Research Trend Topic Area on Mobile Anchor Localization: A Systematic Mapping Study

Review Paper

Gita Indah Hapsari
Telkom university, Faculty of Informatics,
Department of Cyber-Physical System
Telekomunikasi Street, Bandung, Indonesia
gitaindahhapsari@telkomuniversity.ac.id

Bayu Erfianto
Telkom university, Faculty of Informatics,
Department of Cyber Physical System
Telekomunikasi Street, Bandung, Indonesia
erfianto@telkomuniversity.ac.id

Rendy Munadi
Telkom university, Faculty of Informatics,
Department of Cyber-Physical System
Telekomunikasi Street, Bandung, Indonesia
rendymunadi@telkomuniversity.ac.id

Indrarini Dyah Irawati
Telkom university, Faculty of Informatics,
Department of Cyber Physical System
Telekomunikasi Street, Bandung, Indonesia
indrarini@telkomuniversity.ac.id

Abstract *– Localization in a dynamic environment is one of the challenges in WSN localization involving dynamic sensor nodes or anchor nodes. Mobile anchors can be an efficient solution for the number of anchors in a 3-dimensional environment requiring more local anchors. The reliability of a localization system using mobile anchors is determined by various parameters such as energy efficiency, coverage, computational complexity, and cost. Various methods have been proposed by researchers to build a reliable mobile anchor localization system. This certainly shows the many research opportunities that can be carried out in mobile anchor localization. The many opportunities in this topic will be very confusing for researchers who want to research in this field in choosing a topic area early. However, until now there is still no paper that discusses systematic mapping studies that can provide information on topic areas and trends in the field of mobile anchor localization. A systematic Mapping Study (SMS) was conducted to determine the topic area and its trends, influential authors, and produce modeling topics and trends from the resulting modeling topics. This SMS can be a solution for researchers who are interested in research in the field of mobile anchor localization in determining the research topics they are interested in for further research. This paper gives information on the mobile anchor research area, the author who has influenced mobile anchor localization research, and the topic modeling and trend that potentially promissing research in the future. The SMS includes a chronology of publications from 2017-2022, bibliometric co-occurrence, co-author analysis, topic modeling, and trends. The results show that the development of mobile anchor localization publications is still developing until 2022. There are 10 topic models with 6 of them included in the promising topic. The results of this SMS can be used as preliminary research from the literacy stage, namely Systematic Literature Review (SLR).*

Keywords*: Mobile anchor, Localization, Systematic Mapping Study, Trend Topic Area*

1. INTRODUCTION

Wireless sensor network (WSN) localization is still being developed by researchers recently. WSN is one of the low-cost solutions to build smart environments such as smart manufacturing, smart cities, transportation, comprehensive, and real-time health monitoring [1]. In addition, localization in WSN is an important aspect in determining network coverage, routes in location-based routing protocols, sending messages to neighboring nodes, and playing a role in increasing energy efficiency [2].

Some WSN implementations must include location/position information (localization) so that the measured data will be meaningless if it is not accompanied by accurate location/position data. Examples of WSN localization implementations are environmental monitoring systems, monitoring of animal habitats [3], forest fire surveillance [4], monitoring of natural disasters [5], tracking and navigation of robots [6], and underwater wireless sensor network/ UWSN [7].

The localization technique in WSN estimates the location of the unknown node/sensor node on the network using position knowledge from several sensors on the network which is called the Anchor Node. An anchor Node is a node that knows its position by installing a position sensor such as a GPS sensor or installing position knowledge on the node. Recently localization research on WSN refers to improving accuracy, minimizing computation, reducing the number of anchors, reducing costs, overcoming obstacles from unusual landscapes, and network security [8]. In the case of a large-scale WSN involving many sensor nodes, a very large number of an-

chors is required as well, this is certainly against the cost and energy performance. The localization technique from 2-dimensional to 3-dimensional coordinates is also a challenge for researchers because it requires more anchors to determine the position of the sensor node.

Mobile anchors are one solution to reduce the number of anchors [9], but this is also a challenge for researchers to produce accurate localization involving moving anchors. The dynamic environment involves moving objects (mobile sensor node/mobile anchor node) and it becomes a challenge for researchers to find the right method solution to produce accurate position calculations. One of the challenges in the dynamic environment localization technique is the calculation of distance and positioning which is influenced by the relative position of the anchor (doppler shift).

Another challenge is the trajectory of the mobile anchor to the sensor nodes and the coverage area adjusted to the deployment of sensor nodes in each case. Until now, the challenge in mobile anchor localization is to propose a localization with high accuracy, high energy efficiency, computation, communication with low cost, and the minimum number of anchors [10]. The challenge in localization using moving anchors is to produce a path planning algorithm for mobile anchors' movement to optimize minimum error localization, energy efficiency, and coverage.

This shows that the field of mobile anchor localization in WSN still has a lot of opportunities to be researched. It is very important to have a helicopter view of the latest research areas and topic areas in that field through a literature review of many papers. Researchers often have difficulty in collecting papers, conducting literacy, mapping them into research topic areas, and classifying them based on trends. In addition, researchers also sometimes have difficulty determining topics that are promising and have great research potential.

Systematic Literature Study (SMS) is a literature review methodology quantitatively and systematically to identify the appropriate research topic areas to be researched based on the classification and calculation of the contribution of the classified categories [11]. SMS is used by many researchers in several research areas to map the research area of the research field that they will research. SMS is a solution for researchers to identify the right research area and find research potential and its trends. The goal of this study is to classify, identify, and evaluate the domain of mobile anchor localization research and extract information about the topic area, the latest method, author contribution, topic modeling, and its trend.

The main contribution of this paper is given:

1. The information of the anchor localization research area in a global view of WSN through bibliometrics, so we can know the position of mobile anchor research in the field of WSN. This paper also presents the helicopter view of the current state of mobile anchor localization research.
2. The information on the authors who contributed and influenced the research topic of mobile anchor localization can direct the new researcher to follow or discuss this topic.
3. The topic modeling and trend of mobile anchor localization indicate the promising topic research that has the potential to be promising research to be further developed.

