Indonesian Journal of Science & Technology

Journal homepage: http://ejournal.upi.edu/index.php/ijost/

# Measurement Enhancement of Ultrasonic Sensor using Pelican Optimization Algorithm for Robotic Application

*Hind Zuhair Khaleel[1], Attarid Khudhair Ahmed[1], Abdulkareem Sh. Mahdi Al-Obaidi[2,*], Senny Luckyardi[3], Dwi Fitria Al Husaeni[4], Rawnaq Adnan Mahmod[5], Amjad J. Humaidi[1]*

[1]Control and Systems Engineering Department, University of Technology- Iraq, Baghdad, Iraq.
[2]School of Engineering, Taylor's University, Taylor's Lakeside Campus, Subang Jaya, Selangor DE, Malaysia.
[3]Universitas Komputer Indonesia, Bandung, Indonesia.
[4]Universitas Pendidikan Indonesia, Bandung, Indonesia.
[5]Ministry of Electricity, Training & Energy Researches Office, Iraq.
Correspondence: E-mail: abdulkareem.mahdi@taylors.edu.my

## ABSTRACT

HC-SR04 ultrasonic sensor is one of the famous low-cost sensors. It is measured distance from 2 to 400 cm. It depends on ultrasonic sound waves that are sent by an electronic device to determine the distance of the object, and the reflected sound is converted into an electronic signal. This paper proposed a flowchart of the modern optimization method Pelican Optimization Algorithm (POA) to enhance the distance measurement of ultrasonic sensor kind HC-SR04. In addition, the experimental system designed and interfacing between MATLAB with Ardunio is implemented to easily save the measured and desired distances and enter these distances into the POA as pelicans. The error comparison between two methods implemented, one method called the classical method, and another method is proposed named POA. The results show the minimum distance error between ultrasonic and object in POA is less than the error without POA. The best-measured distance results were achieved and approximately equal to the desired distances. The proposed method of POA for ultrasonic distance sensor enhanced by 99.97%. This sensor accurately detects objects from 2 to 400 cm which can be used in a robotic application.



## ARTICLE INFO

***Article History:***
*Submitted/Received 28 Aug 2023*
*First Revised 29 Oct 2023*
*Accepted 28 Nov 2023*
*First Available online 01 Dec 2023*
*Publication Date 01 Apr 2024*

***Keyword:***
*Arduino,*
*Distance,*
*Pelican optimization algorithm,*
*Ultrasonic sensor.*

## 1. INTRODUCTION

A sensor is a device that detects input of any kind from the physical world and reacts to a variety of environmental phenomena (Abulude *et al*., 2023; Ratsame *et al*., 2021; Jebur, 2023; Hasanah *et al*., 2020). People's daily lives are now better thanks to sensor technology. Based on the information gathered by sensors, which are devices used to detect changes in the source or surroundings, the response's design is created. A few sources that could be used are light, temperature, motion, pressure, and others. Innovative sensor technologies are employed in several contexts, including daily life, industry, and distance measurement (Javaid *et al.*, 2021) and in the field of medicine (Shero *et al.*, 2020). Ultrasonic sensor kind HC-SR04 is one of the famous sensors. It is a low-cost sensor that can measure distances between 2 cm and 400 cm. It is a reasonably priced and user-friendly distance-measuring sensor. The sensor has 2 transducers of ultrasonic. First is the transmitter sound wave and second receiver wave sound. It has four pins: VCC, Trig, Echo, and GND (for ground) Trig is used for trigger waves (Hatem *et al.*, 2018).

The most popular Arduino board, the UNO, is powered by the Atmega328 processor and is compatible with the majority of expansion board shields (Apellido *et al*., 2021; Sukmafitri *et al*., 2019). The Arduino microcontroller comes in a variety of forms. The ATmega 2560 CPU powers the Arduino Mega, which has more I/O pins and more memory than the UNO. The Arduino connected and controlled an ultrasonic sensor (Kim *et al.*, 2020). Many researchers worked in ultrasonic HC-SR04.

Abdulkhaleq *et al.* (2020) examined the ultrasonic HC-SR04 sensor, one of the well-known sensors coupled to the Arduino microcontroller, for its resolution capabilities. The essential components of this sensor are a transmitter and a receiver that operate in the sonar frequency band. Similar to the radar principle, it's used to show how far away things are. According to the test, the authors found a characteristic called distance resolution that might be added to this sensor's datasheet.

Qiu *et al.* (2022) studied examination of the foundations of each modern ultrasonic ranging technique, the advantages and disadvantages of each technique, techniques for signal processing, the effectiveness of the entire system, and important ultrasonic transducer parameters. Additionally, the ultrasonic ranging systems' error sources and compensatory strategies are talked about. An overview of the ultrasonic range technique was included.

Latha *et al.* (2016) presented Arduino board may influence its surroundings by controlling Liquid Crystal Display (LCD). It perceives the environment by receiving input from a range of sensors. Using "non-contact" technology, ultrasonic sensors can measure the distance between target materials or objects in the air. They are simple to use and measure distance without being harmed. An ultrasonic sensor identified obstacles and determined their precise distance.

Zhmud *et al.* (2018) used ultrasonic HC-SR04 sensor that depended on a calculation STM32VLDISCOVERY board. The traits of comparable models were provided for comparison. Their sensor distance is used in robot applications. The same ultrasonic sensor type was used in robot application as in. The robot with many tools is used for surveillance applications (Al-Obaidi *et al.*, 2021).

Optimization algorithms enable humans to get empathy from enormous volumes of fields for speeding data. They help to overcome many problems. The most type of optimization algorithm is the Grey-wolf optimization (Al-Qassar *et al.*, 2021a) whale optimization algorithm (Al-Qassar *et al.*, 2021b). The Swarm Optimization (PSO), Genetic Algorithm (GA), and Particle Ant Colony Optimization (ACO) (Ghaleb *et al.*, 2023; Alawad *et al.*, 2022; Humaidi *et al.*, 2018).

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

The butterfly optimization algorithm (Abdul-Kareem *et al.*, 2022; Ali *et al.*, 2022). One of the modern optimization algorithms is called Pelican Optimization Algorithm (POA). Trojovský & Dehghani *et al.* (2022) presented a pelican optimization algorithm which is summarized as (POA) in the year 2022. It was a clever adaptation that allowed the pelican birds to become skilled hunters, based on the method in which pelicans go about their hunts and the techniques they employ. Other researchers worked on the modern method called POA (Algamal *et al.*, 2023).

The following points indicate the contributions of this study:

(i) Development of Pelican Optimization Algorithm for enhancing the measurements of Ultrasonic sensor.

(ii) Conducting a comparison study between the POA-based method and the classic method.

In addition, we also added bibliometric analysis. Bibliometric is one of the best methods to understand research trend. Previous studies on bibliometric analysis are presented in **Table 1**.

