260,080.95 hectares.

Oil palm plantations are scattered in various districts in North Sumatra. Starting from the east end of North Sumatra to the west end. These areas have a climate suitable for the growth and development of oil palm trees. Oil palm plantations will also be developed to the south of North Sumatra, especially in the Regencies of Padang Lawas, North Padang Lawas and Mandailing Natal. These regencies also have the potential for developing oil palm plantations [4].

The expansion of the area of oil palm plantations which continues to increase coupled with efforts to increase production per unit of land as well as the People's Palm Rejuvenation Program (PSR) in North Sumatra makes this sector very promising for the future [5-7]. However, environmental issues and climate factors are still obstacles to the development of the palm oil industry [8]. The opening of new land for oil palm plantations in Indonesia is considered to be a factor in increasing CO2 levels in the air [9]. Deforestation due to land use change, carbon emissions and loss of biodiversity has become an international issue. Fluctuations in CO2 levels are related to the conditions of the dry and rainy seasons, day and night as well as extreme climatic conditions that make it difficult to predict.

This is a challenge for oil palm stakeholders in Indonesia. Oil palm plantations must have a dual function, namely as plantation land with high economic value, a source of income, employment opportunities, and non-oil and gas export income. Oil palm plantations must also be a medium for preserving nature and the environment, as a producer of oxygen (O2) and absorb carbon dioxide (CO2) emissions..

In the process of photosynthesis, oil palm will absorb CO2 from the air and will release O2 into the air [10, 11]. This process will continue as long as its growth and development can reach more than 25 years with good management. Based on research from IOPRI (Indonesian Oil Palm Research Institute) that CO2 fixation is 25.71 tons/ha/year [12]. Oil palm is able to store more than 80 tonnes C/ha. This amount is achieved after 10-15 years of growth so that the average amount of carbon anchored by oil palm plants is around 60.4 tons/ha or an average of around 2.44 tons C/ha/year and equivalent to 8.95 ton CO2/ha/year [12-15].

Based on the parameters of CO2 levels in oil palm plantations, this research needs to be studied further to find out how to detect CO2 levels in order to know and observe environmental conditions due to the expansion of oil palm plantations. Information on CO2 levels must be displayed and accessed in real-time via the internet via a computer. This is useful for determining policies related to mitigation when environmental conditions are in extreme circumstances.

This research needs to be studied further to develop an IoT (*Internet of Things*) based CO2 level detector device. The placement of the CO2 level detector will be placed in an oil palm plantation. His position will be far from the community, electricity resources and internet networks. So this research needs to be studied further to develop a tool to detect environmental conditions using solar panels as a source of electricity and wireless network technology. This CO2 level detector is one of the efforts to achieve Sustainable Development Goals in the palm oil industry..

1.2 Formulation of the problem

The formulation of the problem in this study is how to monitor environmental parameters such as CO2 levels as a result of the expansion of oil palm plantations.

1.3 Research Limitations

The limitation in this study is that the soil analyzer tool uses IoT-based components such as the SIM7600 communication module, ADC module, ESP32 microcontroller and MG-811 carbon sensor. Information about CO2 level data can be accessed and displayed in real-time via the internet.

1.4 Research purposes

The aim of this research is:

1. Building a smart system as a solution to environmental problems in the palm oil industry. The smart system is a CO2 detector that will be placed in oil palm plantations using carbon sensors, and using IoT-based components such as the SIM 7600 communication module, ADC module and ESP32 microcontroller. Information about environmental data can be accessed and displayed in real-time via the internet.
2. Develop a mitigation framework for extreme environmental conditions so that the sustainable development goals (Sustainable Development Goals) in the palm oil industry can continue.
3. Utilizing green technology for electricity resources in devices for detecting CO2 levels in oil palm plantations.

