

Survey of Sleep Awake Mechanism in Wireless Sensor Networks

Deepika Tyagi^{1*}, Sanjeev Indora²

^{1*} CSE, Deenbandhu Chhotu Ram University of Science and Technology, Murthal, India

² CSE, Deenbandhu Chhotu Ram University of Science and Technology, Murthal, India

*Corresponding Author: deepikatyagi015@gmail.com

Available online at: www.ijcseonline.org

Accepted: 21/May/2018, Published: 21/May/20182018

Abstract- Remote sensor systems (WSNs) incorporate independent hubs which may be equipped with sensors to screen the physical or ecological circumstances. The objective of a WSN is to feel the environment and to convey the amassed records to the base station. Since quality is the bottleneck property of the WSNs, bringing down excess quality admission is a decent estimated examine issue. Rather than rest booking, accessible if the need arises for or occasion initiated task of the group will upgrade the execution and the lifetime. This approach is conceivable with the wake-up recipient age. The present wake-up beneficiary equipment items in the commercial center in conjunction with its continuous equipment thinks about enable us to evaluate the wake-up collector technique as a competitor work for various WSN bundles. In this paper, we investigate the wake-up collector time exceptionally well with its past, blessing and future. Subsequent to offering the country of the specialty of the wake-up innovation, we dissect the focal points and difficulties and call attention to their utility districts in the wi-fi sensor arranges In this paper, we address the favors and the requesting circumstances of utilizing the rest wakeup recipients inside the WSN bundles.

Keywords: *wireless sensor networks, heterogeneous network Clustering Sleep-awake, Wake-up receiver.*

1. Introduction

Remote Sensor Networks will be systems of little sensors arranged with radio interfaces for talking. They are utilized to cover enormous land locales on which they're normally haphazardly apportioned, by methods for intermittently showing up estimations which may be along these lines despatched to the sink hub for handling and putting away. Their application fields assortment from catastrophe recuperating to agribusiness checking, from business systems to movement contamination observing, et cetera. A few of such one of a kind applications have moreover strict trustworthiness prerequisites [1], [2] that should be happy by means of sensors regularly controlled through low voltage batteries confining their lifetime. We can contend that a WSN is a power restricted machine.

Keeping in mind the end goal to enhance the power administration with the reason for boosting the WSN unwavering quality by method for diminishing and limiting the hub power allow, an ordinary practice is to trade WSN hubs into a decline fueled nation, perceived as rest mode, by utilizing deactivating the radio when no data must be transmitted [3]. By partner the battery release to the WSN

hub maturing strategy, the hub dependability can be analyzed and related to the battery value level. Another factor that may influence the WSN dependability is the impedance among hubs that negatively affects the hub unwavering quality on account of the vitality squander for retransmissions.

As far as dependability a WSN can be muller over as a frameworks accumulating hubs/added substances, which unwavering quality might be hence communicated as capacity of such added substances unwavering quality. All the more especially a WSN is a dynamic gadget since standby standards and impedances influence its hubs/added substances, while the added substances' basic connections are analyzed by means of the group topology. Distinctive people group topologies might be determined and therefore excellent records steering systems should be executed (both unmarried-or multi-bounce).

Consistent following frameworks constitute an essential brilliance of sensor group applications, wherein a gigantic scope of sensor hubs screen nature and intermittently record to an unmarried (or a couple) base station(s). This utility

class incorporates numerous reasonable sensor arrange programs which incorporate living space following [4] common shape following and assembling unit upkeep [5].

To deal with the huge scope of sensor hubs in such bundles, a versatile approach is to intermittently association sensors inside a land zone directly into a group. The sensors can be overseen locally by means of a bunch head (CH) – a hub chose to facilitate the hubs inside the group and to be in charge of verbal trade between the bunch and the base station or other group heads. Bunching manages a convenient structure for valuable asset control, insights combination, and neighborhood decision making. One issue with bunching is that the group head is firmly used for both intra-group coordination and between bunch correspondences. In this way, the bunch head will quick consume its power. To address this trouble, occasional re-grouping is executed to disperse the power utilization among sensor hubs.