SMS methodology is applied which aims to provide an objective and systematic approach that answers a series of research questions about the state of the art of the topic. The PRISMA protocol is used to search papers, study selections, and data extraction. We involved 511 papers to map and analyze. VOS Viewer is used as a tool to get the domain of the topic area and the latest research on mobile anchor localization. Meanwhile, Orange Data Mining is a tool for processing LDA data mining that produces research domains and trends in mobile anchor localization.

This paper presented the introduction to section one. Section 2 is focused on materials and methods which are explained starting from designing the methodology, conducting, and documenting the study as well as presenting the demographics of the paper. In section 3, the results of SMS are presented by presenting bibliometrics, research domains, and trends of each domain. This section also explains which domains have the potential to be further developed.

2. RELATED WORK

Before doing SMS, it would be better to do research first on paper reviews and surveys that have been done by other researchers regarding mobile anchor localization. This is done to provide appropriate contributions and insights from systematic mapping studies so that they can be a guide for other researchers, especially in the field of mobile anchor localization. When researchers explore a topic, they must carry out literacy papers with a large enough number of papers so that there is rarely a literacy process that is less focused on the problem to be solved. The literacy system that is carried out is limited in time and cost, so it is necessary to use the right method to explore knowledge in a field so that the process becomes more efficient.

The SLR method is applied systematically and explicitly to collect, select, and analyze research literature [12, 13]. Qualitative and quantitative observations were made on the subjects to be studied to answer research questions. Meanwhile, SMS is a method that tends to be more quantitative in organizing research areas. SMS is carried out using the same protocol as SLR to search and find the required literature. However, the SMS method focuses on identifying and classifying sub-fields in the research area based on author, keyword, publication type, publication date, and publication source [14]. SMS can be used as preliminary research as an initial stage to map the topic area so that it can produce a more valuable method design [15, 16].

Table 1. The methodology used in the mobile anchor localization review paper

Methodology	2015	2016	2017	2018	2019	2020	2021	2022
Review/survey	[17] [18]	[19]	-	-	[20] [21]	-	[22]	[23]
Systematic Mapping Study (SMS)	-	-	-	-	-	-	-	-
Systematic Literature Review (SLR)	-	-	-	-	-	-	-	-

A comparison of paper reviews is carried out to get a maximum understanding of the published paper reviews and the SMS paper that will be produced more precisely and can be used as a guide to proceed to the SLR paper review. The paper review search was carried out from 2012 to 2022. The search was carried out by searching for papers using the query 'Mobile Anchor Localization review' and 'Mobile Anchor Localization Survey from the Scopus, IEEE, and Science Direct databases. The search results obtained as many papers as possible with the composition of the paper shown in Table 1.

The data in Table 1 shows paper reviews and survey papers on mobile anchor localization from 2015-2022. A survey paper by Liang Yue et al [17] in 2015 directly explained the path-planning method on mobile anchors that had been carried out by researchers. Guang Jie Han [18] describes localization theory in general including path planning in it. However, these two papers do not explain the process of collecting and classifying paper sources. Direct presentation is carried out based on the analysis of papers related to the topic. Both papers also do not explain the opportunities for research trends, topic models, and related researchers who have contributed to research topics in this field.

Likewise, the papers proposed by Subir Halder [19] Hala Abukhalaf [20] Yuxuan Long [21] and Ketan Sabale[22, 23] explained mobile anchor localization and path planning with a very brief review. In these five papers, there is no information about how the helicopter view is related to this topic with other fields. These papers also did not explain the relation among existing methods which can give insight and have opportunities for other solutions more broadly. In addition, objective information is not given on whether this topic is promising research or a good trend.

Of all the existing paper reviews, there is still no paper that explains the research area, modeling topics, and researchers and investigates the promising topic of mobile anchor localization research. No one has yet explored using the SMS method in the process of collecting, mapping, and classifying their papers to dig deeper into information about trends of topics, influential researchers, and research areas.

Weaknesses in existing paper reviews can make new researchers unable to see whether the topic still has an increasing trend and whether there are still many researchers who are interested in research in that field. Researchers also cannot know the latest methods that are being or are being proposed by many researchers related to mobile anchor localization, so there is a risk that it is difficult to get updated methods.

Mapping papers using SMS is a new thing in mobile anchor localization. With topic mapping in this paper, researchers can focus more on getting the intended paper, knowing the trend of the topic, and having knowledge about contributing and influential researchers to make it easier to find papers and do correspondence. Topic mapping using the SLR can also be used as a starting point for conducting SLR to conduct paper literacy more precisely on target to get the right research gap in SLR.

3. METHODOLOGY

This process was conducted by combining quantitative and qualitative approaches. The method is described in Fig. 1. The initial stage is determining the subject of interest and then identifying research questions that lead to the research objectives and reviewing the scope, identifying sources of research literature, conducting literature selection, collecting literature, and extracting data according to the RQ as shown in Table 2. Bibliometric analysis is conducted to answer RQ2 and 3 while paper distribution analysis is conducted to answer RQ1. Research topic analysis is making modeling topics from the collected papers and then analyzing trends from each modeling topic to answer RQ4.

