Energy Harvesting using Wireless Powered Communication Network

Vinod V. Lonkar[1] Jitendra Kumar Mishra[2]
[1]PG Student [2]Assistant Professor & Head of Dept.
[1,2]Department of Electronics & Communication Engineering
[1,2]Patel Institute of Engineering & Science, Bhopal, India

Abstract— Wireless powered communication networking (WPCN) could be a new networking paradigm wherever the battery of wireless communication devices will be remotely replenished by using microwave wireless power transfer (WPT) technology. In this paper, we performed the network and K wireless nodes. The wireless nodes have energy harvesting skills and may harvest power from hybrid access point (H-AP) and alternative nodes in numerous allotted time slots. The created network send and receive the data which is compared through the energy monitoring system. The output of compared energy is low enough then goes towards the energy harvester. We recommend two new schemes serial energy harvesting (SEH) & circular energy harvesting CEH for the WPC that perform powered harvesting among peer nodes. Inside the first scheme, each node harvests power from peer nodes transmitting in the preceding time slots, at the same time as each wireless node harvests power from all nodes in the second scheme. Heuristic recursive optimization algorithm used to search optimum solutions of two optimizations based on different working modes. The network has reasonable energy gain with the aid of SEH with fewer process quality. Otherwise, the network provides greater feasible output performance, as soon as it adopts CEH scheme.

Key words: WPCN, CHE, SHE, WEH, Heuristic Algorithm

I. Introduction

Wireless powered Communication Networks (WPCN) is one amongst the promising approaches to increase the life of the energy-constrained wireless networks like Wireless sensor Networks (WSNs). With the advancement in energy harvest in terms of Wireless Energy Transmission (WET), WPCN overcomes the matter of replacing fixed energy sources like batteries in tough access areas of business networks. Article [24].introduces a energy utilization involved sleep planning in WPCNs with associate degree aim to balance network demands and residual energy with harvested energy. Within the proposed scheme, once the harvested energy combined with residual energy is a smaller amount than the energy consumption owing to information transmission, then the detector node goes to sleep-state so as to prevent death acceleration. Because the sleep node obtains enough energy, this node goes to active-state in next epoch if the network demand will increase.

Wireless energy harvesting (WEH) is turning into one among the key techniques in energy harvesting in wireless networks. On the opposite hand, interference alignment (IA) could be a promising resolution for interference management in wireless networks studied in [10]. The idea of wireless power transmission offers larger possibilities for transmission power with negligible losses. For the long range power transmission power will be sent from source to receivers outright without wires, reducing the price. Batteries got to be recharge or modified eventually, thus the requirement for this type of work is projected in [14].

A similar wireless communication network consisting of dual-hop wireless high-powered communication network (DH-WPCN), wherever the communication between a Hybrid Access point (HAP) and variety of users is assisted by energy-constrained relays who have to be compelled to harvest energy from radio frequency signals broadcast by the HAP [25].

II. Related Work

A related system model was considered in [5] and [8]. H. Ju and R. Zhang Presented an EH network model which a set of users can harvest energy in downlink and transmit information in uplink. X. Kang, C. Ho and S. Sun investigated the difference is that a dual function H-AP is assumed to be equipped with two antennas to perform downlink energy transfer and uplink communication, respectively. Comparatively speaking, the optimum time allocation between energy harvesting and information transmission is complex. In this system model, there are one H-AP, one relay and one source .A time switching cooperative communication scheme is studied to achieve downlink wireless energy transfer and uplink wireless information transmission. In all of these works, the wireless nodes only harvest energy from the H-AP.

Chin Keong ho and Rui Zhang take into account the use of energy harvesters, in situ of typical batteries with fixed energy storage, for point-to-point wireless communications. additionally to the challenge of transmission in a channel with time selective fading, additionally take into account the matter of energy allocation over a finite horizon, taking into consideration channel conditions and energy sources that are time varied, thus on maximize the throughput [2].Furthermore, wireless power transfer was investigated supported relay networks, formulated the offline end-to-end turnout maximization drawback with energy transfer from the source to the relay subject to energy causality at each nodes and information causality at the relay node and K. Huang showed that it's a convex optimization drawback [3]. Liang Liu, Rui Zhang, and Kee-Chaing Chua assume that the transmitter encompasses a fixed power supply, whereas the receiver has no fixed power supplies and therefore must fill again energy via WEH from the received interference and signal sent by the transmitter [4]

New sort of wireless RF powered communication network with a harvest then-transmit protocol, wherever the H-AP first broadcasts wireless energy to distributed users within the downlink and so the users transmit their independent data to the H-AP within the uplink by TDMA. H. Ju & R. Zhang propose a new common throughput maximization approach to allocate equal rates to all users in spite of their distances from the H-AP by allocating the transmission time to users inversely proportional to their distances to the H-AP [5].