In far reaching, the vitality ate up for discussion is predominant when contrasted with that for calculation or detecting games of the sensors. Thus, the primary objective in WSN thinks about is to diminish the unnecessary verbal trade. A proficient convention format need to diminish the amount of report while achieving the necessities of the group.

One way to deal with bring down the futile quality admission is to put in constrain a quality green setup convention where sensors perform underneath a pleasantly characterized rest time table. That is, idle sensors change to off-mode or low-quality listening mode. At the point when two hubs are to impart, the collector hub must be wide alert while the sender starts the correspondence that is alluded as Scheduling [6]. There are 3 assortments of Scheduling plans:

1.1 Types of Sleep Wake Scheduling

- **Pure synchronous Scheduling:** the sensor timekeepers are pre-synchronized with the end goal that the wake-up time of every hub is thought from the earlier. This plan calls for intermittent time synchronization that expends sizeable power. In addition, the sensors wake up regardless of whether there might be no bundle to transmit or gain which brings about sit without moving tuning in or catching.
- **Pseudo-nonconcurrent Scheduling:** source hubs stir and emanate a prelude flag that shows the objective for data transmission. The prelude time is sufficiently extensive to agree with the wake-up plan of the goal hub. After awakening and detecting the prelude the excursion spot hub recognizes the implied bundle transmission. In this plan,

time synchronization isn't required, however sensors regardless take after a duty cycle and eat up enormous quality with preface flagging.

- **Pure offbeat Scheduling:** Sensors are living in profound rest and might be arouse up through their neighbors available to come back to work for with low-control wake-up recipients. At whatever point a hub expects to send a parcel, before all that it awakens the excursion spot hub, at that point sends the bundle. Accordingly, wake-up recipients are a route to the excess vitality utilization coming about because of Scheduling.

1.2 Benefits of Sleep Awake Mechanism

1.2.1.1 Energy-conservation

An overwhelming power squander decided in WSN bundles is the sit out of gear listening which happens in view of periodical wake-up regardless of the insights discussion wished. The wake-up procedure ought to be vitality green. The wake-up recipient gives a power green system to the sit without moving listening in light of the fact that the hubs best wake-up when there might be planned message for them. The quality admission of S-MAC might be lessened broadly the utilization of wake-up beneficiaries [7]. Since vigorous wake-up collectors additionally are a power utilization supply for the sensor hubs, they should be amazingly low-power to gather the quality pick up.

1.2.1.2 Minimum overhead

As the wake-up collector gives just offbeat meet plan, the overhead acquired by the point synchronization of the 2 distinctive meet plans are dispersed. This overhead causes higher power admission. The correspondence overhead to shape the steering spine moreover will end up repetitive as each hub awakens its hand-off.

1.2.1.3 Different form of use

For green utilization of the WSN for an objective utility, wake-up beneficiary period permits various new procedures including the available to come back to work for target checking approach wherein the hub that recognizes an objective awakens every one of its neighbors to get their perceptions about the objective. Segment

1.2.1.4 Dynamic behavior

Framework broad parameters make wasteful aspects in light of the fact that the group stack contrasts fundamentally in view of the region. Henceforth, parameters comprising of the obligation cycle, the preface length ought to be progressively set basically in light of the restricted necessities. Since wake-up recipient grants dynamic duty cycling and dynamic discussion meet, various wasteful

parameter definitions end up being pointless that outcome in an additional green group.

1.2.1.5 Overhearing is decreased

With the help of identitybased wake-up receivers, overhearing is reduced seeing that simplest the destined nodes will awaken and concentrate the medium.

1.3 Challenges

1.3.1 Cost and Hardware Complexity

On the off chance that the wake-up radio makes utilization of discrete channel(s), at that point the equipment many-sided quality and the estimation of the sensor hubs will increment. This is especially basic when various wake-up channels are utilized. Notwithstanding, the radio ordinarily cash owed for under 15% of the charge of a sensor hub.