2. RESEARCH METHOD

2.1 Research Stages

In this study, there are 7 stages that will be carried out. These stages are:

1) The first stage is a literature study of the references that will be used in this study. References can be in the form of journals, books, reports and various other references sourced from the internet and offline media.
2) The second stage is to design the CO2 level detector hardware. At this stage, appropriate components are selected, both the main components and supporting components. The main components are the ESP32 microcontroller, the MG-811 sensor and the SIM7600 communication module.
3) The second stage is to design the hardware CO2 level detector. At this stage, appropriate components are selected, both the main components and supporting components. The main components are the ESP32 microcontroller, the MG-811 sensor and the SIM7600 communication module.
4) The fourth stage is hardware manufacture. At this stage, the main components and supporting components are designed and assembled into an integrated circuit.
5) The fifth stage is software development. The CO2 level detector control system program is embedded in the ESP32 microcontroller chip and web programming is done on a laptop.
6) The sixth stage is testing the system as a whole against the CO2 level detector.
7) The seventh stage is the analysis of the measurement results from the CO2 sensor.
8) The stages of this research are explained with a flowchart in Figure 1.

https://doi.org/10.53893/ijrvocas.v2i4.171

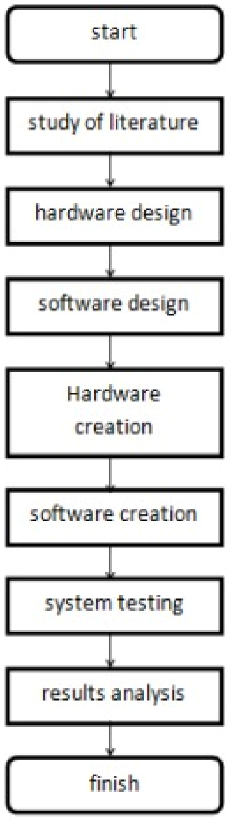

Figure 1. *Flowchart of research stages*

2.2 Research sites

The location of the research was carried out at the Telecommunications Laboratory of the Medan State Polytechnic and in an oil palm plantation.

2.3 Measurement and Observation Parameters

The parameter to be measured in this study is the level of carbon dioxide (CO_2). The measurement table to be used in this study is shown in Table 1.

Table 1.Measurement result data

Time	Carbon Dioxide/CO2(ppm)
Average value	

2.4 Research Model

This study was designed to be able to acquire data on CO_2 levels resulting from the expansion of oil palm plantations. This tool will be placed near the oil palm trees. Figure 2 is an illustration of the position of a CO_2 detector placed near an oil palm tree.