**Table 1.** Previous studies on bibliometric.

| No | Title | References |
|---|---|---|
| 1 | Involving Particle Technology in Computational Fluid Dynamics Research: A Bibliometric Analysis | Nandiyanto *et al.* (2023a) |
| 2 | Bibliometric Computational Mapping Analysis of Trend Metaverse in Education using VOSviewer | Muktiarni *et al.* (2023) |
| 3 | The Use of Information Technology and Lifestyle: An Evaluation of Digital Technology Intervention for Improving Physical Activity and Eating Behavior | Rahayu *et al.* (2023) |
| 4 | Strategies in language education to improve science student understanding during practicum in laboratory: Review and computational bibliometric analysis | Fauziah *et al.* (2021) |
| 5 | How language and technology can improve student learning quality in engineering? definition, factors for enhancing students' comprehension, and computational bibliometric analysis | Al Husaeni *et al.* (2022) |
| 6 | Mapping of nanotechnology research in animal science: Scientometric analysis | Kumar (2021) |
| 7 | Scientific research trends of flooding stress in plant science and agriculture subject areas (1962-2021) | Nurrahma *et al.* (2023) |
| 8 | Introducing ASEAN Journal of Science and Engineering: A bibliometric analysis study | Nandiyanto *et al.* (2023b) |
| 9 | A bibliometric analysis of chemical engineering research using VOSviewer and its correlation with Covid-19 pandemic condition | Nandiyanto *et al.* (2021) |
| 10 | A bibliometric analysis of materials research in Indonesian journal using VOSviewer | Nandiyanto and Al Husaeni (2021) |
| 11 | Bibliometric analysis of engineering research using Vosviewer indexed by google scholar | Nandiyanto and Al Husaeni (2022) |
| 12 | Bibliometric computational mapping analysis of publications on mechanical engineering education using VOSviewer | Al Husaeni and Nandiyanto (2022) |
| 13 | Research trend on the use of mercury in gold mining: Literature review and bibliometric analysis | Nandiyanto *et al.* (2023c) |
| 14 | Domestic waste (eggshells and banana peels particles) as sustainable and renewable resources for improving resin-based brakepad performance: Bibliometric literature review, techno-economic analysis, dual-sized reinforcing experiments, to comparison with commercial product | Nandiyanto *et al.* (2022a) |
| 15 | Bibliometric analysis of educational research in 2017 to 2021 using VOSviewer: Google scholar indexed research | Al Husaeni *et al.* (2023a) |

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

| No | Title | References |
|---|---|---|
| 16 | A bibliometric analysis of vocational school keywords using VOSviewer | Al Husaeni *et al*. (2023b) |
| 17 | Bibliometric analysis of high school keyword using VOSviewer indexed by google scholar | Al Husaeni *et al*. (2023c) |
| 18 | Bibliometric analysis of special needs education keyword using VOSviewer indexed by google scholar | Al Husaeni *et al*. (2023d) |
| 19 | Bibliometric analysis for understanding the correlation between chemistry and special needs education using vosviewer indexed by google | Bilad (2022) |
| 20 | Bibliometric analysis of engineering research using vosviewer indexed by google scholar | Nandiyanto and Al Husaeni (2022) |
| 21 | Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis | Maryanti *et al*. (2022) |
| 22 | Evaluation on research effectiveness in a subject area among top class universities: a case of Indonesia's academic publication dataset on chemical and material sciences | Nandiyanto *et al*. (2020) |
| 23 | Trends in research related to photonic crystal (PHC) from 2009 to 2019: A bibliometric and knowledge mapping analysis | Wiendartun *et al*. (2022) |
| 24 | The evolution of smart working and sustainability in socio-technical perspective: A scientometrics technology analysis | Mubaroq *et al*. (2020) |
| 25 | Teaching high school students with/without special needs and their misconception on corrosion | Maryanti *et al*. (2022) |
| 26 | Counseling guidance in science education: Definition, literature review, and bibliometric analysis | Solehuddin *et al*. (2023) |
| 27 | A bibliometric analysis: research trend of critical thinking in science education | Misbah *et al*. (2022) |
| 28 | The bibliometric analysis for identifying future research on habits of mind topic | Hizqiyah *et al*. (2022) |
| 29 | Digitalizing museums: A bibliometric study | Yulifar *et al*. (2021) |
| 30 | The impact of problem-based learning toward enhancing mathematical thinking: A meta-analysis study | Juandi and Tamur (2021) |
| 31 | Computational bibliometric analysis of english research in science education for students with special needs using vosviewer | Sukyadi *et al*. (2023) |
| 32 | Renewable energy online learning: A systematic literature network analysis | Nasrudin *et al*. (2022) |
| 33 | Research trend of local wisdom in physics education from 2018 to 2022: A bibliometric review and analysis | Misbah *et al*. (2022) |
| 34 | Particle size and pore size of rice husk ash on the resin-based brake pads performance: experiments and bibliometric literature review | Nandiyanto *et al*. (2022b) |
| 35 | Teaching the concept of brake pads based on composites of palm fronds and rice husks to high school students | Anggraeni *et al*. (2022c) |
| 36 | Natural zeolite as the reinforcement for resin-based brake pad using dual particle size | Nandiyanto *et al*. (2022d) |
| 37 | The development of strength training instruction video for virtual community of students IN pandemic era of COVID19 | Rahayu *et al*. (2022) |

## 2. METHOD

### 2.1. Mathematical Model of POA

Pelicans have included the population, which is the basis of the population-based algorithm (POA). Each pelican population represents a potential solution in population-based algorithms. According to where they are in the search space, each population of members

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

presented values of variables in the problem of optimization. Using Eq. (1), a lower boundary and upper boundary for a problem are used to initialize the population members at random. The stages of POA are explained and begin with the Initialization of the population. The starting position of each pelican in the population is random and may be represented because pelicans typically hunt for prey within a certain search region.

$$x_{i,j} = lb_{i,j} + random(ub_j - lb_j) \quad (1)$$

where $i$ equals from 1 to n, $j$ equals from 1 to m, $x_{i,j}$= initial position of the pelican. The n is the population number, m presented as a problem variable number, $random$= number randomly between 0 and 1 and $ub$ , $lb$ are lower and upper bound of m respectively (Trojovský & Dehghani, *et al.*, 2022).

The pelican population matrix $X$ can be expressed as Eq. (2) and $X_i$= $i^{th}$ pelican

$$X = \begin{bmatrix} X_1 \\ \vdots \\ X_i \\ \vdots \\ X_{n,1} \end{bmatrix} = \begin{bmatrix} x_{1,1} & \cdots & x_{1,j} & \cdots & x_{1,m} \\ \vdots & \ddots & \vdots & \cdots & \vdots \\ x_{i,1} & \cdots & x_{i,j} & \cdots & x_{i,m} \\ \vdots & \cdots & \cdots & \ddots & \vdots \\ x_{n,1} & \cdots & x_{n,j} & \cdots & x_{n,m} \end{bmatrix} \quad (2)$$

The fitness function represented as fitness function matrix as below:

$$f = \begin{bmatrix} f_1 \\ \vdots \\ f_i \\ \vdots \\ f_n \end{bmatrix} = \begin{bmatrix} f_1(x_1) \\ \vdots \\ f_1(x_i) \\ \vdots \\ f_1(x_n) \end{bmatrix} \quad (3)$$

1) Motion toward preying is called the phase of exploration

The pelicans locate prey in the first phase, and they then fly toward that place. The scanning of the search of space and an exploration of is power of the POA are made possible by modeling the pelican's tactical approach. The crucial aspect of POA is the produced position of prey randomly inside the search for space. A strengthens POA's capability for exploring a problem-solving domain precisely. Equation (4) uses mathematics to replicate the aforementioned ideas and the pelican's approach to its target.

$$x_{i,j}^{p_1} = \begin{cases} x_{i,j} + random(p_j - I.x_{i,j}), & \text{if } f_1 < f_i \\ x_{i,j} + random(x_{i,j} - p_j), & else \end{cases} \quad (4)$$

where $x_{i,j}^{p_1}$= updated position pelican of the exploration phase. $p_j$ = prey location, $I$ = random value equals to 1 or 2.