1.3.2 Delay

With the inactive wake-up radio, wake-up delay is caused which may likewise end up being great estimated for the necessities of the utility. The effect of the stop-to-stop put off might be far reaching, while the amount of jumps to the sink is tremendous. For applications which incorporates target following, factor-to-factor (one-bounce) delay is basic for the execution of the product.

1.3.3 Topology Change

Since the wake-up run won't be the same as the correspondence assortment of the principle radio, topology for the wake-up beneficiaries might be restrictive than the genuine system topology. The areas did with wake-up recipients, in this manner, result in a unique topology than the real system topology. The previous may likewise achieve a disengaged group, notwithstanding the way that the last is associated. In such conditions, the inconvenience should be acknowledged by the conventions and key answers must be done. Moreover, notwithstanding assuming the wake-up collectors frame a connected system, the quantity of jumps at the steering course can likewise development if the wake-up assortment is not as much as the dispatch assortment that can reason wasteful directing of the parcels. Sadly, there might be no work in the writing yet that explores the effect of discrete topology coming about because of the wake-up beneficiaries.

1.3.4 Energy Hole problem

Ahmed et al. Layout the empty issue as the final product of a couple of abnormalities inside the remote sensor arranges that impede the ability of the group. In particular, the scope opening is depicted as the place excluded with the guide of any sensor, on account of the abnormalities alongside arbitrary arrangement creating voids, hub disappointments, or sticking. On the off chance that the wake-up go is littler

than the correspondence scope of the fundamental radio, the topology of the group molded by means of the wake-up recipients may also incorporate more prominent or bigger power gaps. This may also bring about wasteful system utilization, for instance to skirt the greater power openings requires more actualities correspondence and subsequently more noteworthy power.

1.3.5 Overhearing increases

Catching will increment for the common channel and assortment based stir recipients: For go essentially based wakeup plans, every one of the hubs tuning in to the tone exchange to the vigorous country. Since all encompassing hubs will wakeup at every transmission, catching might be quickened contrasted with different conventions. To keep the catching, recognizable proof based wake-up collectors can be utilized.

1.4 Related Works

Hwee-Pink Tan et al., 2009 [8] In this paper The utilization of remote sensor systems (WSNs) for basic wellbeing following is picking up notoriety since it considers an ease, quick and solid assessment of auxiliary respectability. In the mean time, current advances in surrounding power gathering time have made it a suitable open door wellspring of quality for fueling WSNs. WSNs controlled with the guide of encompassing quality collecting (WSN-HEAP) are without a doubt more useful and not expensive in the long time than customary battery fueled WSNs as they can work for appallingly long terms of time without the need for human contribution, therefore making ready toward soothing force limitations that hold to assignment WSNs.

C. Zhu, Y. Chen, L. Wang, 2010 [9] This paper goes for relieving the purported Funneling Effect for S-MAC, particularly by means of upgrading the throughput and reasonableness of S-MAC. Remote sensor systems (WSNs) flaunt a couple of marvel named Funneling Effect because of the development of unbalanced huge number of bundles inside the territories close to the sink. The impact and blockage due to the Funneling Effect firmly debilitate the power and heartiness of WSNs. Concerning S-MAC which accomplishes splendid power execution, the alleviation of channeling sway appears to be more noteworthy huge and squeezing. With full-measure recreations, we will demonstrate that SPFB can pick up significantly preferred throughput over conventional S-MAC, especially while the system is substantial stacked. SPFB additionally can advantage exact quality proficiency.

R. C. Carrano, D. Passos, L. C. Magalhaes 2014 [10] Motivated by method for stringent quality limitations, obligation biking - the act of turning a bit's radio on and stale

to safeguard power - has end up being a basic system in the outline of Wireless Sensor Networks. Due to its criticalness, a choice of techniques to obligation cycling have developed over the previous decade and are by and large now proposed with progressively aspiring wants, comprising of achieving ultra low duty cycles as low as 0.1%.