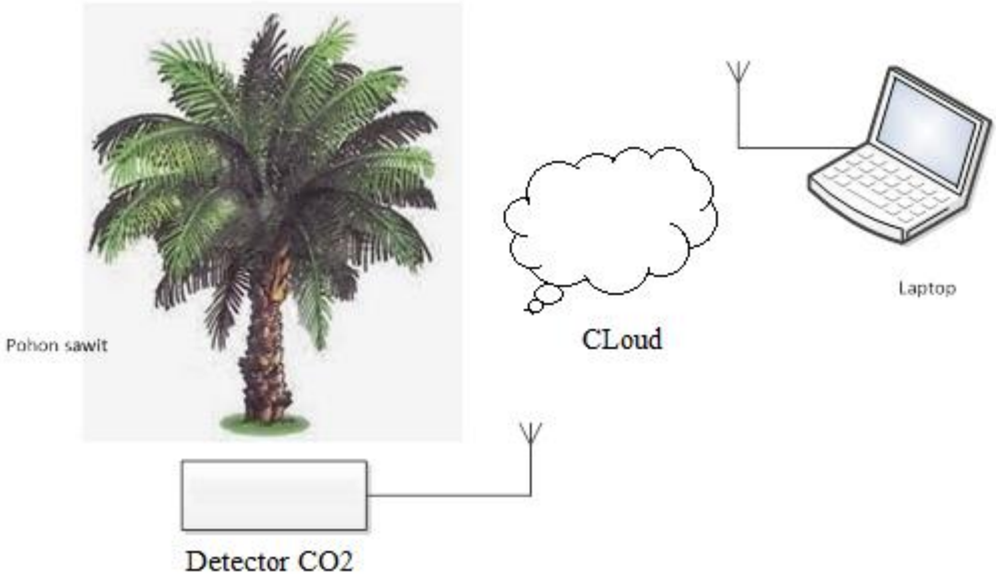

Figure 2. Illustration of CO2 detector position

2.5 Research design

The research design is described in the form of a block diagram as shown in Figure 3. There are 4 main blocks, namely the MG-811 sensor block, the analog digital converter (ADC) block, the microcontroller block, the SIM7600 block. In this design, an ADC circuit is needed to convert measurement data that is still analog from sensors. Furthermore, the sensor reading results will be sent by SIM7600 to the cloud server.

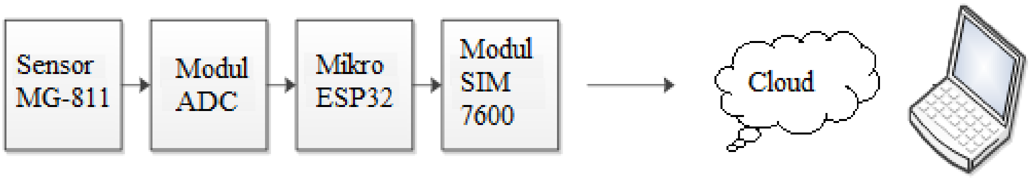

Figure 3. Block Diagram of Research Design

Based on the block diagram, a circuit scheme will then be designed. Figure 4 is a schematic design of a series of studies.