This factor is randomly changed in each iteration. When this parameter's value is two, a member experiences greater displacement, which may take them to new regions of a search space. As a result, a parameter $I$ influences how well a POA can explore the search for space. A pelican's new location is allowed if it increases the fitness function. An algorithm is stopped from traveling to suboptimal locations during this form of updating, also known as effective updating. Equation (5) is used to simulate this process.

$$X_i = \begin{cases} X_i^{p_1}, & \text{if } f_1 < f_i \\ X_i, & else \end{cases} \quad (5)$$

where $X_i^{p_1}$= updated position of $i^{th}$ pelican of exploration phase and $f_i^{p_1}$ = fitness function value of exploration phase.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

2) Exploitation Phase

When pelicans reached the surface of the water for a second phase, pelicans stretched their wings to push fish higher before catching them in their throat pouches. Many fish in attacked regions are caught via pelicans as a result of this tactic. A POA converged to get better places in the hunting zone as a result of displaying this pelican behavior. This procedure improved the POA's capability for exploitation and local search. For the algorithm to converge a better solution, it is necessary to mathematically investigate the locations near the pelican site. Equation (6) uses mathematics to model the pelican's hunting activity.

$$x_{i,j}^{p_2} = x_{i,j} + R\left(1 - \frac{t}{T}\right)(2.random - 1)\, x_{i,j} \quad (6)$$

Where $x_i^{p_2}$= updated position pelican of exploitation phase and $f_i^{p_1}$ = fitness function value of exploitation phase. The factor R equals 0.2. The $R.\left(1 - \frac{t}{T}\right)$ is a coefficient is a pelican population radius neighborhood of $x_{i,j}$. $t$= counter of iteration, $T$ = maximum iteration, $R.\left(1 - \frac{t}{T}\right)$ coefficient helps the POA's exploitation power approach to the best overall solution. In the beginning iterations, this coefficient's value is high, which causes consideration to be given to a greater area surrounding each member. It lowers as the method replicates more, resulting in a decrease in the radii for each neighborhood member. For this reason, POA could adapt for the solutions that are near to a global solution and it means perfectly global optimal depending on the utilization thought. This enables scanning regions around every population member with fewer and also, more precise steps. In this stage, an updated pelican position becomes:

$$X_i = \begin{cases} X_i^{p_2}, & \text{if } f_i^{p_2} < f_{\text{i}} \\ X_i, & else \end{cases} \quad (7)$$

where $X_i^{p_2}$= updated position pelican of exploitation phase and $f_i^{p_2}$= fitness function of exploitation phase (Algamal, *et al.*, 2023).

### 2.2. Proposed Flowchart

**Figure 1** shows the proposed flowchart of this work. It begins with the initialization of all the POA parameters. After the experimental set, up as described in sections later. The ultrasonic sensor reads and evaluates the measured distances and saves these distances in the MATLAB program, at the same time the measuring tape tool fixed it on the ground and we manually computed the desired distance between the object and the sensor and save the results in MATLAB Then the error computed due to Equation (9). This method is called a classical method. The proposed POA begins with the chosen two distance variables. One variable is the measured distance and the other is the desired distance. After setting the lower bound and upper bound of two pelicans' inputs (measured and desired) distances, the fitness function of Equation (9) is minimized to evaluate the best error fitness function and best pelicans of measured and desired distances and end the proposed POA.

### 2.3. The Principle Work of the HC-SR04 Ultrasonic Sensor

An Ultrasonic sensor type HC-SR04 was used to measure the distance ranging between 2 cm to 400 cm as mentioned in the introduction section. It contains a transmitter to generate an ultrasonic wave named trigger (Trig) and a receiver called Echo (Seethai *et al.*, 2013) the principle work of this sensor is seen in **Figure 2.** The sound speed in the air is approximately 340 m/s. This information coupled with the time interval between sending and receiving the sound pulses, is used by the Ultrasonic Sensor to calculate an object's distance. The distance

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

is divided by two to take into consideration the fact that the sound wave moves both forward and backward. The sensor distance in cm becomes (Seethai *et al.*, 2013). The speed of sound is marked as S and equals 0.034 cm/second The Time is the time calculated between an ultrasonic sensor and an object.