Optimum time and energy allocation to maximize the sum throughput for the case once the nodes will save energy for later blocks. To maximize the sum throughput over a finite horizon, the initial optimization problem is separated into 2 sub-problems and finally are often formulated into a standard box constrained optimization problem, which might be resolved efficiently by Rui Wang and D. Richard Brown [6]. The Performance Analysis and optimization in WPC system, wherever associate energy forced supply, powered by an obsessive power beacon (PB), communicates with a destination. It's assumed that the lead is capable of playing channel estimation, digital beam forming, and spectrum sensing as a communication device [9]-[12]. Parisa Ramezani, and Abbas Jamalipour study of dual-hop wireless powered communication network (DH-WPCN), wherever the communication between a Hybrid Access purpose (HAP) and variety of users is power-assisted by energy-constrained relays who ought to harvest energy from radio frequency signals broadcast by the HAP. So as to power the relays for helping the uplink communication, the HAP broadcasts an obsessive energy signal within the downlink. Every relay harvests energy from this signal and utilizes the harvested energy in forwarding its corresponding user's information to the HAP [25]. Especially, considers a wireless powered communication network (WPCN) wherever user first harvest energy in downlink then utilize the energy to transmit information signal in uplink at the same time. Xin Lin, Lei Huang goal is to maximize the energy efficiency (EE) of the network via joint time allocation and power control [16].

Full duplex wireless-powered two approach communication networks, wherever two hybrid access points (HAPs) and variety of amplify and forward relays each operate in full duplex situation. Gaojie Chen, pei Xiao use time switching (TS) and static power splitting (SPS) schemes with two approach full duplex wireless-powered networks as a benchmark studied in [23].

III. Existing System

In existing system a WPC network consisting of one H-AP and K wireless nodes the place EH amongst nodes is also performed. Effective peer harvesting techniques are used to enhance the gain of WPC system. This paper affords two new schemes for WPC system are serial energy harvesting (SEH) & circular energy harvesting (CEH). In SHE, the k th node harvests energy serially from the H-AP and previous k-1 transmitting nodes and goes to sleep after data transmission. In CEH scheme, the k th node not only harvests energy from the previous k -1 transmitting nodes, but also from the following K-k nodes, every node can harvest power from the H-AP and other nodes when it does not transmit information. Although CEH can usually obtain higher performance, it is greater difficult than SHE and requires the energy harvester to be turned on all the time without sleeping. They are suitable to different scenarios, which is the network has average energy gain by SEH with fewer computational complexity. Otherwise, the network can offer better possible throughput performance, when it adopts CEH scheme. Therefore, the proposed schemes can provide different tradeoffs between performance and complexity, and can be applied to different scenarios. SEH is suitable for a network with cellular nodes and unbalanced topology structure, where some nodes are a bit far away from the H-AP but nearer to the pervious nodes. SEH is additionally suitable for applications with simple power storage and management. CEH is appropriate for a network with constant and clustered nodes, the place all nodes are close to every other. CEH is additionally suitable for applications the place energy storage and management are not restrained by complexity.

IV. Proposed System

This paper proposed serial & circular effective peer harvesting methods are used to improve the gain of WPC system. Specifically, in SEH, the k th node harvests energy serially from the H-AP and previous k−1 transmitting nodes and goes to sleep after data transmission. For the CEH, each node can harvest energy from the H-AP and other nodes when it doesn't transmit information. They are appropriate to unique situations. That is, the network has slight energy advantage with the aid of SEH with fewer computational complexity. Otherwise, the network can provide better attainable throughput performance, while it adopts CEH scheme.