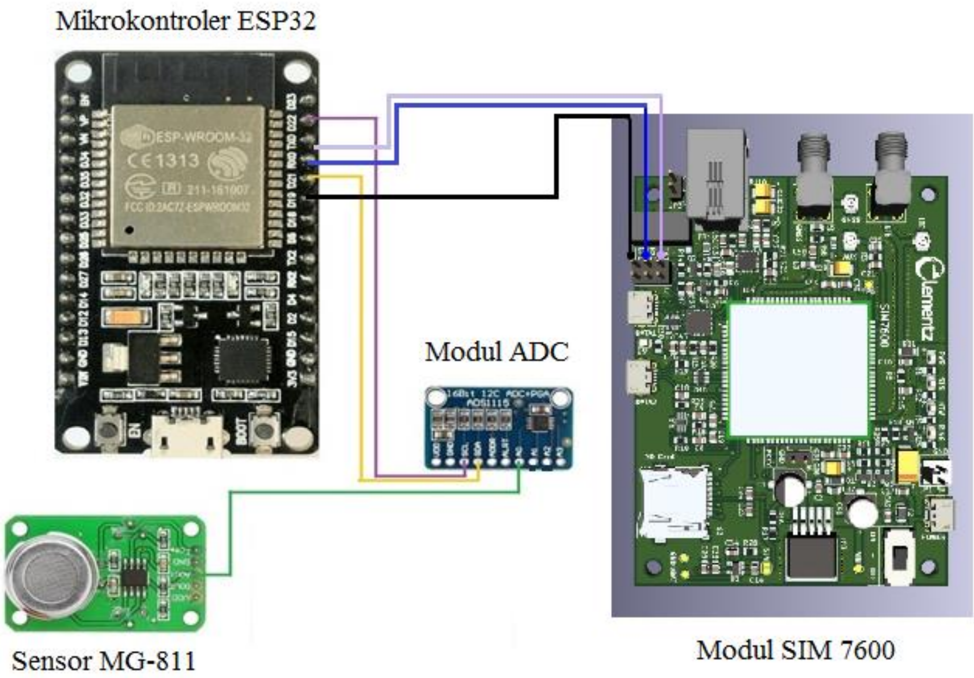

Figure 4. Research series scheme

3. RESULTS AND ANALYSIS

The measurement location is in the oil palm plantation and the Telecommunications Engineering Laboratory of the Medan State Polytechnic. The implementation time starts from September – November 2022. The observation point is determined by 2 factors with 3 treatments and 3 repetitions. Factor 1 is the observation point in the area of accumulation of cut fronds and other litter (B1) and factor 2 is the observation point in the road area around the tree (B2). While the treatment was (A1) natural roots, (A2) cut roots 50 tertiary roots and 50 quaternary roots when measurements were to be taken and (A3) cut roots and permanently restricted. CO2 measurements were carried out using a survey method on oil palm plantations, using a CO2 detector (MG-811 sensor) for 3 minutes. Determination of the measurement location area is carried out using a purposive sampling method, namely the determination of a location that is considered representative.

3.1. Data

Data on average CO2 concentrations measured in September, October, and November are shown in Figure 5-7.

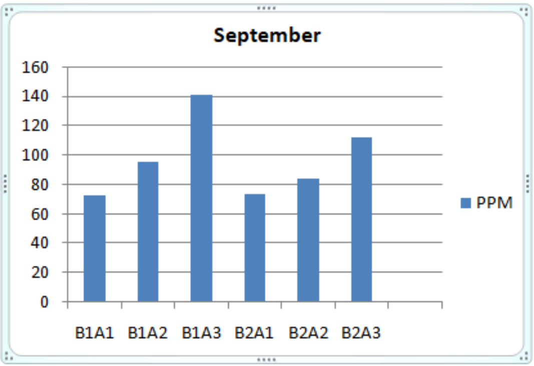

Figure 5. CO_2 concentration in September 2022

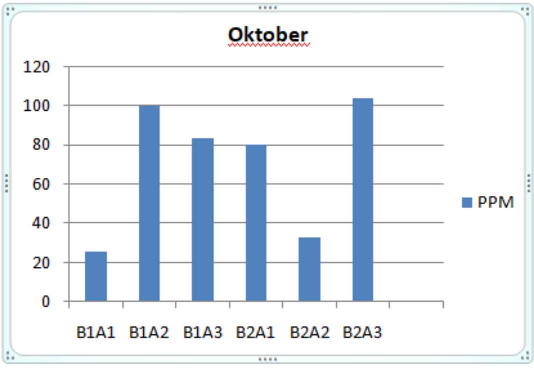

Figure 6. CO_2 concentration in Oktober 2022

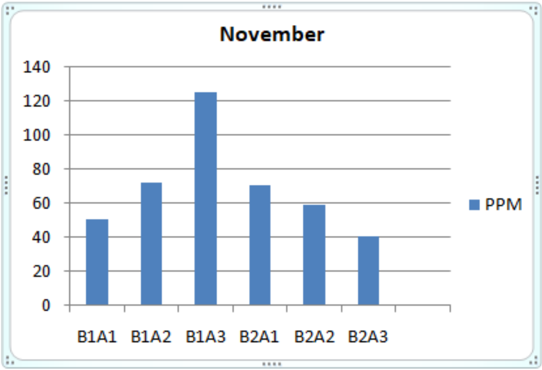

Figure 7. CO_2 concentration in November 2022

Information:
B1A1 : Area in the same direction as the natural root
B1A2 : Area in the direction of the root was cut during measurement
B1A3 : Limited area in the same direction as the cut root
B2A1: Common Street area with natural roots
B2A2 : Road area whose roots were cut off during measurement
B2A3 : Road area with limited permanent cut roots

From Figure 5-7, it can be seen that the highest change in CO2 concentration in September was in treatment B1A3 (139.4 ppm), October was in treatment B2A3 (105.2 ppm), and November B1A3 (123.7 ppm. Meanwhile, the lowest CO2 concentration was in September was in treatment B1A1 (72.4 ppm), October was in treatment B1A1 (24.8 ppm), and November was B2A3 (39.7 ppm).Changes in CO2 occurred from the root respiration process, this is in accordance with the opinion of Berglund et al. al., 2011, that the contribution of root respiration to CO2 emissions is 27-63%.Changes in CO2 are also caused by the decomposition of peat by soil microorganisms.