$$\text{Ultrasonic sensor distance} = \frac{\text{Time} * S}{2} \quad (8)$$

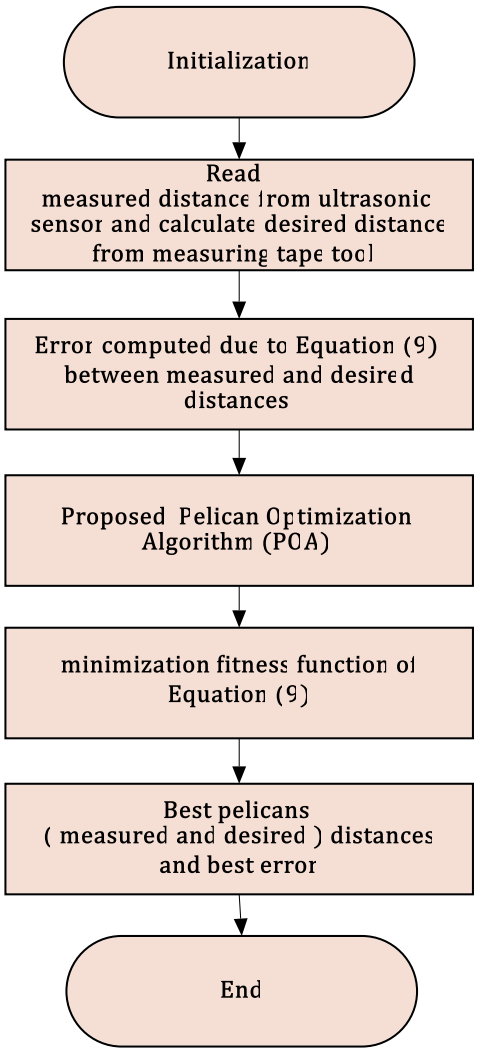



**Figure 1.** Proposed flowchart.

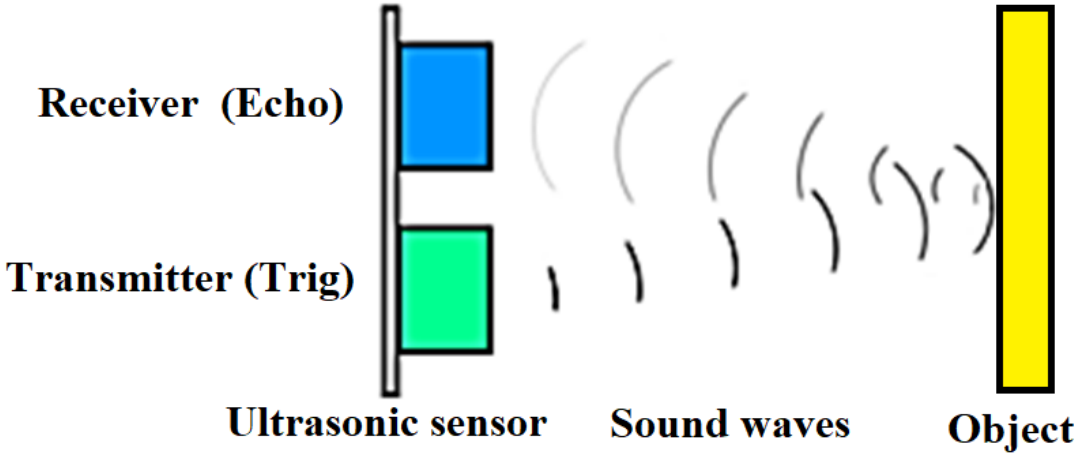



**Figure 2.** Ultrasonic signal principle work.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

### 2.4. Experimental Setup

In this work, an experimental setup of the hardware connected is shown in **Figure 3.** It consists of the following: a microcontroller board called Arduino Uno which is based on ATmega328. The breadboard is defined as a solderless tool designed for a temporary model with the circuit. The Ultrasonic sensor type HC-SR04 is useful for measuring the distance between the sensor and the object as described in the introduction section. The ultrasonic sensor pins: trig, echo, VCC, and GND linked to Arduino Uno pins 10, 11, and 5 volts and GND respectively using four wires. The five-volt power has been supplied to the Arduino Uno using a USB cable from a laptop. The Arduino Uno interfacing with the MATLAB program on a laptop is described in the next section.

### 2.5. Interfacing Arduino and MATLAB

The interfacing between MATLAB and Arduino Uno is implemented in this work using USB. This is done by setting up the Arduino package on MATLAB program R2018b as seen in **Figure 3.** The following codes have been written on the MATLAB Command Window to connect our Arduino with MATLAB as following:

```
>> a = arduino ()
a =
 Arduino with properties:
                Port: 'COM5'
               Board: 'Uno'
```

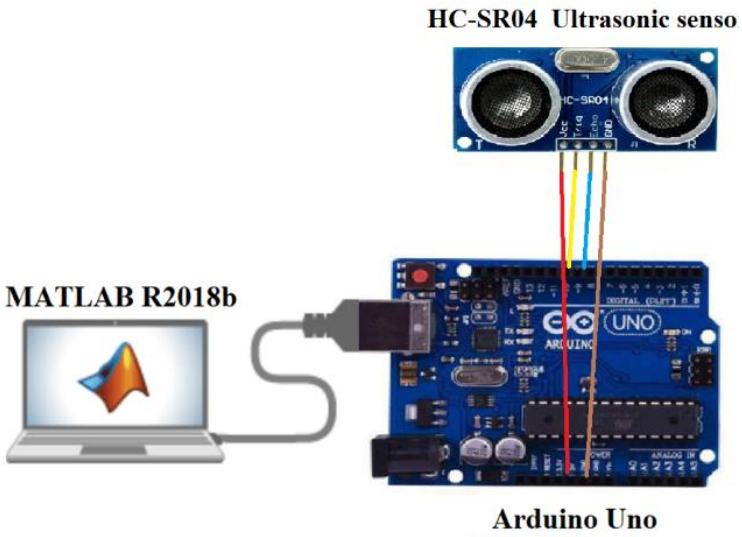



**Figure 3.** Experimental setup of distance measurement.

### 2.6. Data Preparing

The dataset of this work includes two distances data. The first one is called measured distances which are measured from ultrasonic sensors and saved in MATLAB. The second one is called desired distances which are calculated from the measuring tape tool (put it on the ground) and it is useful to measure the desired distance between the sensor and the object manually. The error between measured and desired distances is evaluated as the following equation (Seethai *et al.*, 2013).

$$\text{error} = \text{measured distance} - \text{desired distance} \quad (9)$$

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

### 2.7. Implementation POA

After the data is prepared and the error is computed between the measured and desired distances of the ultrasonic sensor, the implementation of POA is executed in the MATLAB program. The parameters of POA for this work are seen in **Table 2.** The Eq. (9) has been chosen and minimized to become a fitness function.

**Table 2.** The POA parameters of enhanced ultrasonic sensor distance.

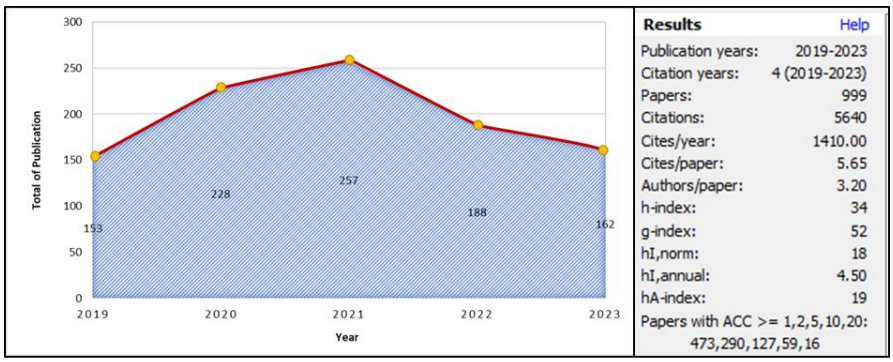
| n (number of POA population) | m (number of variables) | T (maximum iteration) | minimization fitness function |
|---|---|---|---|
| 431 | 2 | 10 | 2.0*10^(-6) cm |

### 2.8. Bibliometric

The article data used in this research was taken using Publish or Perish 7 with the keywords "Ultrasonic sensor AND Robotic Application AND Arduino" based on the title and abstract requirements. Data collection was carried out on December 1, 2023. Each selected article is a Google Scholar indexed publication published in an International Journal. Article research years are limited from 2019 to 2023. Bibliometric analysis was carried out using the mapping analysis method using the VOSviewer application. Detailed steps on how to install and use Publish or Perish 7 and VOSviewer have been explained in our previous research (Al Husaeni & Nandiyanto, 2022).

## 3. RESULTS AND DISCUSSION

**Figure 4** shows the development of previous research regarding the use of Arduino ultrasonic sensors as robotic applications. **Figure 4a** shows the development of research on this theme based on search results from the Google Scholar database. It is known that the number of publications has increased from 2019 to 2021, but the number of publications has decreased in 2022 and 2023. The total number of publications regarding the use of Arduino ultrasonic sensors as robotic applications is based on the results Publish or Perish 7 searches as shown in **Figure 4b** are 999 with a maximum article search limit of 1000 articles. However, we re-sorted the articles used as analysis material based on the completeness of the metadata so that we found 988 that met the research criteria. The detailed number of publications each year is 2019 totaling 153 publications, 2020 totaling 228 publications, 2021 totaling 257 publications, 2022 totaling 188 publications, and 2023 totaling 162 publications.