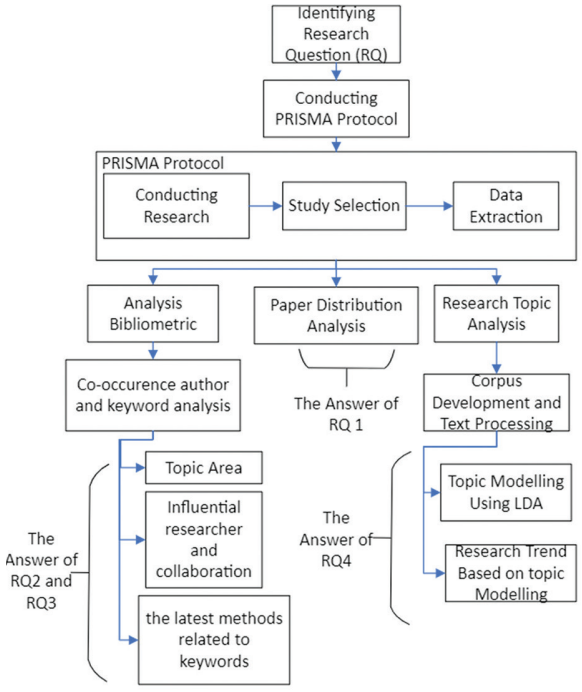


Fig. 1. Methodology of systematic mapping study

The PRISMA protocol is paper searching related to the research topic to be analyzed. The research database resources that will be used to search the paper are Scopus, Science Direct, and IEEE research databases as shown in Fig. 2. Study selection is the stage of selecting a paper based on the query keywords used and the year of publication. The keyword queries from each research database are shown in Table 3. Meanwhile, the selected year is the publication of the last 5 years, namely 2017 to 2022.

As shown in Fig. 2, 479 papers were obtained from Scopus, 317 papers from IEEE, and 29 papers from Science Direct in the process of searching and gathering papers. After all the papers are combined, the total number of papers becomes 825 papers. Study selection is continued by excluding empty keywords and duplicate papers by title. From the excluded process, there are 511 papers left. The next stage is the data extraction of 511 papers to answer the research questions such as bibliometric analysis, paper distribution analysis, and research topic analysis.

Table 2. Research Question of SMS

Research Question (RQ)	Question
RQ1	What is the population of publications on mobile anchor localization research in 2017-2022?
RQ2	What is included in the research topic areas of mobile anchor localization?
RQ3	Who are the most influential and contributing researchers on the topic of mobile anchor localization research?
RQ4	What are topic modeling and the trend of each modeling topic in mobile anchor localization?

Bibliometric analysis determines the progress of studies that have been carried out related to the topic of mobile anchor localization research. Bibliometric mapping helps researchers to get a visualization of publication metadata so that it is easier to manage and analyze to identify research topics and clusters in certain disciplines, map authors, and map author collaboration as part of a framework to identify emerging technologies [24].

Bibliometric analysis was performed using the Vos Viewer tool. Vos Viewer is an open-source tool created by Nees Jan van Eck and Ludo Waltman at The Center for Science and Technology Studies (CWTS), Leiden University, The Netherlands. Vos Viewer features co-authorship mapping, keyword-based co-occurrence, and citation mapping [25].

As shown in Fig. 3, the bibliometric analysis covers topic areas based on keywords related to the topic and its trends, author collaboration, and author based on the number of publications and citations. The type of analysis and calculation method used in VOS Viewer is co-occurrence analysis based on author keywords and co-authorship analysis. Both are carried out using the full counting method, all have the same weight [14]. From all the documents obtained from all research databases, they are combined in a Scopus template with CSV (merged document) format then filtering the document and extracting data using Vos Viewer to obtain bibliometric visualization.

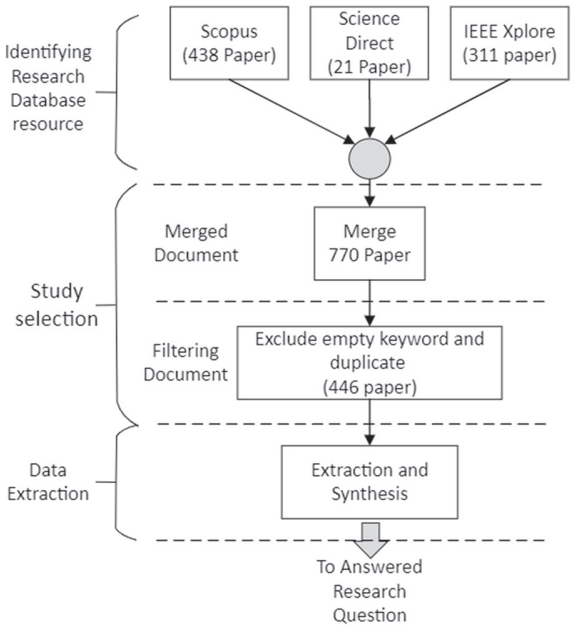


Fig. 2. PRISMA process

Research topic analysis which consists of corpus development and text processing, topic modeling, and research trend of topic modeling. The tool used is Orange Data Mining with the process structure as shown in Fig. 4. The data mining process is carried out using a corpus consisting of keywords and years. Corpus uses the Scopus template because of the merge document which only consists of the year and keywords.

The corpus is processed using preprocess text which will separate the text into smaller units (tokens) then filter and normalize (stemming, lemmatization), create n-grams, and tag tokens with part of speech labels. The text will house everything first to lowercase and remove the URL if there is a URL in the text. The tokenization selected is Regexp which will separate the text with the provided regex and remove punctuation. Filtering is done to delete or save word choices. A stop word is selected to remove stop words from words such as or, and, and in. Regex removes words that match the regular expression set to remove punctuation.