Z.- Y. Xu, S.- G. Zhao 2015 [11] this paper proposes a grouping rest planning instrument essentially in light of sentinel hubs following for WSN. The component joins the group bunching technique with the hub torpidity strategy, and enhances the strategy for picking the competitor bunch heads arbitrarily in Energy-Efficient Unequal Clustering (EEUC) calculation. The prospect of sentinel hub is included based absolutely EEUC, and the neighbor hub set of sentinel hub will be lethargic when the sentinel hub's records trade expense is diminish than the putting limit. Recreation impacts demonstrate that this system can effectively adjust the vitality admission of the whole system, and radically expand the group lifetime.

H. Chen, X. Li, and F. Zhao 2016 [12] In this paper, a support acing based rest planning for scope (RLSSC) calculation is proposed for economical time-opened task in rechargeable sensor systems. RLSSC is a - level rest planning calculation. It incorporates the need administrator based association development set of principles and the Q examining based absolutely vigorous hub decision calculation. The results show that RLSSC can viably modify the working methods of hubs in a set by means of seeing the environment. Also, it accomplishes the power admission adjust among hubs with an end goal to delay the group lifetime in the meantime as protecting the favored scope.

H. P. Gupta, S. V. Rao, and T. Venkatesh 2016 [13] A basic issue in a three-D remote sensor connect with thick and arbitrary arrangement of sensors is the minimization of the assortment of sensors required to cover a territory of leisure activity (FoI). We demonstrate a final product to decide whether a sensor is repetitive for approve protection, that is best in light of records roughly the scope of neighbors and their kind. We propose an administered convention to time table the repetitive sensors to rest, which requires no land data. Results demonstrate that the booking convention lessens the amount of vivacious sensors and, in this way, draws out the group lifetime.

J. Oller, I. Demirkol, J. Casademont 2016 [14] Wake-up radio (WuR) structures considerably reduce those issues with the guide of completely turning off the hubs' microcontroller unit (MCU) and essential radio handset until an auxiliary, to a great degree low-power beneficiary is

expedited by a particular wi-fi transmission, the so known as notice call. Tragically, most WuR thinks about discernment on hypothetical stages and additionally custom-manufactured test systems. Both those components diminish the related handiness of the got impacts. In this paper, we demonstrate and reproduce a genuine, current, and promising

R. Xie, A. Liu, and J. Gao 2016 [15] In this paper, we deliberately break down the relationship among anticipated power use, bundle misfortune proportion, quit to stop put off and long lasting of remote sensor systems. Right off the bat, we show that streamlined obligation cycle plans can procure a change-off a portion of the lifetime of group, transmission deferral and parcel misfortune proportion. At that point, a leftover power mindful with movable obligation cycle plot (READC) is proposed principally in light of the truth that quality admission is higher inside the region near sink, while it's miles bring down inside the region far from the sink. In READC conspire, sensor hubs near sink attempt appropriate commitment cycles to meet with the prerequisite of sending records, while the higher commitment cycles are needed in some separation sink locale. In this way, the leftover quality of the hubs might be completely utilized.

S. B. Baba and K. M. Rao 2016 [16] In this paper we recommend entrepreneurial directing arrangement of standards, in which the choice of neighboring hubs plays an extremely fundamental capacity. Determination of neighboring hubs inside the group is one of the elements that upgrade the Energy admission and system lifetime. To extemporize this crafty directing arrangement of principles to works of art significantly more effectively, we present a rest set of standards known as, PSS set of tenets for the sensor hubs incorporating with Opportunistic Routing Protocol. Applications/Improvements: We put into impact our proposed framework in NS-2. By coordinating the PSS set of standards to the Opportunistic Routing Protocol in a power bound WSN, we have executed the Optimal power admission with considerably less vitality overhead, which at last builds the charming of steering inside the sensor arrange.