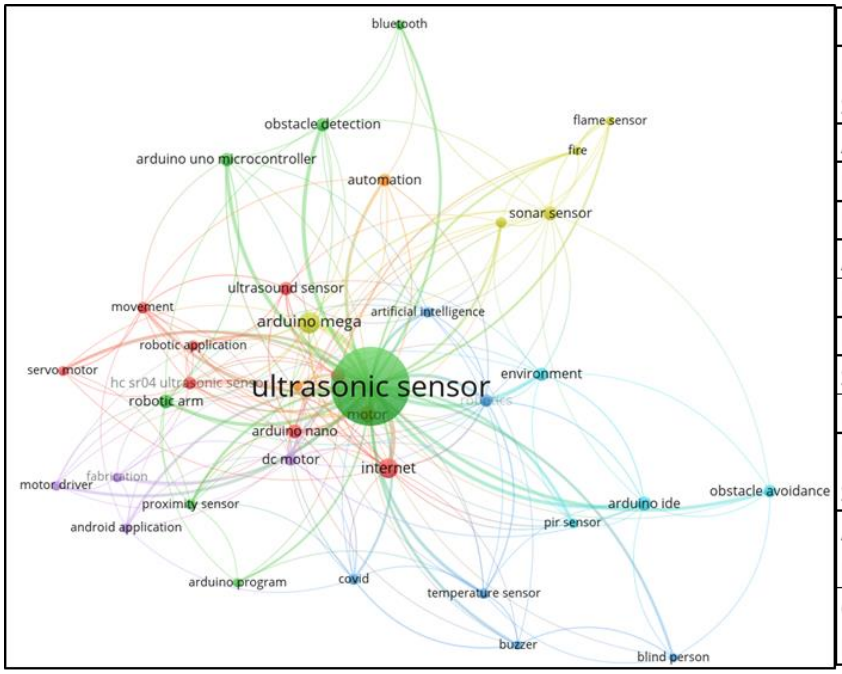

(a) (b)

**Figure 4.** Research developments regarding the Arduino ultrasonic sensor as a robotic application; (a) Research development, (b) Conclusion of search results.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

**Figure 5** shows an analysis of topics that are often discussed in research regarding the use of Arduino ultrasonic sensors as robotic applications. **Figure 5a** shows a visualization network of connections between discussion keywords, while **Figure 5b** shows trends in research topics based on the number of topic appearances. Based on the results of this analysis, it is known that research on ultrasonic sensors is connected with other research topics such as artificial intelligence, Arduino, microcontroller, robotics, and with other types of sensors such as sonar sensors, pir sensors, temperature sensors, and ultrasound sensors. Apart from that, research on ultrasonic is also connected to the use of cellular data transmission such as the internet and Bluetooth.

From these topics we concluded that several topics had the highest number of appearances, including Ultrasonic sensors discovered 732 times, Arduino mega discovered 58 times, internet discovered 46 times, motorbikes discovered 32 times, Arduino IDE discovered 25 times, robotic systems 24 times, robotics arm 24 times, sonar sensor 24 times, robotics 20 times, ultrasound sensor 21 times, Arduino Uno microcontroller 21 times, obstacle and detection 21 times.




| Topic | Frequency |
|---|---|
| Ultrasonic Sensor | 732 |
| Arduino Mega | 58 |
| Internet | 46 |
| Motor | 32 |
| Arduino IDE | 25 |
| Robotic System | 24 |
| Robotic Arm | 24 |
| Sonar Sensor | 24 |
| Robotics | 20 |
| Ultrasound Sensor | 21 |
| Arduino Uno Microcontroller | 21 |
| Obstacle Detection | 21 |

(a) (b)

**Figure 5.** Analysis of previous research topics; (a) Network visualization; (b) Trend topic based on frequency of appearance.

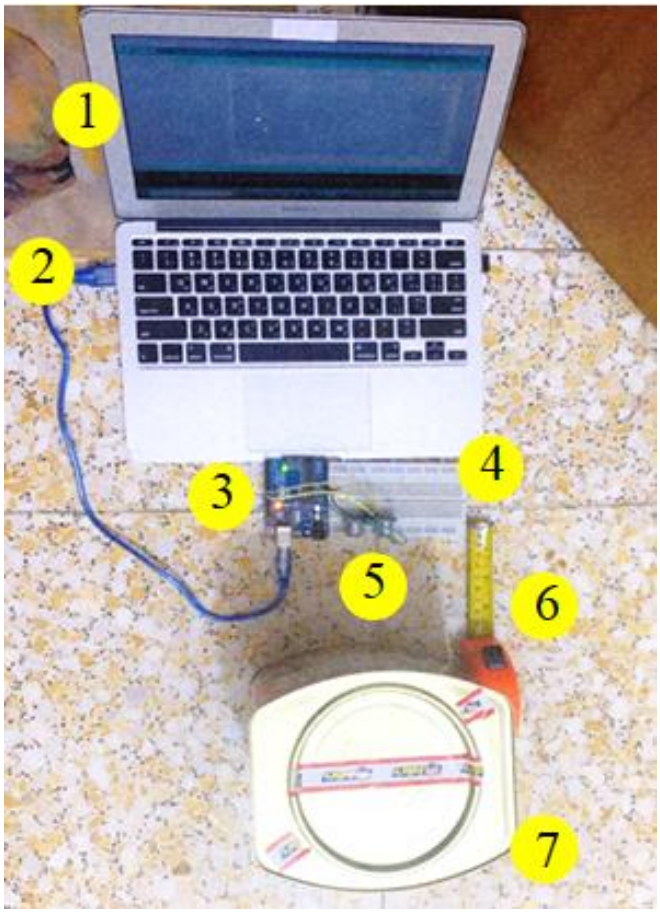
The result of our hardware experimental connection has been implemented as seen in **Figures 6** and **7.** In these figures, the ultrasonic detects the object for this case study which the distance between an object and a sensor is 20 cm, and 300 cm respectively. A POA is implemented in MATLAB program version R2018b and according to Equations (1) to (7) it can simulate the fitness function and minimum fitness function error between measured and desired distance. The best minimum fitness error function achieved 2.0*10^(-6) cm at iteration number 2 as seen in **Figure 8** and this best fitness function is labeled as a red star. The error computed before POA and due to Equation (9) equals 0.00745 cm.

**Figure 9** shows the best POA desired and measured distances VS number of the population which is equal to 431. From this figure, it can be concluded that the measured marked as blue

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

color and the desired marked as red color after POA are approximately equal in their results, and the error between them is near zero. The dimension of the object chosen is 30X20 cm.

The comparison between minimum errors between measured and desired distances due to Eq. (9) without POA and with POA is seen in **Table 3**. The improvement results show that the ultrasonic distance sensor with POA enhanced by 99.9700 %.




**(1) Laptop. (2) Arduino cable. (3) Arduino Uno. (4) Breadbord. (5) Ultrasonic sensor. (6 measuring tape tool. (7) Object.**

**Figure 6.** Case study of experimental work implantation for 20 cm detection.


**(1) Laptop. (2) Arduino cable. (3) Arduino Uno. (4) Breadbord. (5) Ultrasonic sensor. (6 measuring tape tool. (7) Object.**

**Figure 7.** Case study of experimental work implantation for 300 cm detection.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