Fig. 3. Bibliometric analysis

Table 3. Database research and query

Database Research	Query
Scopus	TITLE-ABS-KEY (mobile AND anchor AND localization) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cr") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "ENGI"))
Science Direct	Title-abstract-keyword : Mobile Anchor Localization Year : 2017-2022 Subject Area : Computer Science and Engineering
IEEE Xplore	Keyword : Mobile Anchor Localization Year 2017-2022 Article Tipe : Research Article

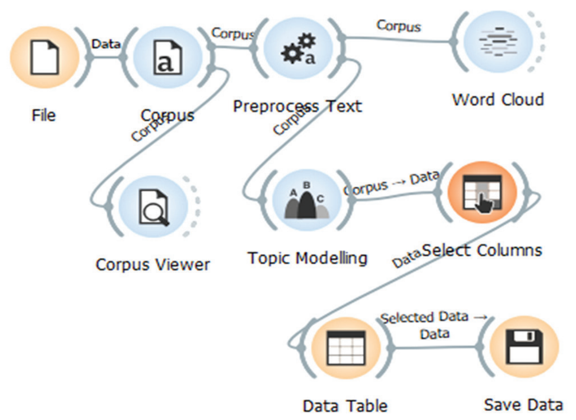


Fig. 4. Research topic analysis framework

The word cloud displays tokens in the corpus, the size of which represents the frequency of occurrence in the corpus or the average word count. Words will be listed based on weights that represent frequencies. We can find out what keywords are contained in the topic of mobile anchor localization and which keywords are often used in research from this word cloud. Fig. 5 shows the word cloud of keywords generated on the topic of mobile anchor localization. Some keywords that have a high-frequency weight of emergence from the topic of mobile anchor localization are localization, wireless, sensor, network, mobile, node, indoor, path planning, positioning, algorithm, and optimization.

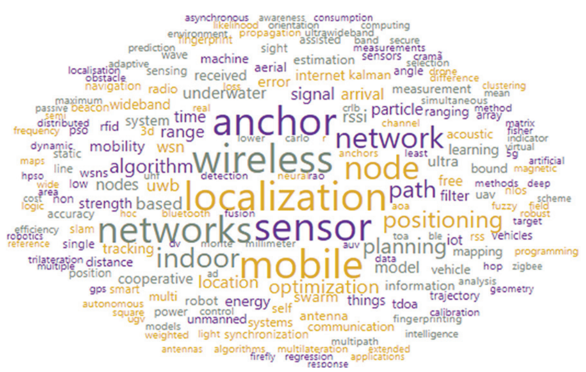


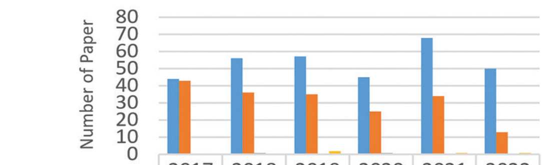
Fig. 5. Word cloud of mobile anchor localization

The function of topic modeling is to find abstract topics in the corpus based on the word groups found in each document and their respective frequencies. A document usually contains several topics in different proportions, so the widget also reports topic weights per document. LDA (Latent Dirichlet Allocation) is a probabilistic generative model of a corpus where the document is represented as a random mixture of latent subjects, each of which is defined by the word distribution as its core premise [26]. LDA is used to analyze text/word patterns and their interrelationships. LDA is an effective topic modeling technique that can be used for classification, feature selection, and information retrieval [27].

4. RESULT AND DISCUSSION

4.1. PAPER DISTRIBUTION ANALYSIS

RQ1 refers to the number of publications per year by article type. Data collection was carried out on 511 papers from filtering results based on the type of publication of articles, conferences, book chapters, and reviews every year. Fig. 6 shows a graph of publications on the topic of mobile anchor localization per year based on the type of publication. As previously explained, there are still few paper reviews and surveys in the field of mobile anchor localization. The graph shows that the topic of mobile anchor localization is mostly documented in the form of journals, followed by conferences.



	2017	2018	2019	2020	2021	2022
Article	44	56	57	45	68	50
Conference	43	36	35	25	34	13
Book Chapter	0	1	0	1	0	0
Review	0	0	2	0	1	1

Fig. 6. Publication of mobile anchor localization per year

4.2. KEYWORD CO-OCCURRENCE AND CO-AUTHOR ANALYSIS

RQ2 refers to the topic area of mobile anchor localization. Bibliometric analysis was performed to answer RQ 2. Related keywords are analyzed to find mobile anchor

localization topic areas based on keywords. The results of the bibliometric visualization of the co-occurrence analysis based on author keywords in the Mobile Anchor Localization topic area are shown in Fig. 7. As a result, there are 50 keywords identified as meeting the threshold by the Vos Viewer. The link thickness in the figure shows the weight of each link, while the size of the nodes shows the accuracy of the related keyword, and the color shows the clusters on each node and link.

In bibliometrics, 9 clusters are formed with each cluster consisting of several keywords. As shown in Table 4, the cluster contains keyword data. The keyword of Cluster 1 consists of Angle of Arrival (AOA), cooperative localization, fingerprinting, GPS, indoor localization, machine learning, Receive Signal Strength (RSS), Time Difference of Arrival (TDoA), Time of Arrival (ToA), and ultra-wideband. This cluster represents the application of machine learning to indoor localization using several ranging techniques such as TDoA, ToA, RSS, and AOA. Implementation can use ultra-wideband (UWB) to be applied indoors as proposed by the following papers [28-31]. Cluster 2 represents the keywords localization error, mobile wireless sensor network, optimization, positioning, PSO, range free, received signal strength, and trilateration. The conclusions from cluster 2 are related to the research area for optimizing WSN dynamic environments using PSO with ranging range-free or RSS techniques in the positioning process using trilateration. Several papers describe research on this cluster [32, 33].

Keywords in cluster 3 are anchor, DV hop, IoT, localization, mobile beacon, mobile node RSSI, and wins. Research related to these keywords is the localization of mobile nodes using mobile anchors and emitting beacons on a WSN/IoT with RSSI or DV-hop ranging techniques. Paper [34] applies RSSI to the ranging technique and paper [35] uses RSSI which is converted into distance using machine learning. RSSI was also used in a paper on [7] underwater localization.

Cluster 4 is a topic of interest discussed in this paper, which is related to localization using mobile anchors in wireless sensor networks. Path planning is one part of the method for estimating the location of a sensor using a mobile anchor. One of which is proposing a localization algorithm based on ELPMA path planning [22]. A survey paper on path planning was also put forward by Sabale which discussed various path-planning techniques for mobile anchor localization [21]. Path planning is also applied to disaster management [36].