This paper proposes a heuristic recursive optimization algorithm using particle swarm optimization (PSO) to search most desirable options of two optimizations primarily based on different working modes. The proposed recursive optimization method can effectively resolve the optimization problems, regardless of the complexity of goal functions. Put another way, it has better adaptability technically to solve some objective functions that are complex multidimensional problems. As a result, it doesn't need too many extra works to simplify the objective function to fit the needs of solving process. Otherwise, it will occupy extra time on expression derivation instead of optimization. Relatively speaking, the proposed strategies can supply a increased simple way if any one honestly desires to fulfill an technical requirement.

By using new concept of peer harvesting challenges added as follow.

The peer harvesting have now not been studied inside the literature, even though it is straightforward that harvesting electricity from other devices except the HAP will enhance the performance. But, the implementation and the analysis of such system are greater hard because of the coupling among all nodes to optimize the time of EH and transmission. Accordingly, at each node we want to analyze the greater harvested power.

Two optimization problems want to be formulated for practical designs. Since the optimization is more complicated than the prevailing works besides peer harvesting and the objective functions of proposed schemes are difficult, we must use viable and occasional complexity approach to obtain the optimization manner.

This system contribute the two new peer harvesting schemes, the system of two applicable optimizations and their solutions by using of heuristic optimization algorithm, which has better technical adaptability for fixing complex objective features. In WPC networks Simulation consequences display the effectiveness of the proposed schemes.

V. SYSTEM MODEL

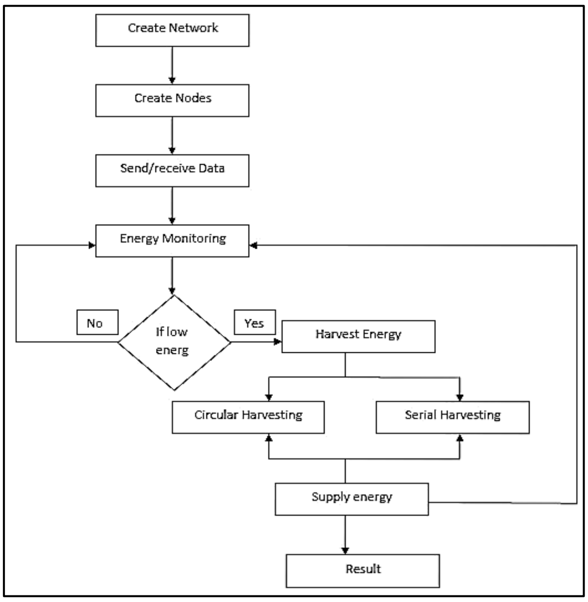

Fig. 1: WPC Network Model

Consider a wireless powered communication network with one H-AP (node 0) and K wireless nodes (nodes 1… K). Assume that all nodes are outfitted with a single antenna. In addition, anticipate that the H-AP has a constant energy and that the K nodes do not have any embedded energy supply. In the first time slot, the H-AP transfers the preliminary energy to all the wireless nodes in the down link for t_0T seconds, the place T is the total duration of communication and $0 < t_0 < 1$. In the second time slot, node 1 transmits data to the H-AP for t_1T seconds, observed by using node 2 for t_2T seconds, until node K for t_K T seconds. One has $t_0 + t_1 + \ldots\ldots + t_K = 1$.

WPC network model is shown in Fig.1, first we have to create some network by using nodes which transmit and receive data from each other, and this data is given to energy monitoring system. If energy level is more then it again given to energy monitoring otherwise is diverted towards the energy harvester, it adopts two working schemes.

In SEH, the kth node only harvests energy from the 1st, 2nd, ⋯, $(k-1)^{th}$ nodes that have transmitted before it, and then goes to sleep after its own transmission. The timing diagram of SHE for energy harvesting and information transmission is shown in Fig. 2.

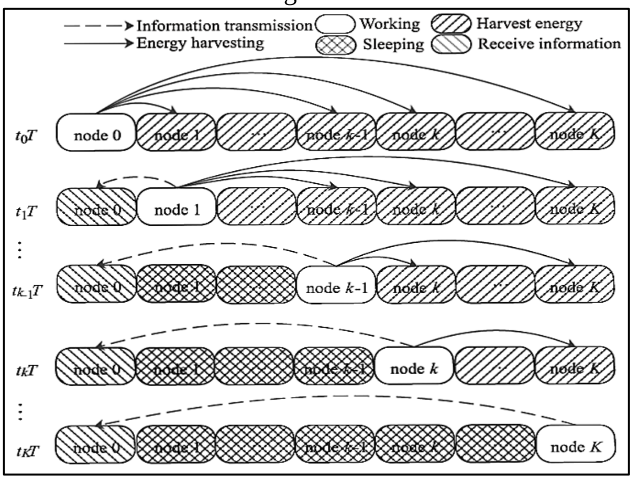

Fig. 2: The timing diagram of SHE.