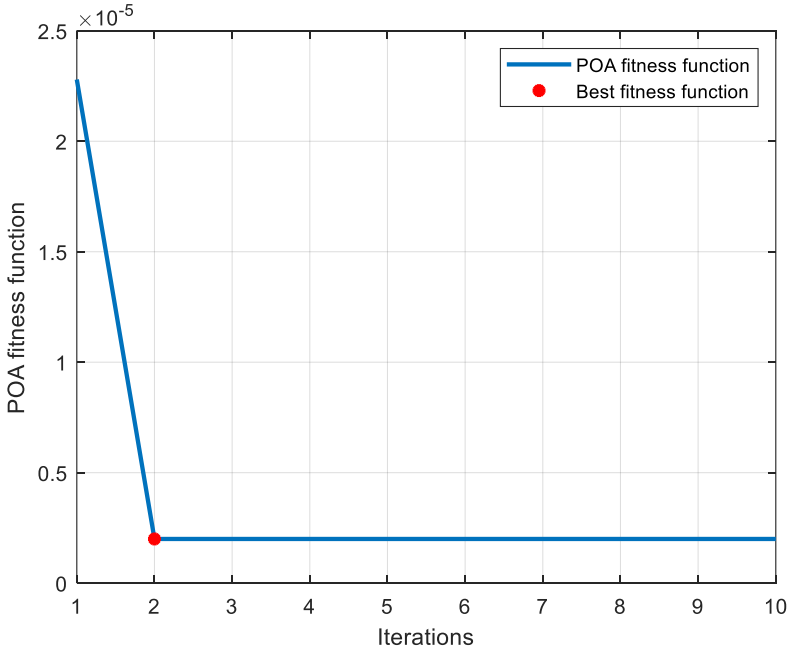



**Figure 8.** POA fitness function error result.

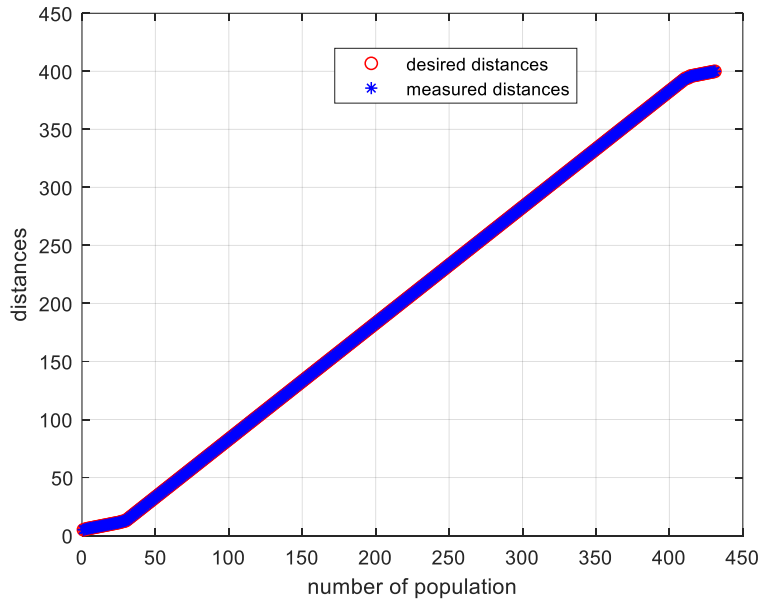



**Figure 9.** Best POA desired and measured distances.

**Table 3.** Report of ultrasonic sensor distance performance improvement.

| The error of the Classical method | The error with the proposed POA | Improvement |
|---|---|---|
| 0.00745 cm | 2.0*10^(-6) cm | 99.9700 % |

## 4. CONCLUSION

From this work, it can be concluded the following points. The first point designing and implementing the ultrasonic sensor system using a pelican optimization algorithm for object detection and it is low-cost and accurate distances. The second point minimizing the error between measured and desired distances of the ultrasonic sensor for classical and POA

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

methods. The third point is concluding the error of POA is less than the error without POA (classical method). So that the best distances are achieved. The fourth point achieving high improvement of POA reached 99.9700 %. The fourth point is that the POA is too fast and accurate a method because the minimum fitness function is achieved in iteration 2 of 10 iterations. The fifth point is interfacing between MATLAB and Arduino used to speed up the connection between them and save results easily for use in POA. In future work, the designed system will be very useful in robotic applications to detect objects and obstacle avoidance. In addition, in the future, it can be utilized different controller types which enhance the performance of distance measurement of the ultrasonic sensor (Hameed *et al.,* 2019; Abood *et al.,* 2023; Humaidi & Abdulkareem, 2019; Hassan *et al.,* 2022; Husain *et al.,* 2023).

## 5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

## 6. REFERENCES

Abdul-Kareem, A. I., Hasan, A. F., Al-Qassar, A. A., Humaidi, A. J., Hassan, R. F., Ibraheem, I. K., and Azar, A. T. (2022). Rejection of wing-rock motion in delta wing aircrafts based on optimal LADRC schemes with butterfly optimization algorithm. *Journal of Engineering Science and Technology*, *17*(4), 2476-2495.

Abdulkhaleq, N. I., Hasan, I. J., and Salih, N. A. J. (2020). Investigating the resolution ability of the HC-SRO4 ultrasonic sensor. *IOP Conference Series: Materials Science and Engineering*, *745*(1), 012043.

Abood, L. H., Oleiwi, B. K., Humaidi, A. J., Al-Qassar, A. A., and Al-Obaidi, A. S. M. (2023). Design a robust controller for congestion avoidance in TCP/AQM system. *Advances in Engineering Software*, *176*, 103395.

Abulude, F.O., Acha, S., Arifalo, K.M., Akinnusotu, A., Oluwagbayide, S.D., Al Shoumik, B.A., and Gbotoso, A.O. (2023). Monitoring of air quality with satellite-based sensor: The case of four towns in Southeast, Nigeria. *ASEAN Journal of Science and Engineering*, *3*(1), 39-46.

Al Husaeni, D. F., and Nandiyanto, A. B. D. (2022). Bibliometric computational mapping analysis of publications on mechanical engineering education using vosviewer. *Journal of Engineering Science and Technology*, *17*(2), 1135-1149.

Al Husaeni, D. F., and Nandiyanto, A. B. D. (2022). Bibliometric using Vosviewer with Publish or Perish (using google scholar data): From step-by-step processing for users to the practical examples in the analysis of digital learning articles in pre and post Covid-19 pandemic. *ASEAN Journal of Science and Engineering*, *2*(1), 19-46.

Al Husaeni, D. F., Nandiyanto, A. B. D., and Maryanti, R. (2023a). Bibliometric analysis of educational research in 2017 to 2021 using VOSviewer: Google scholar indexed research. *Indonesian Journal of Teaching in Science*, *3*(1), 1-8.

Al Husaeni, D. N., Nandiyanto, A. B. D., and Maryanti, R. (2023b). Bibliometric analysis of special needs education keyword using VOSviewer indexed by google scholar. *Indonesian Journal of Community and Special Needs Education*, *3*(1), 1-10.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

Al Husaeni, D. N., Nandiyanto, A. B. D., and Maryanti, R. (2023c). Bibliometric analysis of special needs education keyword using VOSviewer indexed by google scholar. *Indonesian Journal of Community and Special Needs Education*, *3*(1), 1-10.

Al Husaeni, D. N., Nandiyanto, A. B. D., and Maryanti, R. (2023d). Bibliometric analysis of special needs education keyword using VOSviewer indexed by google scholar. *Indonesian Journal of Community and Special Needs Education*, *3*(1), 1-10.

Al Husaeni, D.F., Al Husaeni, D.N., Ragadhita, R., Bilad, M.R., Al-Obaidi, A.S.M., Abduh, A., Nandiyanto, A.B.D. (2022). How language and technology can improve student learning quality in engineering? definition, factors for enhancing students comprehension, and computational bibliometric analysis. *International Journal of Language Education*, *6*(4), 445-476.

Alawad, N. A., Humaidi, A. J., Al-Obaidi, A. S. M., and Alaraji, A. S. (2022). Active disturbance rejection control of wearable lower-limb system based on reduced ESO. *Indonesian Journal of Science and Technology*, *7*(2), 203-218.