The keywords in the 5th cluster are also related to the mobile localization algorithm on the wireless sensor network using the Kalman filter or particle filter. The filter on the mobile anchor localization is used to overcome measurement noise. As in the paper [36], EKF (Extended Kalman Filter) is used to obtain accurate sensor node locations around the mobile anchor. Paper [34] proposes a Kalman Filter based on the Bounding Box Localization Algorithm to minimize energy, hardware costs, and computational complexity. The 6th cluster is related to location awareness in IoT, and position estimation using UAV anchors [34]. The 7th and 8th clusters are related to the WSN dynamic environment and accuracy [18, 19, 32, 37].

We try to highlight the nodes on the mobile anchor in cluster 4 to get a more focused keyword area. Figure 8 shows the topic of mobile anchor localization by average year which shows that many publications regarding mobile anchors were made in 2019. Meanwhile, the latest issues on mobile anchors are estimation and location awareness. Research on path planning and the use of UAVs to bring moving anchors was also widely used around 2019-2020.

The results in Figure 9 show that studies related to mobile anchor nodes are localization, wireless sensor network, localization algorithm, path planning, Receive Signal Strength Indicator (RSSI), range free, TDoA, connectivity, machine learning, mobile beacons, and anchor nodes. Bibliometric visualization shows that the closer the distance, the stronger the relationship between the keywords. In addition, the larger the node formed, the more often these keywords are used on the topic of mobile anchor localization.

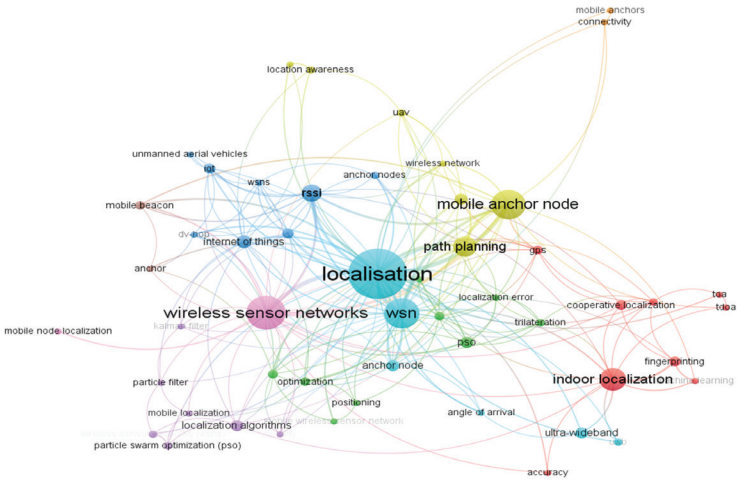


Fig. 7. Visualisasi Bibliometric

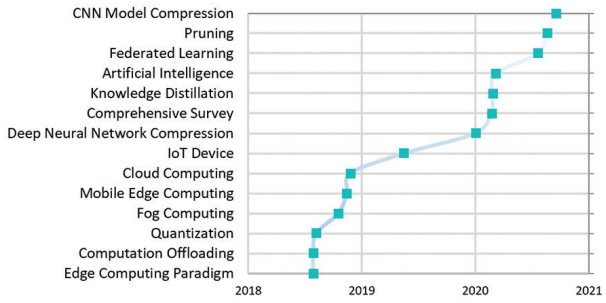


Fig. 8. Mobile anchor localization topic by an average year

The visualization results also show that the nodes most often associated with mobile anchor nodes are localization and wireless sensor networks. This shows that most of the mobile anchor publications are used for localization schemes related to wireless sensor networks. Another node is path planning, which is one of the keywords that often appears in localization publications. This shows that path planning is one part of the mobile anchor localization topic studied by researchers.

The trend topic area based on keywords can be seen in the bibliometric visualization in Fig. 9. Based on the color, we can see that machine learning is one of the methods proposed to solve the localization problem in the latest research on mobile anchor localization. UAV is also a node that is still in the current year and shows that UAV is one of the tools used as a mobile anchor in the current study.

RQ3 refers to the author's collaboration and the researchers who have most contributed to and influenced the research on mobile anchor localization. RQ3 can be answered by conducting a bibliometric analysis of the author's collaboration. The results of the bibliometric visualization of author collaboration using network visualization, overlay visualization, and density visualization where each node represents the author are shown in Fig. 10.

There are 6 research clusters formed in Fig. 10(a). Researchers with nodes close to each other have a stronger relationship based on bibliographic coupling. Researchers who are close together tend to cite the same publication or collaborate, whereas researchers with nodes that are far apart usually do not cite or collaborate on the same publication. For example, Liu Y collaborated with Yang C in research on the dynamic path planning method on mobile anchors[37]. Liu Y also collaborated with Shen Y in his research on single anchor passive localization[38]. From this co-author's bibliometrics, we can search for journals further based on the research clusters formed and the research area of each research cluster. In addition, we can also find out the author by our research topic area.