3.2. Analysis

The palm oil industry in Indonesia has grown rapidly supported by very rapid plantation growth, reaching more than 8.0 million hectares in 2010; about 62% are cultivated by large plantations and 38% by smallholders [16]. Indonesia's palm oil production in 2012 amounted to 27 million tonnes, consisting of 18 million tonnes for export purposes and the remainder for domestic consumption.

In explained that the level of carbon stored in biomass in tropical forests ranges from 41.5% to 50% [17]. Furthermore, according to forests in Indonesia are estimated to have stored carbon stocks between 161 tons ha-1 to 300 tons ha-1[18].

Oil palm is able to store more than 80 tonnes of C ha-1. However, it was said by [19], that this amount was achieved after 10-15 years of growth so that the average amount of carbon anchored by oil palm plants was around 60.4 t ha-1 or an average of around 2.44 t C ha -1 year-1 and equivalent to 8.95 t CO2 ha-1 year-1[20].

4. CONCLUSION

The palm oil commodity is increasingly showing its existence and has become the backbone of the Indonesian economy. Starting from the east end of North Sumatra to the west end. However, environmental issues and climate factors are still obstacles to the development of the palm oil industry. The problem of environmental damage caused by the palm oil industry has become a global issue. This often becomes an obstacle to the development of the palm oil industry in Indonesia. In fact, millions of Indonesians work in the palm oil sector and are a source of non-oil and gas state revenue. For this reason, efforts to support a sustainable palm oil industry need to be carried out. One of them is the implementation of a smart system in the form of a carbon dioxide (CO_2) level detection system. It is important to know these parameters because they are affected by the expansion of oil palm plantations. The measurement results can be accessed and displayed in real-time web-based using the SIM7600 communication module. It is hoped that this CO_2 detector will be a solution to environmental problems and related parties can determine mitigation actions in the most extreme conditions.

ACKNOWLEDGEMENTS

We would like to thank you to Director of Politeknik Negeri Medan, Chief of The First Director in Academic Affair, Head of P3M POLMED. This research has funded by DIPA POLMED 2022 in Penelitian Terapan Inovasi (PTI).

REFERENCES

[1] D. H. Azahari, "Hilirisasi kelapa sawit: Kinerja, kendala, dan prospek," in *Forum penelitian Agro Ekonomi*, 2019, vol. 36, no. 2, pp. 81-95.

[2] P. Purwadi, Y. T. M. Astuti, K. Budihardjo, and R. F. Simbolon, "KAJIAN DAMPAK FLUKTUASI HARGAMINYAK KELAPA SAWIT DUNIATERHADAP HARGA TANDAN BUAH SEGAR DI TINGKAT PETANI," in *PROSIDING SEMINAR INSTIPER TAHUN 2018*, 2019, vol. 1, no. 1.

[3] D. I. T. Sipayung, *Ekonomi agribisnis minyak sawit*. PT Penerbit IPB Press, 2019.

[4] E. S. Ginting, "Sumatera Utara: Pengembangan Potensi Daerah dalam Dikotomi Spasial dan Non Spasial," *JAUR (JOURNAL OF ARCHITECTURE AND URBANISM RESEARCH),* vol. 3, no. 2, pp. 139-153, 2020.

[5] M. Aulifa and P. P. P. MEDAN, "Partisipasi Petani dalam Pelaksanaan Program Peremajaan Sawit Rakyat (PSR) di Kecamatan Selesai Kabupaten Langkat," *Tugas Akhir. Medan. Politeknik Pembangunan Pertanian Medan,* 2019.

[6] N. A. B. Hutabarat, "Analisis Peranan Penyuluh Pertanian Dalam Penerapan Program Peremajaan Sawit Rakyat (PSR) di Kecamatan Bahorok Kabupaten Langkat," *Jurnal Ilmiah Mahasiswa Pertanian [JIMTANI],* vol. 1, no. 4, 2021.