Y.Wang, H. Chen, X.Wu 2016 [17] In this paper a Software-portrayed Network (SDN) based Sleep Scheduling calculation SDN-ECCKN is proposed to deal with the energy of the system. EC-CKN is embraced as the essential arrangement of guidelines while actualizing our arrangement of tenets. In the proposed SDN-ECCKN set of tenets, each calculation is finished inside the controller set up of the sensors themselves and there's no communicating among each hub, which are the rule elements of the customary EC-CKN approach. The results of our SDN-ECCKN show its

favors in vitality administration, alongside organize lifetime, the amount of stay hubs and the assortment of solo hubs in the group.

D. Wang, M. Mukherjee, L. Shu 2017 [18] Sleep booking is one of the methodologies to keep leftover vitality of wi-fi hubs in quality limitation IWSNs even as charming system availability and unwavering quality. This article makes a claim to fame of organize those CNs to rest more prominent than different hubs while in transit to store their power resulting expand overall availability in association based IWSNs. The proposed rest planning plan broadly outflanks the best in class rest planning for terms of wide assortment of vital hubs underneath crucial vitality, aggregate network, and proportion of normally conscious fundamental hubs inside the gathering based IWSNs.

D. Ye and M. Zhang 2017 [19] In this paper, a self-versatile rest/wake-up booking strategy is proposed. Dissimilar to most extreme ebb and flow explore that utilization the commitment biking technique, which brings about a tradeoff among bundle conveyance postponement and power sparing, the proposed approach, which does no longer us obligation cycling, maintains a strategic distance from one of these tradeoff. The proposed system, construct absolutely with respect to the support picking up learning of strategy, allows each hub to self-sufficiently choose its own one of a kind task mode (rest, focus, or transmission) in at whatever point opening decentralizedly. Recreation comes about exhibit the coolest general execution of the proposed approach in different examples.

H. Mostafaei, A. Montieri, V. Persico 2017 [20] Our investigate centers around the issue of incomplete protection, focused on situations wherein the persistent following of a limited bit of the area of leisure activity is sufficient. In this paper we blessing PCLA, a novel arrangement of principles that depends on Learning Automata to actualize rest planning procedures. It desire at limiting the quantity of sensors to actuate for concealing a favored segment of the region of enthusiasm protecting the network among sensors. Recreation outcomes show how PCLA can choose sensors in a green way to satisfy the forced imperatives, subsequently making certain appropriate general execution as far as time many-sided quality, working-hub proportion, versatility, and WSN lifetime. In addition, in contrast with the best in class, PCLA is fit for guarantee higher execution.

M. I. Khalil, M. A. Hossain, R. Mamtaz 2017 [21] Underwater sensor arrange has streamed as a compelling procedure for amphibian projects. A Sleep Scheduling technique is a doable plan developed on tree topology joining TDMA with commitment biking. Subsequently TDMA has availabilities, so here isn't any measurements crash in this system. ROSS, a Receiver Oriented Sleep booking approach utilize TDMA in light of tree topology. Be that as it may, they have not given any system to the Energy opening issue. They don't have any actualities mending decision, if any hub has dismissed measurements as:

Table:1

Author	Year	Key Issues	Network Structure	Energy	Solution	Advantages	Disadvantages
Kordafshari et al. [22]	2017	trade-o between energy conservation and network throughput	static	non-rechargeable battery	evolutionary game theory	achieve an stable and optimal schedule	Serious assumption and slow convergence
Ye et al. [19]	2017	multi agent non-cooperative game	static	non-rechargeable battery	fussy logic and Q-learning algorithm	dynamical adjustment	Slow Convergence
Mostafaei et al. [20]	2017	partial coverage and preserve connectivity	static	non-rechargeable battery	learning automation	adaptive control, global optimization and good robustness	Slow Convergence
Chen et	2017	reduce to-sink	static	non-	comparison	dynamic	Lacks