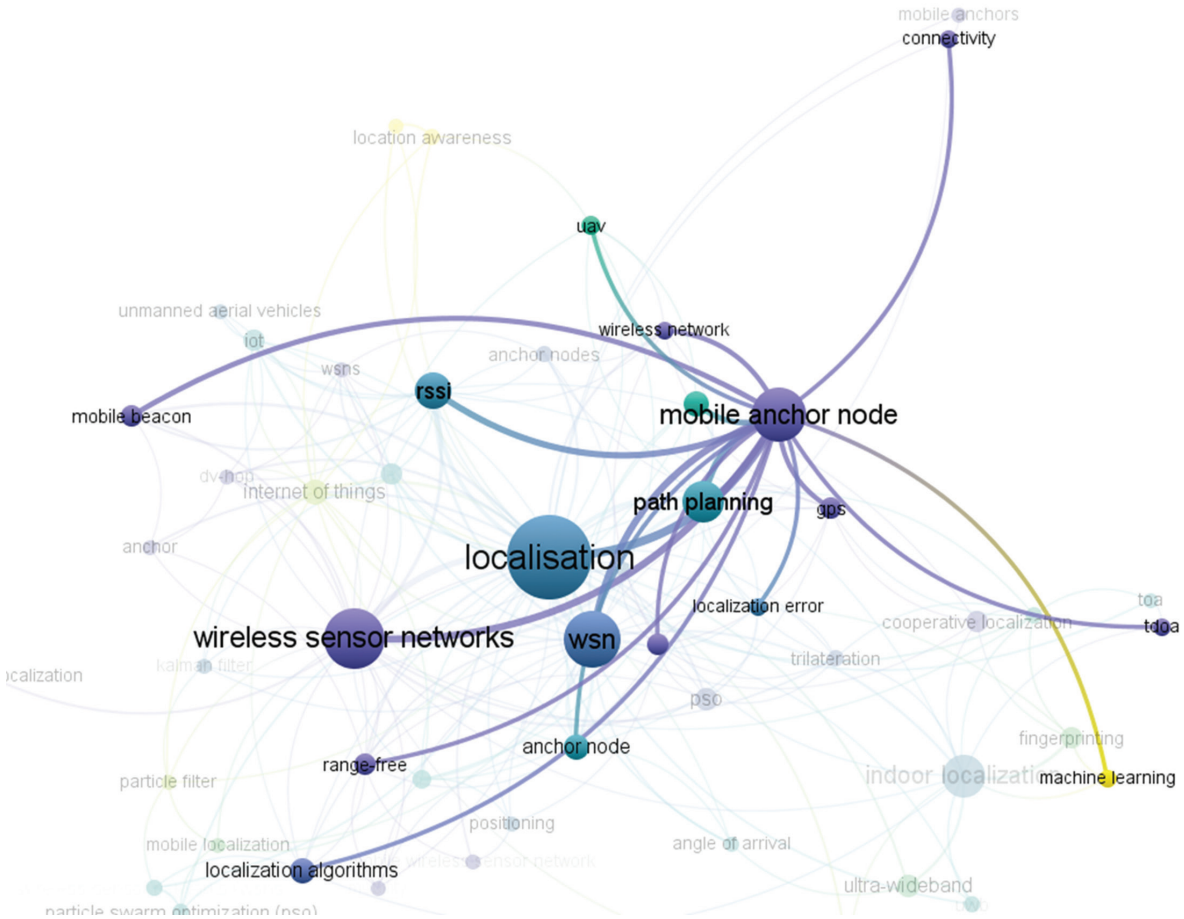
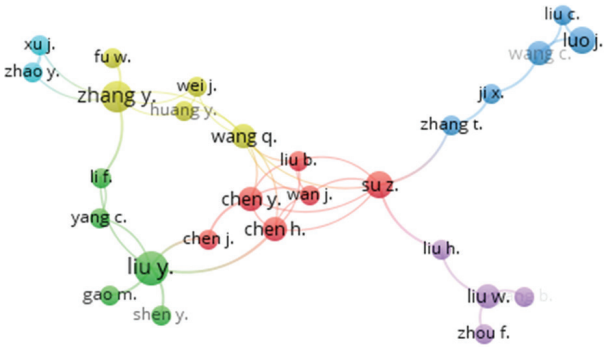
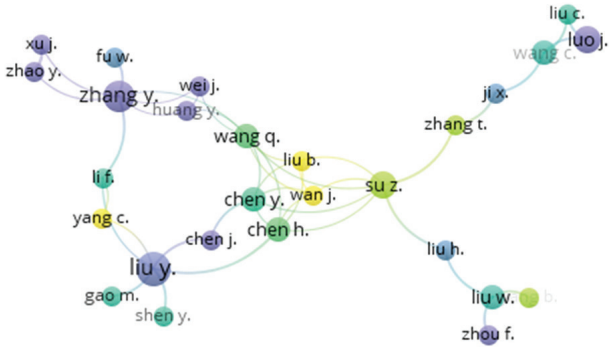


Fig. 9. The bibliometric trend of mobile anchor node topic area based on a related keyword.



(a) Network Visualization



(b) Overlay Visualization

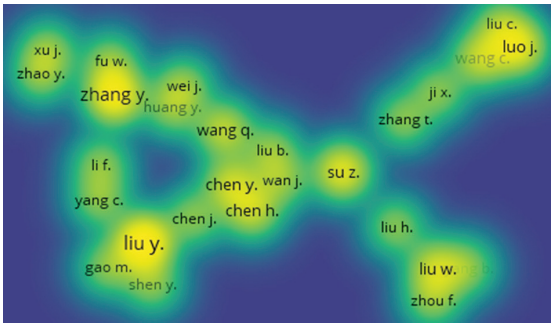
Fig. 10. Bibliometric co-author based on network and overlay visualization

In Fig. 10 (b) Liu B., Yang C., and Wan J., have yellow nodes so that they are the authors who are researching in the latest year, 2021. Liu B and Wan J proposed research on node localization algorithms in 3D environments using mobile anchors. While Yang C researched node localization using dynamic path planning in a 3D environment [37].

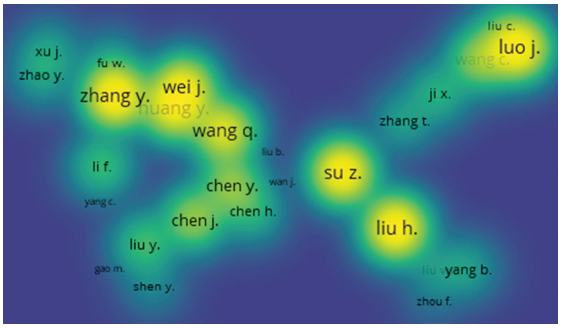
In Fig. 11 (a) with weights based on documents, Liu Y and Zhang Y is the author who has the most research on the topic of Mobile Anchor Localization. While Liu Y is the initials of several researchers including Yuan Liu, Liu Ying, Yan Liu, and Yiwen Liu who all researched mobile anchor localization. Yuan Liu conducted research on localization algorithms with collaborative and predictive algorithms, Liu Ying proposed localization using moving anchors based on network connectivity, and Yiwen Liu researched error analysis on positioning nodes on underwater acoustic sensors. Yan Liu proposed 2 studies consisting of node localization in a 3-dimensional environment using intelligent dynamic path planning and proposing the use of a single anchor. [38-40].