In CEH scheme, the timing diagram of energy harvesting and information transmission is shown in Fig. 3.

In CEH, the k th node not only harvests energy from the previous $k-1$ nodes that have transmitted information before it, but also harvests energy from the following K-k nodes that will transmit after it. In other words, the k th node does not go to sleep after its own data transmission but keeps harvesting energy from others. Therefore, its optimization and derivation are more mathematically involved. Assume that all nodes exhaust the harvested energy for transmitting information and do not consider energy storage and power allocation for future transmission

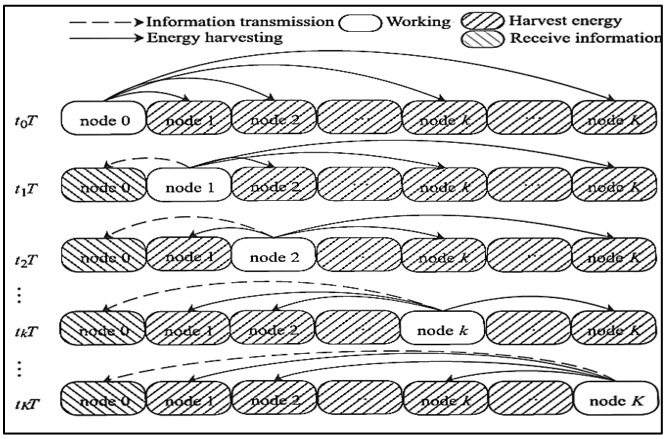

Fig. 3: The timing diagram of CEH.

Assume that the H-AP assigns the random transmission order and initial time slots through the control channel, and the WPC system abides through the TDMA protocol. This means that the nodes can transmit signals within the assigned time slot and then harvest energy or fall asleep in their idle time slots. Because each time slot simply exists one user node to transmit data, other nodes can estimate their CSI between themselves and working node, respectively. Finally, H-AP achieves optimization and schedule based on nodes' remarks information.

VI. IMPLEMENTATION DETAILS AND RESULT

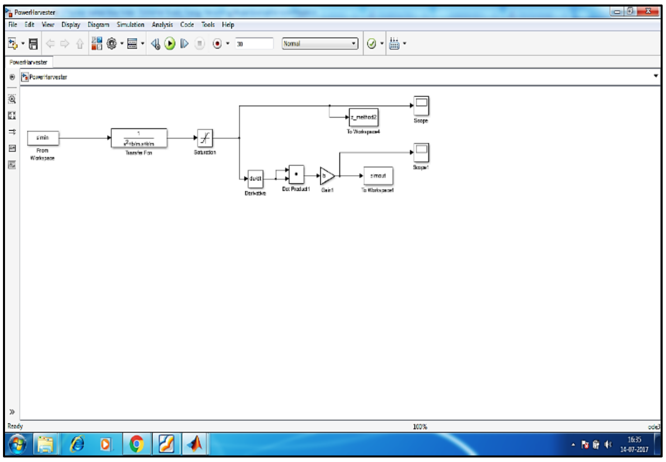

Fig. 4: Power Harvesting

Fig 4 shows the simulation result of power harvesting

A. *Simin*

It load signal data from workspace block reads signal data from a workspace and outputs the data as a signal. We can specify how the data is loaded, including sample time, how to handle data for missing data points, and whether to use zero-crossing detection. In the Data parameter Workspace block, specify the workspace data to load. That evaluate a structure of MATLAB time series objects, a structure, with or without time and two-dimensional matrix.

B. Transfer FCN

A transfer function also known as system function or network function and, mathematical representation in the form of graph, transfer curve or to describe inputs and outputs of black box models. Typically it is a representation in terms of spatial or temporal frequency, of the relation between the input and output of a linear time-invariant (LTI) system with zero initial conditions and zero point equilibrium.

C. Saturation

A Saturation block accepts and outputs real signals of any data .it also imposes upper and lower bounds on a signal. When the input signal is within the range specified by the Lower limit and Upper limit parameters, the input signal passes through unchanged. The upper bound on the input signal. While the signal is above this value, the block output is set to this value. When the input signal is outside these bounds, the signal is clipped to the upper or lower bound. When the parameters are set to the same value, the block outputs that value.