al. [25]		data transmission delay while lifetime is also improved		rechargeable battery	and adaptation duty-cycle control	adjustment and consider energy hole	comparison of algorithms in the same type
Kumar et al. [23]	2017	minimize the active time period of every node	multi-channel and static	non-rechargeable battery	integer linear programming	less energy consumption and minimize the network latency	hard handoff of channel cause ping-pong effect
Wang et al. [17]	2016	critical nodes sleep scheduling	grouped and static	non-rechargeable battery	depth first search-based algorithms and k-means cluster algorithm	maintain group-connectivity	not consider network latency
Mukherjee et al. [18]	2017	a trade-off between energy harvesting and data transmission	static, multi-sink, and tree-based	rechargeable battery and solar energy	comparative and random scheduling	intuitive, lower control overhead and avoid energy hole	more complex hardware and not consider networking network latency
Khalil et al. [21]	2017	energy hole and data recovery	mobile, tree topology	non-rechargeable battery	received oriented method based on TDMA	no data collision and save transaction time	prone to cause energy hole
Chen et al. [12]	2016	desired area coverage and energy consumption balance	Static	rechargeable battery and solar energy	reinforcement learning	dynamic scheduling and high coverage ratio	high cost for hardware and not comparing with other energy harvested algorithms
Xie et al. [15]	2016	a trade-off among the lifetime of network, transmission delay and packet loss ratio	Static	non-rechargeable battery	based on residual energy	adjustable schedule	not considering network latency
Mukherjee et al. [24]	2017	maintain the network connectivity	software defined network (SDN) and static	non-rechargeable battery	SDN-ECCKN algorithm	energy management and low faulty ratio	not considering network latency
Oller et al. [14]	2016	decrease degrees of overhearing and idle	Static	non-rechargeable battery	wake-up radio	reduce unnecessary energy waste, e.g., idle	add extra hardware

		listening				listening	
Baba et al. [16]	2016	improve the energy efficiency	Static	replaceable battery	progressive sleep scheduling and opportunistic routing	less energy overhead and increase the routing quality	not considering communication collision and energy hole
Gupta et al. [13]	2016	minimize the number of active nodes in a field of interest	Three dimensions and static	non-rechargeable battery	estimate the probability of a sensor being redundant	lower energy waste and maintain sensing coverage	not considering network latency
Xu et al. [11]	2015	make some nodes sleep and maintain monitoring accuracy	clustering and static	non-rechargeable battery	sentinel nodes and select the cluster head randomly	effectively balance the energy consumption and extend network lifetime	sentinel nodes run out of energy quickly
Babar Nazir [26]	2011	Multi-hop Wireless Sensor Network is introduced to address delay minimization problem.	Static	non-rechargeable battery	performs scheduling that is dependent on traffic loads.	wake interval of nodes may also be increased due to their topological importance	Non fault tolerance, impact of aggregation, Handling Clustered Environments
Guofang Nan [27]	2012	Coverage-guaranteed distributed sleep/wake scheduling scheme	Dynamic	non-rechargeable battery	divides sensor nodes into clusters based on sensing coverage metrics	overcome the deadlock problem during cluster merging process	Large Time Complexity $O((m^2 + 2)n^2)$.

1.5 Conclusion and Future Scope

Because of test in the length of sensors, they couldn't be prepared with colossal vitality components, thus little batteries are utilized to give their quality. Battery substitution is outlandish in most extreme projects. Consequently, numerous investigations organizations consideration on giving vitality streamlining procedures to WSNs. Since sensor hubs are vitality restricted, it's far wasteful for every one of the sensors to transmit the records without a moment's delay to the BS. Information produced from neighboring sensors is as often as possible repetitive and detectably related. Also, the measure of insights produced in huge sensor systems is regularly critical for the BS to framework. To understand those issues, They can perform information total in sensor hubs. As established bunching conventions depend on that each one the hubs are prepared with the equivalent measure of vitality and thus, they can not take full preferred standpoint

of the nearness of hub heterogeneity. In our Future work we will contemplate the impact of heterogeneity of hubs, in phrases in their vitality, in wi-fi sensor arranges that are progressively grouped. In those systems some of the hubs move toward becoming group heads, total the certainties in their bunch members and transmit it to the sink. It is trusted that a level of the number of inhabitants in sensor hubs is outfitted with additional power sources. This is a wellspring of heterogeneity which can likewise come about because of the underlying setting or as the task of the system develops.