[7] M. Wahyuni and F. A. Barus, "Peningkatan Pola Pikir Petani Untuk Mengikuti Program Peremajaan Sawit Rakyat di Desa Laut Tador Batu Bara Provinsi Sumatera Utara," *Dinamisia: Jurnal Pengabdian Kepada Masyarakat,* vol. 5, no. 3, pp. 724-732, 2021.

[8] J. Sitompul, "Analisis Pengaruh Luas Lahan Dan Produksi Perkebunan Kelapa Sawit Terhadap Penyerapan Tenaga Kerja Di Kabupaten Kampar," Universitas Islam Riau, 2019.

[9] K. Khatimah, "ANALISIS DAMPAK-DAMPAK YANG DITIMBULKAN DARI PERKEBUNAN SAWIT DI INDONESIA."

[10] L. Advinda, *Dasar–dasar fisiologi tumbuhan*. Deepublish, 2018.

[11] Z. Zainuri, D. Zargustin, G. Yanti, and S. W. Megasari, "Pengurangan Emisi CO2 dari Pemanfaatan Limbah Pelepah Kelapa Sawit pada Produksi Batako Serat," *Jurnal Teknologi Lingkungan,* vol. 20, no. 1, pp. 37-44, 2019.

[12] S. Anggraini, "CADANGAN KARBON KELAPA SAWIT UNTUK LAHAN BERPIRIT," *PUBLISH BUKU UNPRI PRESS ISBN,* vol. 1, no. 1, 2021.

[13] F. Agus and I. M. Subiksa, "Lahan Gambut: Potensi untuk pertanian dan aspek lingkungan," ed: Balai Penelitian Tanah, 2008.

[14] M. Mubekti, "Estimasi Jejak Karbon Industri Minyak Kelapa Sawit," *Jurnal Teknologi Lingkungan,* vol. 15, no. 1, pp. 35-42, 2016.

[15] S. W. Ulfa, "Estimasi karbon tersimpan pada beberapa kelas umur tanaman kelapa sawit (elaeis guineensis jacq) di perkebunan rakyat Kecamatan Percut Sei Tuan kabupaten Deli Serdang," 2017.

[16] Z. Jiao, K. Ma, Y. Rong, P. Wang, H. Zhang, and S. Wang, "A path planning method using adaptive polymorphic ant colony algorithm for smart wheelchairs," *Journal of Computational Science,* vol. 25, pp. 50-57, 2018.

[17] C. García-Martínez, O. Cordón, and F. Herrera, "A taxonomy and an empirical analysis of multiple objective ant colony optimization algorithms for the bi-criteria TSP," *European journal of operational research,* vol. 180, no. 1, pp. 116-148, 2007.

[18] D. Gavalas, C. Konstantopoulos, K. Mastakas, G. Pantziou, and N. Vathis, "Heuristics for the time dependent team orienteering problem: Application to tourist route planning," Comput. Oper. Res., vol. 62, pp. 36–50, 2015, doi: 10.1016/j.cor.2015.03.016.

[19] L. Melo, F. Pereira, and E. Costa, "Extended experiments with ant colony optimization with heterogeneous ants for large dynamic traveling salesperson problems," in *2014 14th International Conference on Computational Science and Its Applications*, 2014, pp. 171-175: IEEE.

[20] V. R. Kalatjari and M. H. Talebpour, "An improved ant colony algorithm for the optimization of skeletal structures by the proposed sampling search space method," *Periodica Polytechnica Civil Engineering,* vol. 61, no. 2, pp. 232-243, 2017.

How to Cite

Batubara, F. A., Sundawa, B. V., & Nasution, T. A. T. (2023). System of Carbon Dioxide (Co2) Detection Using Sim7600 Communication Module in Palm Oil Plantations. International Journal of Research in Vocational Studies (IJRVOCAS), 2(4), 77–85. https://doi.org/10.53893/ijrvocas.v2i4.171