Zhang Y is the initials of several researchers who conducted research in localization including Yijin Zhang, Yuan Zhang, Yueyue Zhang, Yunzhou Zhang, Yuexia Zhang, Yuli Zhang, Yu Zhang, and Ying Zhang. However, from the listed paper, only Yuli Zhang who conducted the research on mobile anchors proposed a sensor node localization method, namely real-time localization based on neighbor nodes and real-time positioning based on mobile anchor nodes.

Fig. 11 (b) shows the initials of the researcher whose paper was cited by other researchers. The figure shows that papers from researchers with the initials Zhang Y were cited the most by other researchers, reaching a total of 58 citations. Furthermore, the researcher with the initials Luo J represents the researcher Juan Luo with 29 citations and Luo Junhai with 28 citations.



(a) Density document weight-based



(b) density citation web-based

Fig. 11. Bibliometric of influential and contribute co-author

Juan Luo produced 3 papers proposing the ELPMA (Efficient Localization Algorithm based Path Planning for Mobile Anchor) method [41], GTMA (Group Tri-Mobile Anchor) [42], and indoor localization based on extracting trusted fingerprints [43]. Meanwhile, Luo Junhai produced a paper on a localization algorithm using a two-phase time synchronization-free for the localization of underwater sensor networks [44].

4.3. TOPIC MODELLING AND TREND

Topic modeling will be generated using Orange Data Mining. Fig. 11 shows the 10 topic modeling results generated from the year and keyword databases from 511 papers. The topic area on the ten topics of modeling orange data mining shows compatibility with the topic area generated using the Vos Viewer. As in topic 3, which relates to the keywords localization, positioning, RFID, indoor, UWB, ultra, wideband, system, particle, and range which are related to cluster 1 on Vos Viewer. Likewise, the 9th topic model related to cluster 4 on the Vos Viewer.

A Trend analysis is created after generating the topic modeling. Trend analysis is performed by calculating the

average weight value of each keyword on each topic model based on the year. The results of the trend graph for each modeling topic are shown in Fig. 13. The results show that several topics experienced a decreasing trend, and several other topics experienced an increasing trend. If the topic model has an upward trend line, then the topic is included in the promising topic. From Fig. 11, an increase in the topic models 2, 3, 7, 8, 9, and 10. The 2nd topic model relates to the topic of sensor node localization using a 3-dimensional environment.

Topic	Topic keywords
1	localization, wireless, sensor, mobile, anchor, networks, network, node, indoor, rssi
2	localization, mobile, node, sensor, wireless, networks, anchor, nodes, mobility, 3d
3	localization, positioning, rfid, indoor, uwb, ultra, wideband, system, particle, range
4	localization, sensor, wireless, anchor, networks, node, network, mobile, planning, path
5	localization, indoor, nlos, non, model, line, sight, uwb, tdoa, anchor
6	localization, sensor, optimization, particle, swarm, mobile, networks, wireless, low, indoor
7	localization, mapping, simultaneous, positioning, anchor, slam, optimization, channel, multipath, r
8	localization, networks, time, location, cooperative, arrival, underwater, strength, signal, difference
9	localization, mobile, sensor, wireless, path, algorithm, planning, anchor, network, networks
10	indoor, localization, aerial, positioning, vehicles, navigation, uwb, arrival, unmanned, ultra

Fig. 12. Topic Modelling

Several studies have implemented mobile anchors in 3-dimensional environments such as underwater WSN (UWSN) [35, 45, 46]. and aerial anchors [47, 48]. Model topic 3 relates to UWB, indoor, localization, positioning, RFID, ultra-wideband, particle, and system. Research with mobile anchors related to UWB among them is [29-31].

Furthermore, the topic of the 7th model is related to the keyword's localization, mapping, simultaneous, positioning, anchor, slam, optimization, channel, and multipath. WSN is one of the infrastructures used to produce SLAM (Simultaneous Localization and Mapping). Optimization is also carried out to produce reliable mapping and localization such as the use of filters and computational intelligence [49]. Another topic model that has an increasing trend is the 8th topic model which relates to localization, network, time, location, cooperative, arrival, underwater, strength, signal, and difference and is related to mobile anchor research underwater [30, 40].

The 9th topic model has an upward trend and relates to localization, mobile, sensors, wireless, path, algorithm, planning, anchor, and network. So, this topic relates to path planning algorithms and localization algorithms which propose various static or dynamic path planning algorithms to optimize accuracy, energy, and coverage [22, 36, 41, 51]. The last topic is the 10th topic model related to the keywords indoor, localization, aerial, positioning, vehicles, navigation, UWB, arrival, and unmanned. UWB is used to position the robot which can be a UAV that is carried out indoors as a navigation function as proposed in papers [52-55].

4.4 MOBILE ANCHOR LOCALIZATION PAPER IN 2023

The search for papers in 2023 was carried out to find the latest research information on mobile anchor localization and obtained 4 journals and 2 conferences.

A paper at the end of 2022 was put forward by Fei Tong *et. al.* [56] who proposed the single anchor mobile localization (TSAL) method. In 2023 Huimin Chen et al [57] proposed a mobile anchor using LORA to reduce deployment costs. Gauss Markov-based mobile anchor localization (GM-MAL) was proposed by Song Xinchao et al which can improve localization precision [58].

