AGRICULTURAL JOURNAL
MEDWELL PUBLICATIONS SINCE 2000

Review of Relaying Protocols for Wireless Energy Harvesting and Information Processing

[1]Nada Tahar, [2]Abdul Kadum Jafar Al Yasiri and [1]Ahmad T. Abdulsadda
[1]*Al Najaf Technical Engineering College, Najaf, Iraq*
[2]*Al Furat Al Awast Technical University, Najaf, Iraq*

Key words: Wireless nodes, TSR, PSR, delay switching, tolerant

Corresponding Author:
Nada Tahar
Al Najaf Technical Engineering College, Najaf, Iraq

Page No.: 1-6
Volume: 15, Issue 1, 2020
ISSN: 1816-9155
Agricultural Journal
Copy Right: Medwell Publications

Abstract: This study concerned with energy harvesting of the relay nodes. One solution to this particular problem in the larger information processing wireless networks is to feed some energy from the received source RF signal by harvesting it then forward to the next relay or to the destination node. In this study, we will be considered an Amplify and Forward (AF) relaying networks and the energy harvested from the (RF) signal and uses that harvests energy to forward the source information to the destination. There are two protocols will be considered and discussed extensively Time Switching based Relay (TSR) protocol, Power Splitting based Relay (PSR) protocol. The mathematical analysis for both protocols was discussed and analysis.

INTRODUCTION

Firstly, let us presented the Literature Survey of the subjects: Zhou *et al*. (2013), they proposed receiver operation as shown in Fig. 1 which is called Dynamic Power Splitting (DPS), the system has been proposed splits the received signal with adjustable power ratio for energy harvesting and information decoding, separately. Three special cases of DPS, namely, Time Switching (TS), Static Power Splitting (SPS) and On-off Power Splitting (OPS) are investigated.

The TS and SPS schemes can be treated as special cases of OPS. Moreover, they proposed and verified by simulation results the two types of practical receiver architectures, namely, separated versus integrated information and energy receivers.

Nasir *et al*. (2013), they consider an enhance and Forward (AF) handing-off systems (appeared in Fig. 2 and the vitality Reaped From the (RF) flag and uses that harvests vitality to advance the source data to the goal. They consider two convention plans: Time exchanging based transfer (TSR) convention and power part based hand-off (PSR) convention. They did the numerical recreation results to locate the ideal incentive for the division time parameters.

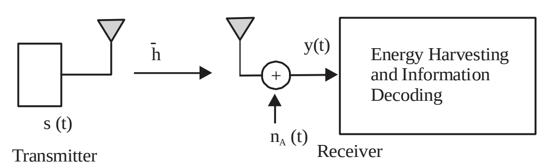

Fig. 1: One relay node wireless sensor network (Zhang and Ho, 2012)

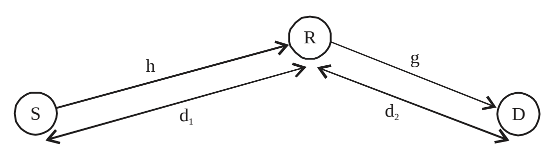

Fig. 2: One relay node wireless sensor network (Nasir *et al*., 2013)

Liu *et al*. (2015), they contemplated with broad scientific induction the streaming terms: the most extreme

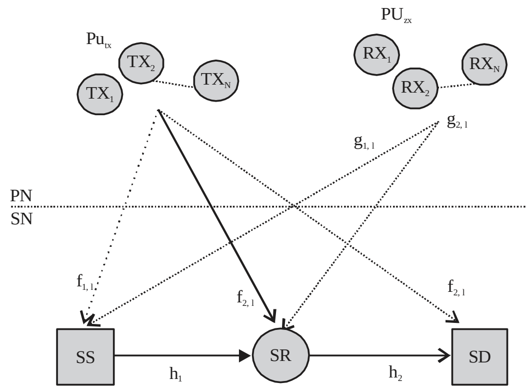

Fig. 3: System model of the energy harvesting cognitive radio system (Liu *et al*., 2015; Do *et al*., 2016)