1.6 References

- [1] Guy, Chris. "Wireless sensor networks." Sixth International Symposium on Instrumentation and Control Technology: Signal Analysis, Measurement Theory, Photo-Electronic Technology, and Artificial Intelligence. Vol. 6357. International Society for Optics and Photonics, 2006.

- [2] Lewis, Franck L. "Wireless sensor networks." *Smart environments: technologies, protocols, and applications* 11 (2004): 46.
- [3] Van Dam, Tijs, and Koen Langendoen. "An adaptive energy-efficient MAC protocol for wireless sensor networks." *Proceedings of the 1st international conference on Embedded networked sensor systems*. ACM, 2003.
- [4] Mainwaring, Alan, et al. "Wireless sensor networks for habitat monitoring." *Proceedings of the 1st ACM international workshop on Wireless sensor networks and applications*. Acm, 2002.
- [5] Chintalapudi, K., Fu, T., Paek, J., Kothari, N., Rangwala, S., Caffrey, J., ... & Masri, S. (2006). Monitoring civil structures with a wireless sensor network. *IEEE Internet Computing*, 10(2), 26-34, 2006.
- [6] Ye, Wei, John Heidemann, and Deborah Estrin. "An energy-efficient MAC protocol for wireless sensor networks." *INFOCOM 2002. Twenty-First Annual Joint Conference of the IEEE Computer and Communications Societies*. Proceedings. IEEE. Vol. 3. IEEE, 2002.
- [7] Ye, W., Heidemann, J., & Estrin, D. (2002). An energy-efficient MAC protocol for wireless sensor networks. In *INFOCOM 2002. Twenty-First Annual Joint Conference of the IEEE Computer and Communications Societies*. Proceedings. IEEE (Vol. 3, pp. 1567-1576). IEEE.
- [8] Tan, Hwee-Pink, et al. "Impact of power control in wireless sensor networks powered by ambient energy harvesting (WSN-HEAP) for railroad health monitoring." *Advanced Information Networking and Applications Workshops, 2009. WAINA'09. International Conference on*. IEEE, 2009.
- [9] C. Zhu, Y. Chen, L. Wang, L. Shu, and Y. Zhang, Smac-based proportional fairness backo scheme in wireless sensor networks," in *The International Wireless Communications and Mobile Computing Conference*, pp. 138{142, 2010.
- [10] R. C. Carrano, D. Passos, L. C. Magalhaes, and C. V. Albuquerque, Survey and taxonomy of duty cycling mechanisms in wireless sensor networks," *IEEE Communications Surveys & Tutorials*, vol. 16, no. 1, pp. 181{194, 2014.
- [11] Z.-Y. Xu, S.-G. Zhao, and Z.-J. Jing, A clustering sleep scheduling mechanism based on sentinel nodes monitor for wsn," *International Journal of Smart Home*, vol. 9, no. 1, pp. 23{32, 2015.
- [12] H. Chen, X. Li, and F. Zhao, A reinforcement learning-based sleep scheduling algorithm for desired area coverage in solar-powered wireless sensor networks," *IEEE Sensors Journal*, vol. 16, no. 8, pp. 2763{2774, 2016.
- [13] H. P. Gupta, S. V. Rao, and T. Venkatesh, Sleep scheduling protocol for k-coverage of three-dimensional heterogeneous wsns," *IEEE Transactions on Vehicular Technology*, vol. 65, no. 10, pp. 8423{8431, 2016.
- [14] J. Oller, I. Demirkol, J. Casademont, J. Paradells, G. U. Gamm, and L. Reindl, Has time come to switch from duty-cycled mac protocols to wake-up radio for wireless sensor networks?," *IEEE/ACM Transactions on Networking*, vol. 24, no. 2, pp. 674{687, 2016.
- [15] R. Xie, A. Liu, and J. Gao, A residual energy aware schedule scheme for wsns employing adjustable awake/sleep duty cycle," *Wireless Personal Communications*, vol. 90, no. 4, pp. 1859{1887, 2016.