Vaishali R Kulkarni [59] conducted a comparative analysis of the use of static and mobile anchors on localization sensors. Rinkesh Mittal et al [60] proposed a study aimed at reducing localization errors by developing moving paths and anchors. Oumaima Liouane proposed an analytical probabilistic model for estimating the multi-hop distance between the mobile anchor and the unknown nodes. The relationship between hop count and distance estimation is represented as a nonlinear function and using the recursive least square algorithm can present new formulas from the DV-Hop localization algorithm on mobile anchor localization [61].

5. CONCLUSION

A systematic SMS process can enable us to dig up information about a broad topic area regarding mobile anchor localization and the position of the research focus aimed at that topic area. Bibliometrics can show influential research topic areas, and recent methods are based on keywords to provide a helicopter view of mobile anchor localization. Research topic analysis allows us to get topic modeling and see the current trends. Previous paper reviews have not applied the SMS method in the classification process and are still focused on explaining the method from existing papers.

SMS using the PRISMA method is recommended to use the right keywords according to the terms used in related papers. By using the right keywords, the collected paper will focus on the intended field. We also find out the chro-

nology of published papers from 2017 to 2022. This can assure us that research in this field is still being carried out so that it is still possible to conduct research in this field.

Bibliometric analysis of the topic area provides a helicopter perspective on the research area and provides insight for other researchers to determine more specific research topic areas and novelty opportunities.

The results show that the mobile anchor localization field is related to localization, wireless sensor networks, and indoor localization research areas. Focusing on mobile anchors, we can find out more specifically what is related to mobile anchors like path planning, machine learning, localization algorithms, and others. The bibliometric results also show machine learning as the latest method such as in path planning.

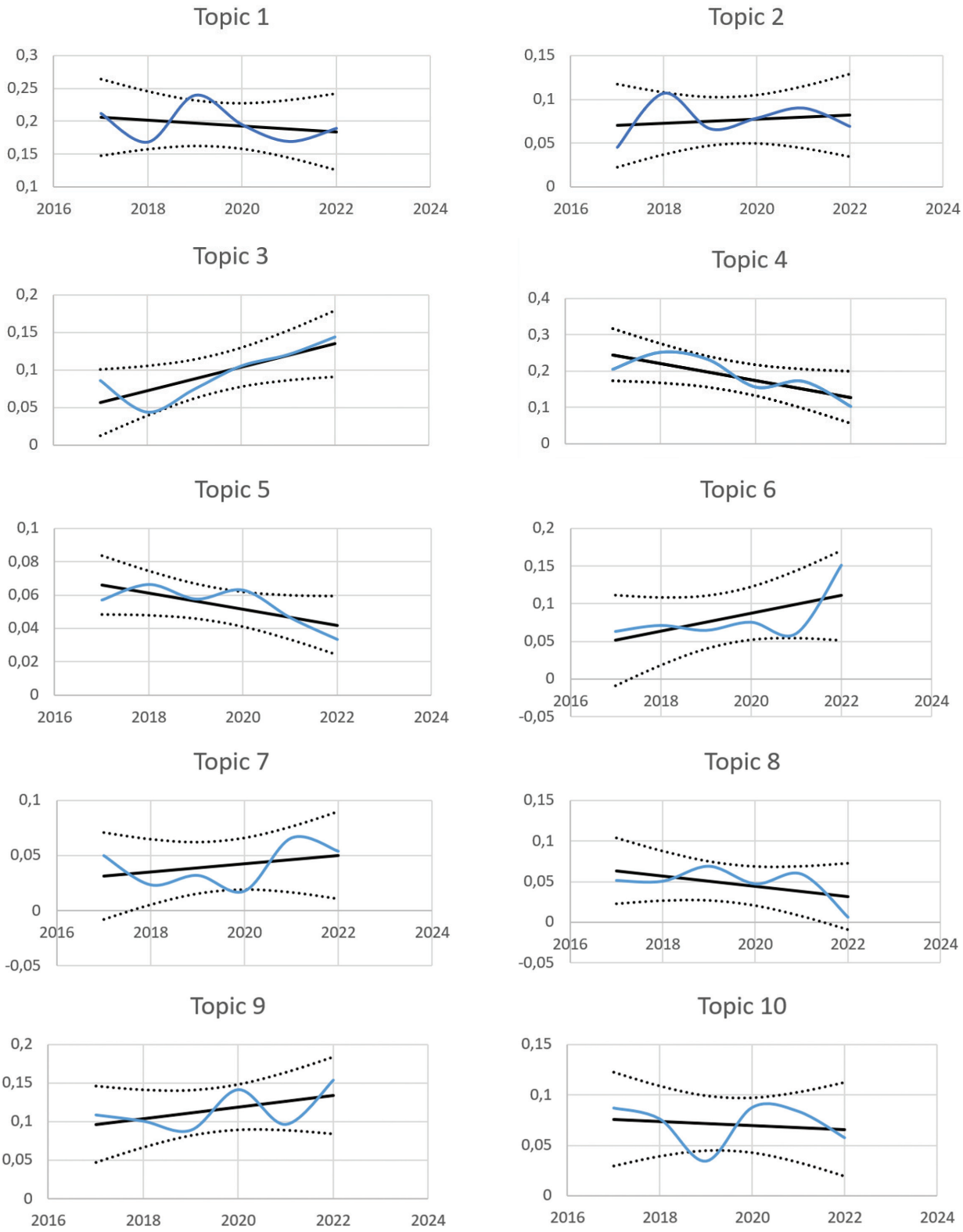


Fig. 13. The trend of each topic modeling

Co-author bibliometric analysis can find out which authors have an influence on the research field from the number of citations to their papers, find out which authors cite each other, and the contributor which allows the same topic area. It can be continued by looking for a community of these researchers. Joining the community is one solution to find a solution by holding discussions or correspondence with other researchers. Topic modeling is a way to find out the topics we can take as research. From the results of topic modeling, 6 topic models are included in the promising topic, which means that these 6 topics still have the potential to be investigated further. For example, in the 9th topic related to path planning, the trend tends to rise so that it can be chosen as the research topic to be studied.

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