Algamal, Z., Firas, A. T., and Qasim, O. (2023). Kernel semi-parametric model improvement based on quasi-oppositional learning pelican optimization algorithm. *Iraqi Journal for Computer Science and Mathematics*, *4*(2), 156-165.

Ali, M. O., Abou-Loukh, S. J., Al-Dujaili, A. Q., Alkhayyat, A. H. M. E. D., Abdulkareem, A. I., Ibraheem, I. K., and Azar, A. T. (2022). Radial basis function neural networks-based short-term electric power load forecasting for super high voltage power grid. *Journal of Engineering Science and Technology*, *17*(1), 0361-0378.

Al-Obaidi, A. S. M., Al-Qassar, A., Nasser, A. R., Alkhayyat, A., Humaidi, A. J., and Ibraheem, I. K. (2021). Embedded design and implementation of mobile robot for surveillance applications. *Indonesian Journal of Science and Technology*, *6*(2), 427-440.

Al-Qassar, A. A., Abdulkareem, A. I., Hasan, A. F., Humaidi, A. J., Ibraheem, I. K., Azar, A. T., and Hameed, A. H. (2021a). Grey-wolf optimization better enhances the dynamic performance of roll motion for tail-sitter VTOL aircraft guided and controlled by STSMC. *Journal of Engineering Science and Technology*, *16*(3), 1932-1950.

Al-Qassar, A. A., Al-Obaidi, A. S. M., Hasan, A. F., Humaidi, A. J., Nasser, A. R., Alkhayyat, A., and Ibraheem, I. K. (2021b). Finite-time control of wing-rock motion for delta wing aircraft based on whale-optimization algorithm. *Indonesian Journal of Science and Technology*, *6*(3), 441-456.

Anggraeni, S., Nandiyanto, A. B. D., Ragadhita, R. I. S. T. I., Girsang, G. C. S., Putri, S. R., Sadiyyah, F. H., ... and Setiadi, D. P. (2022c). Teaching the concept of brake pads based on composites of palm fronds and rice husks to high school students. *Journal of Engineering Science and Technology*, *17*(5), 3149-3159.

Apellido, K., Magbanua, M., Catolos, C., Bernan, B., and Friales, F. (2021). Effectiveness of arduino uno as a teaching model on constructing automatic hand washer. *Indonesian Journal of Multidiciplinary Research, 1*(2), 351-356.

Bilad, M. R. (2022). Bibliometric analysis for understanding the correlation between chemistry and special needs education using vosviewer indexed by google. *ASEAN Journal of Community and Special Needs Education*, *1*(2), 61-68.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

Fauziah, S.P., Suherman, I., Sya, M.F., Roestamy, M., Abduh, A., Nandiyanto, A.B.D. (2021). Strategies in language education to improve science student understanding during practicum in laboratory: Review and computational bibliometric analysis. *International Journal of Language Education*, *5*(4), 409-425.

Ghaleb, A. F., Oglah, A. A., Humaidi, A. J., Al-Obaidi, A. S. M., and Ibraheem, I. K. (2023). Optimum of fractional order fuzzy logic controller with several evolutionary optimization algorithms for inverted pendulum. *International Review of Applied Sciences and Engineering*, *14*(1), 1-12.

Hameed, A. H., Al-Dujaili, A. Q., Humaidi, A. J., and Hussein, H. A. (2019). Design of terminal sliding position control for electronic throttle valve system: A performance comparative study. *International Review of Automatic Control*, *12*(5), 251-260.

Hasanah, L., Mulyanti, B., Pawinanto, R.E., Zain, A.R.M.D., and Purba, J.P. (2020). Simulation of micro-ring resonator using finite-difference time-domain technique for sensors. *Journal of Engineering, Science and Technology*, *15*(2), 1267-1276.

Hassan, R. F., Ajel, A. R., Abbas, S. J., and Humaidi, A. J. (2022). FPGA based HIL co-simulation of 2DOF-PID controller tuned by PSO optimization algorithm. *ICIC Express Letters*, *16*(12), 1269-1278.

Hatem, H. R., Abdalla, A. I., and Al-Rawi, Z. N. A. (2018). Design and implementation of ultrasonic radar system for distance measurements using Arduino. *International Journal of Engineering and Technology*, *7*(4), 3115-3118.

Hizqiyah, I. Y. N., Widodo, A., and Sriyati, S. (2022). The bibliometric analysis for identifying future research on habits of mind topic. *Journal of Engineering Science and Technology*, *17*, 92-100.

Humaidi, A. J., and Abdulkareem, A. I. (2019). Design of augmented nonlinear PD controller of Delta/Par4-like robot. *Journal of Control Science and Engineering*, *2019,* 1-11.

Humaidi, A. J., Hameed, M. R., and Hameed, A. H. (2018). Design of block-backstepping controller to ball and arc system based on zero dynamic theory. *Journal of Engineering Science and Technology*, *13*(7), 2084-2105.

Husain, S. S., Kadhim, M. Q., Al-Obaidi, A. S. M., Hasan, A. F., Humaidi, A. J., and Al Husaeni, D. N. (2023). Design of robust control for vehicle steer-by-wire system. *Indonesian Journal of Science and Technology*, *8*(2), 197-216.

Javaid, M., Haleem, A., Rab, S., Singh, R. P., and Suman, R. (2021). Sensors for daily life: A review. *Sensors International*, *2*, 100121.

Jebur, T.K. (2024). Securing wireless sensor networks, types of attacks, and detection/prevention techniques: An educational perspective. *ASEAN Journal of Science and Engineering Education*, *4*(1), 43-50.

Juandi, D., and Tamur, M. (2021). The impact of problem-based learning toward enhancing mathematical thinking: A meta-analysis study. *Journal of Engineering Science and Technology*, *16*(4), 3548-3561.

Kim, S. M., Choi, Y., and Suh, J. (2020). Applications of the open-source hardware Arduino platform in the mining industry: A review. *Applied Sciences*, *10*(14), 5018.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

Kumar, K. (2021). Mapping of nanotechnology research in animal science: Scientometric anlaysis. *Kumar (22021) Mapping of Nanotechnology Research in Animal Science: Scientometric Analysis. ASEAN Journal of Science and Engineering*, *1*(2), 111-126.

Latha, N. A., Murthy, B. R., and Kumar, K. B. (2016). Distance sensing with ultrasonic sensor and Arduino. *International Journal of Advance Research, Ideas and Innovations in Technology*, *2*(5), 1-5.

Maryanti, R., Hufad, A., Sunardi, S., and Nandiyanto, A. B. D. (2022). Teaching high school students with/without special needs and their misconception on corrosion. *Journal of Engineering Science and Technology*, *17*(1), 0225-0238.

Maryanti, R., Rahayu, N. I., Muktiarni, M., Al Husaeni, D. F., Hufad, A., Sunardi, S., and Nandiyanto, A. B. D. (2022). Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis. *Journal of Engineering Science and Technology*, *17*, 161-181.

Misbah, M., Hamidah, I., Sriyati, S., and Samsudin, A. (2022). A bibliometric analysis: research trend of critical thinking in science education. *Journal of Engineering Science and Technology*, *17*, 118-126.

Misbah, M., Purwasih, D., Muhammad, N., Wahyudi, W., and Nurhayati, N. (2022). Research trend of local wisdom in physics education from 2018 to 2022: A bibliometric review and analysis. *Journal of Engineering Science and Technology*, *17*, 152–160.