D. Dot Product

The Dot Product block generates the dot product of the vectors at its inputs. The scalar output, y, is equal to the MATLAB operation. y = sum (conj (u1).* u2) .where u1 and u2 represent the vectors at the block's top and bottom inputs, respectively. If u1 and u2 are both column vectors, the block outputs the equivalent of the MATLAB expression u1'*u2.

E. Simout

This function from Workspace block inputs a signal and writes the signal data to a workspace. During the simulation, the block writes data to an internal buffer. When the simulation is completed or paused, that data is written to the workspace. Data is not available until the simulation is stopped or paused.

F. Scope

It generated Display signals during simulation. The Simulink Scope block displays time domain signals with respect to simulation time. Input signal characteristics are 1. It generate Signal Continuous (sample-based) or discrete (sample-based and frame-based). 2 Signal data type - Any data type that Simulink supports including real, complex, fixed-point, and enumerated data types 3 Signal dimension-Scalar, one-dimensional (vector), two dimensional (matrix), or multidimensional. Display multiple channels within one signal depending on the dimension.

Fig 5 shows estimated harvested power based on the power and time basis.

Fig 6 shows accelerometer measurement of the time and acceleration basis.

The simulated result of power harvesting shown in fig-4.the basic blocks in MATLAB will explain as above .The fig. 5 shows the result of estimated harvested power in the form of graph shows estimated harvested power based on the power and time basis and Fig. 6 shows accelerometer measurement of the time and acceleration basis.

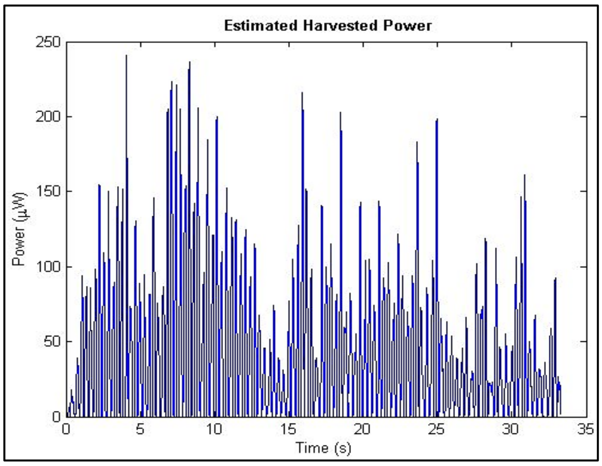

Fig. 5: Result of Estimated Harvested Power

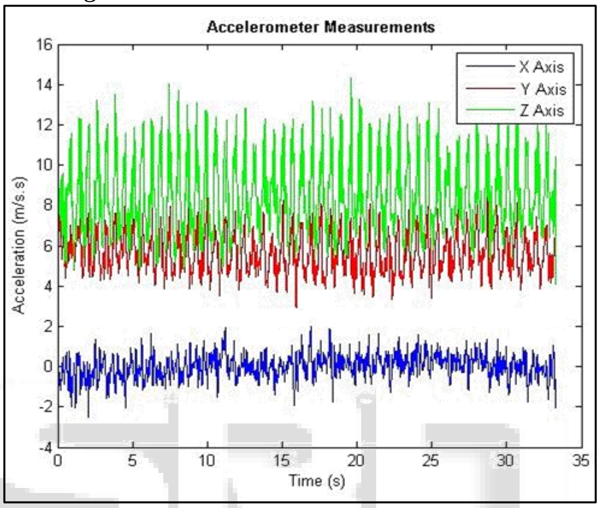

Fig. 6: Result of Accelerometer Mesurement

VII. CONCLUSION & FEATURE SCOPE

To optimize sum possible throughput and required harvested energy this paper has proposed two energy harvesting schemes, SHE & CHE totally based on heuristic algorithms with similar performance. The proposed recursive optimization technique can correctly clear up the optimization issues. Which has better technical adaptability for fixing complex objective features. CEH is better than SHE, to achieve the maximum sum achievable throughput.

In feature work many challenges to be tackled like power control can be used to enhance its overall performance similarly, the tradeoff between most beneficial transmission order and implementation complexity must be investigated. Simulation results exhibit the effectiveness of the proposed schemes in WPC networks.

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