- [16] S. B. Baba and K. M. Rao, Improving the network life time of a wireless sensor network using the integration of progressive sleep scheduling algorithm with opportunistic routing protocol," *Indian Journal of Science and Technology*, vol. 9, no. 17, 2016.
- [17] Y. Wang, H. Chen, X. Wu, and L. Shu, An energy-efficient sdn based sleep scheduling algorithm for wsns," *Journal of Network and Computer Applications*, vol. 59, pp. 39{45, 2016.
- [18] D. Wang, M. Mukherjee, L. Shu, Y. Chen, and G. Hancke, Sleep scheduling for critical nodes in group-based industrial wireless sensor networks," in *Communications Workshops (ICC Workshops), 2017 IEEE International Conference on*, pp. 694{698, IEEE, 2017.
- [19] D. Ye and M. Zhang, A self-adaptive sleep/wake-up scheduling approach for wireless sensor networks," *IEEE Transactions on Cybernetics*, 2017.
- [20] H. Mostafaei, A. Montieri, V. Persico, and A. Pescape, A sleep scheduling approach based on learning automata for wsn partial coverage," *Journal of Network and Computer Applications*, vol. 80, pp. 67{78, 2017.
- [21] M. I. Khalil, M. A. Hossain, R. Mamta, I. Ahmed, and M. Akter, Time efficient receiver oriented sleep scheduling for underwater sensor network," in *Imaging, Vision & Pattern Recognition (icIVPR), 2017 IEEE International Conference on*, pp. 1{6, IEEE, 2017.
- [22] M. Kordafshari, A. Movaghar, and M. Meybodi, A joint duty cycle scheduling and energy aware routing approach based on evolutionary game for wireless sensor networks," *Iranian Journal of Fuzzy Systems*, vol. 14, no. 2, pp. 23{44, 2017.
- [23] S. Kumar and H. Kim, Low energy scheduling of minimal active time slots for multi-channel multi-hop convergence wireless sensor networks," in *Computing, Networking and Communications (ICNC), 2017 International Conference on*, pp. 1051{1057, IEEE, 2017.
- [24] W. Fang, M. Mukherjee, L. Shu, Z. Zhou, and G. P. Hancke, Energy utilization concerned sleep scheduling in wireless powered communication networks," in *Communications Workshops (ICC Workshops), 2017 IEEE International Conference on*, pp. 558{563, IEEE, 2017. A Short Review on Sleep Scheduling Mechanism in Wireless Sensor Networks
- [25] Z. Chen, A. Liu, Z. Li, Y.-j. Choi, and J. Li, Distributed duty cycle control for delay improvement in wireless sensor networks," *Peer-to-Peer Networking and Applications*, vol. 10, no. 3, pp. 559{578, 2017.
- [26] Nazir, Babar, and Halabi Hasbullah. "Dynamic sleep scheduling for minimizing delay in wireless sensor network." *Electronics, Communications and Photonics Conference (SIEPC), 2011 Saudi International*. IEEE, 2011.
- [27] Nan, G., Shi, G., Mao, Z., & Li, M. (2012). CDSWS: coverage-guaranteed distributed sleep/wake scheduling for wireless sensor networks. *EURASIP Journal on Wireless Communications and Networking*, 2012(1), 44.
- [28] Naveen, K. P., & Kumar, A. (2013). Relay selection for geographical forwarding in sleep-wake cycling wireless sensor networks. *IEEE Transactions on Mobile Computing*, 12(3), 475-488.
- [29] Hsu, C. C., Kuo, M. S., Wang, S. C., & Chou, C. F. (2014). Joint design of asynchronous sleep-wake scheduling and opportunistic routing in wireless sensor networks. *IEEE Transactions on Computers*, 63(7), 1840-1846.
- [30] Hammoudeh, M., & Newman, R. (2015). Adaptive routing in wireless sensor networks: QoS optimisation for enhanced application performance. *Information Fusion*, 22, 3-15.