Mubaroq, S. R., Abdullah, A. G., and Setiawan, A. (2020). The evolution of smart working and sustainability in socio-technical perspective: A scientometrics technology analysis. *Journal of Engineering Science and Technology*, *15*(3), 1868-1882.

Muktiarni, M., Rahayu, N. I., Ismail, A., and Wardani, A. K. (2023). Bibliometric computational mapping analysis of trend metaverse in education using vosviewer. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *32*(2), 95-106.

Nandiyanto, A. B. D., Al Husaeni, D. N., and Al Husaeni, D. F. (2023b). Introducing asean journal of science and engineering: A bibliometric analysis study. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *31*(3), 173-190.

Nandiyanto, A. B. D., Al Husaeni, D. N., and Al Husaeni, D. F. (2021). A bibliometric analysis of chemical engineering research using vosviewer and its correlation with covid-19 pandemic condition. *Journal of Engineering Science and Technology*, *16*(6), 4414-4422.

Nandiyanto, A. B. D., and Al Husaeni, D. F. (2021). A bibliometric analysis of materials research in Indonesian journal using VOSviewer. *Journal of Engineering Research*. *9*, 1-16.

Nandiyanto, A. B. D., and Al Husaeni, D. F. (2022). Bibliometric analysis of engineering research using vosviewer indexed by google scholar. *Journal of Engineering Science and Technology*, *17*(2), 883-894.

Nandiyanto, A. B. D., and Al Husaeni, D. F. (2022). Bibliometric analysis of engineering research using vosviewer indexed by google scholar. *Journal of Engineering Science and Technology*, *17*(2), 883-894.

Nandiyanto, A. B. D., Biddinika, M. K., and Triawan, F. A. R. I. D. (2020). Evaluation on research effectiveness in a subject area among top class universities: A case of Indonesia's

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

academic publication dataset on chemical and material sciences. *Journal of Engineering Science and Technology*, *15*(3), 1747-1775.

Nandiyanto, A. B. D., Fatimah, S, Ragadhita, R., and Al Husaeni, D. N. (2022b). Particle size and pore size of rice husk ash on the resin-based brake pads performance: experiments and bibliometric literature review. *Journal of Engineering Science and Technology*, *17*(6), 4065-4081.

Nandiyanto, A. B. D., Putri, S. R., and Kurniawan, T. (2022d). Natural zeolite as the reinforcement for resin-based brake pad using dual particle size. *Journal of Engineering Science and Technology*, *17*(4), 2512-2524.

Nandiyanto, A. B. D., Ragadhita, R., Al Husaeni, D. N., and Nugraha, W. C. (2023c). Research trend on the use of mercury in gold mining: Literature review and bibliometric analysis. *Moroccan Journal of Chemistry*, *11*(1), 11-1.

Nandiyanto, A. B. D., Ragadhita, R., and Aziz, M. (2023a). Involving particle technology in computational fluid dynamics research: A bibliometric analysis. *CFD Letters*, *15*(11), 92-109.

Nandiyanto, A. B. D., Ragadhita, R., Fiandini, M., Al Husaeni, D. F., Al Husaeni, D. N., and Fadhillah, F. (2022a). Domestic waste (eggshells and banana peels particles) as sustainable and renewable resources for improving resin-based brakepad performance: Bibliometric literature review, techno-economic analysis, dual-sized reinforcing experiments, to comparison with commercial product, *Communications in Science and Technology*, *7*(1), 50-61.

Nasrudin, D., Setiawan, A., Rusdiana, D., and Liliasari, L. (2022). Renewable energy online learning: A systematic literature network analysis. *Journal of Engineering Science and Technology*, *17*, 83-91.

Nurrahma, A. H. I., Putri, H. H., and Syahadat, R. M. (2023). Scientific research trends of flooding stress in plant science and agriculture subject areas (1962-2021). *ASEAN Journal of Science and Engineering*, *3*(2), 163-178.

Qiu, Z., Lu, Y., and Qiu, Z. (2022). Review of ultrasonic ranging methods and their current challenges. *Micromachines*, *13*(4), 520.

Rahayu, N. I., Damayanti, I. M. A. S., Ruhayati, Y. A. T. I., and Awaliyah, S. S. R. (2022). The development of strength training instruction video for virtual community of students IN pandemic era of COVID19. *Journal of Engineering Science and Technology*, *17*(1), 0127-0137.

Rahayu, N. I., Suherman, A., and Muktiarni, M. (2023). The use of information technology and lifestyle: An evaluation of digital technology intervention for improving physical activity and eating behavior. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *32*(1), 303-314.

Ratsame, P., Koedsaksit, M., Jitsoontron, S., Jaisamak, U., and Puengsungewan, S. (2021). Vehicle-tracking mobile application without a GPS sensor. *Indonesian Journal of Educational Research and Technology, 1*(2), 11-14.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045

Seethai, A., Periasamy, A., and Muruganand, S. (2013). Rescue Robotics using artificial intelligence. *International Journal of Advanced Research in Computer and Communication Engineering*, *2*(12), 4589-4593.

Shero, F. F., Al-Ani, G. T. S., Khadim, E. J., and Khaleel, H. Z. (2020). Assessment of linear parameters of electrohysterograph (EHG) in diagnosis of true labor. *Ann Trop Med Publ Health*, *23*(04), 139-147.

Solehuddin, M., Muktiarni, M., Rahayu, N. I., and Maryanti, R. (2023). Counseling guidance in science education: Definition, literature review, and bibliometric analysis. *Journal of Engineering Science and Technology*, *18*, 1-13.

Sukmafitri, A., Nandiyanto, A.B.D., Oktiani, R., Ragadhita, R., Abdullah, A.G. (2019). Temperature on the effectiveness of arduino-based portable spectrophotometer with white light-emitting diode (LED) as a light source for analyzing solution concentration. *Journal of Engineering, Science and Technology*, 14(3), 1653-1661

Sukyadi, D., Maryanti, R., Rahayu, N. I., and Muktiarni, M. (2023). Computational bibliometric analysis of english research in science education for students with special needs using vosviewer. *Journal of Engineering Science and Technology*, *18*, 14-26.

Trojovský, P., and Dehghani, M. (2022). Pelican optimization algorithm: A novel nature-inspired algorithm for engineering applications. *Sensors*, *22*(3), 855.

Wiendartun, W., Wulandari, C., Fauzan, J. N., Hasanah, L., Nugroho, H. S., Pawinanto, R. E., and Mulyanti, B. (2022). Trends in research related to photonic crystal (PHC) from 2009 to 2019: A bibliometric and knowledge mapping analysis. *Journal of Engineering Science and Technology*, *17*(1), 0343-0360.

Yulifar, L., Widiaty, I., Anggraini, D. N., Nugraha, E., Minggra, R., and Kurniaty, H. W. (2021). Digitalizing museums: A bibliometric study. *Journal of Engineering Science and Technology*, *16*, 16-26.

Zhmud, V. A., Kondratiev, N. O., Kuznetsov, K. A., Trubin, V. G., and Dimitrov, L. V. (2018). Application of ultrasonic sensor for measuring distances in robotics. *Journal of Physics: Conference Series*, *1015*(3), 032189.

DOI: https://doi.org/10.17509/ijost.v9i1.64843
p- ISSN 2528-1410 e- ISSN 2527-8045