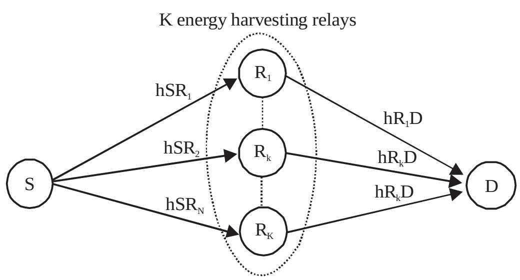

Fig. 4: A dual-hop decode-and-forward cooperative network with K energy harvesting relays (Do *et al*., 2016)

transmit control at the auxiliary Source (SS) and at the optional hand-off (SR), the pinnacle impedance control allowed at every PU beneficiary and the obstruction control from every PU transmitter to the SR and to the auxiliary goal (SD). The framework that they proposed appeared in Fig. 3.

Their results show that the outage probability improves when PU transmitters are located near SS and sufficiently far from SR and SD. Indeed they show that when the number of PU transmitters is large, the detrimental effect of interference from PU transmitters outweighs the benefits of energy harvested from PU transmitters.

Tri *et al*. (2016), they studied the relay selection in decode-and-forward wireless energy harvesting cooperative networks as shown in Fig. 4. They analyzed the system performance in terms of Outage Probability (OP) over independent and nonidentical (i.n. i.d.) rayleigh fading channels. Then, they derived the closed-form approximations for the merical method to find the fraction time for energy harvesting.

Kiev *et al*. (2016), they examined the full duplex hub (appeared in Fig. 5) and think about the effect on two transfer schemes: Amplify-Forward (AF) and Decode and

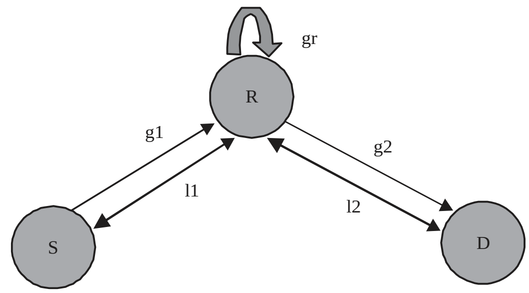

Fig. 5: System model for energy duplex relay wireless network (Kieu *et al*., 2016; Fouladgar and Simeone, 2012; Chalise *et al*., 2012)

Forward (DF). They additionally decide the frameworks reliance on commotion level, blackout likelihood and transfer transmission control.

This study present a new techniques to use the one relay model to charge the mobil aircraft quad copter system or the robotic like fish that will be helping to make them flying or swimming in long time without needing to recharge the battery.

MATERIALS AND METHODS

Problem formulation: The first stage of model of the problem of wireless energy harvesting and information processing in Amplifying and Forward (AF) the information signal into wireless sensor network which is proposed by in this study is shown in Fig. 6 which has the simplest wireless sensor network with the following items:

S is the base station source and it has the following characteristics:

- s(t) time varying information signal should be transmitted from the source node to the destination,
- Ps total power will be transmitted through the RF signal
- d1(t) is the distance from the source to the relay node
- h is the gain factor for the medium that connected the source node and the relay node
- m the exponent ratio losses factor where the power will be decreased exponentially with the distance

R is the Relay node constrained by the energy factor, it has the following characteristics:

- yr(t) the signal received from the source through the connectiond1 which has a gain h
- xr(t) amplified and forward information signal
- Pr power harvested through the harvesting period
- d2 (t) the distance from relay node to the destination node
- g the gain of the connection medium,
- h efficiency for the harvesting energy process, 0<h<1

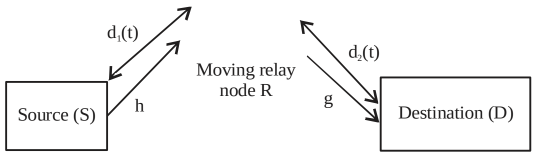

Fig. 6: Schematic diagram of the moving relay node

D is the destination node and it has the following characteristics:

- yd(t) signal with additive noise information signal that is forwarded by the relay node from above discussion we made a set of assumption for that model can be listed as:
  - There is no direct link between the source and the destination node for simplicity we will consider just one relay node
  - The intermediate relay is an energy constrained node. It first harvests energy from the RF source signal
  - The relay node used to Amplify-and Forward (AF) the source signal
  - The processing power required by the transmit/ receive circuitry at the relay is negligible (it is so small if we compare it with Pr)
  - The channel gains, h and g are modeled as quasistatic block-fading and frequency non-selective parameters
  - The channel is constant over the block Time T (is a crucial assumption)

The destination node can estimate the dual-hop channel at the start of information transmission in each block by utilizing the pilots sent from the source node over the dual-hop link.

Time Switching-based Relaying (TSR) protocol: Figure 7 shown the main TSR protocol for energy harvesting and information processing at the relay. This protocol has the following characteristics:

- T is the square time in which a specific square of data is transmitted from the source hub to the goal hub
- α is the fraction of the block time in which relay harvests energy from the source signal, (0<a <1)
- (1-a)T/2 is used for the source to relay information transmission
- The remaining half (1-α) T/2 is used for the relay to destination information transmission
- αT is energy harvesting time

Delay-limited transmission: In the delay-limited transmission mode, the throughput is determined by evaluating the outage probability, P_{out} = p(gD) at a fixed source transmission rate (Rbits/sec./Hz) (Huang and Lau, 2012; Popovski *et al*., 2013; Liu *et al*., 2012), i.e:

$$R = \log_2(1+\gamma_o) \tag{1}$$

Where, γo go the threshold of the (SNR) for the correct data detection at the destination. The main idea in this scheme is that: Given that the transmitter is communicating (Rbits/sec/Hz) and ((1-α)T/2) is the effective communication time from the source node to the destination node in the block of time T seconds, the time t at the destination is given by Zhang and Ho (2012):

$$\tau = 0.5(1-P_{out})R(1-\alpha) \tag{2}$$

where, τ depends on Ps, η, α, d1, d2, R, σ^2 n [r] σ^2 and ^{2}n [d].

Delay-tolerant transmission: In the postponement tolerant transmission mode, the throughput is controlled by assessing the ergodic limit, C at the goal. Not at all like the defer constrained transmission mode where the source transmits at fixed rate R, so as to meet some blackout criteria, the source can transmit information at any rate not exactly or equivalent to the assessed ergodic limit, C in the deferral tolerant transmission mode:

$$\tau = 0.5\times(1-\alpha)\times C \tag{3}$$

where, C = R bits/sec./Hz and τ depends on Ps,η, α, d_1(t), d_2(t), R, σ^2 n[r] and σ^2 n [d].

Power Splitting-based Relaying (PSR) protocol: Figure 8 shown the main PSR protocol for energy harvesting and information processing at the relay. This protocol has the following characteristics.

Where the time is splitting off by 2 and the protocol working based up on the power. The main priority to check always the batter of the relay which mean if the power below the threshold that make the charging process have to start immediately.

Delay-limited transmission: Given that the transmitter is communicating R bits/sec/Hz and T/2 is the effective communication time from the source node to the destination node in the block of time T seconds, t at the destination node in the delay-limited transmission mode is given by:

$$\tau = 0.5\times(1-P_{out})\times R \tag{4}$$

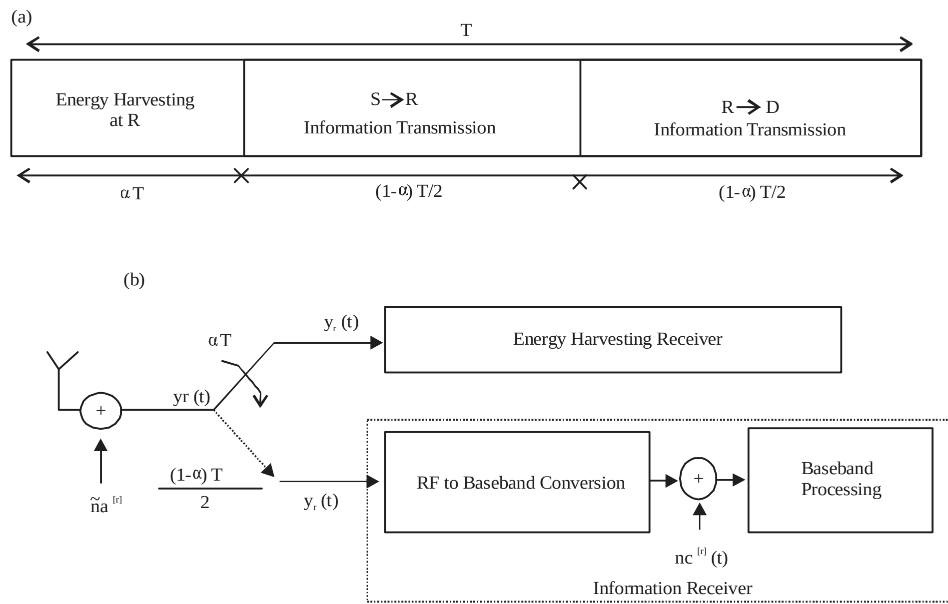

Fig. 7 (a, b): Wireless sensor network: (a) Illustration of the key parameters in the TSR protocol and (b) Block diagram of the relay receiver in the TSR protocol

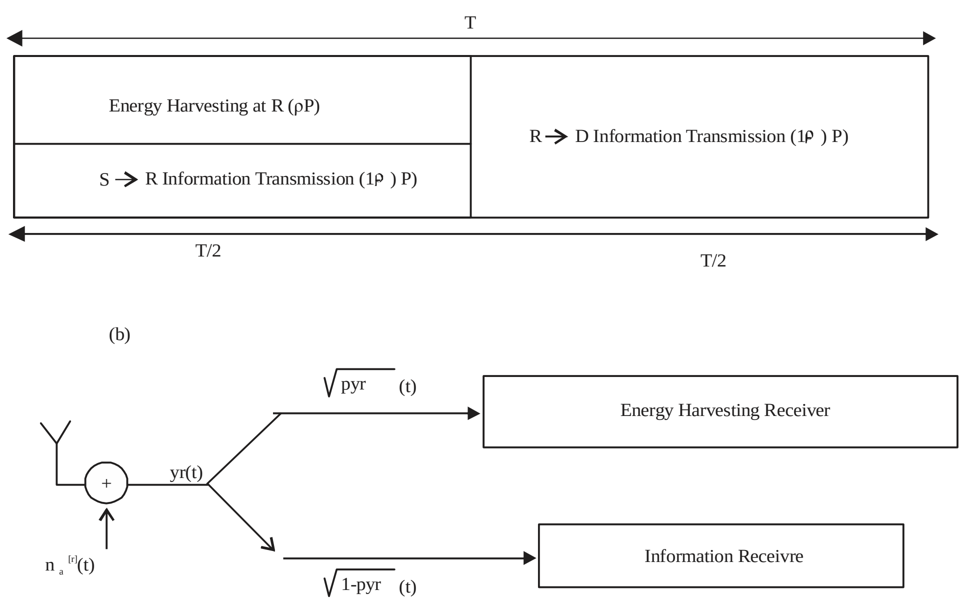

Fig. 8 (a, b): Wireless sensor network: (a) Illustration of the key parameters in the PSR protocol and (b) Block diagram of the relay receiver in the PSR protocol

Delay-tolerant transmission: Since, T/2 is the effective communication time between the source and the destination nodes in the block of time T seconds, t at the destination node in the delay tolerant transmission mode is given by:

$$\tau = 0.5 \times (1-\alpha) \times C \quad (5)$$

RESULTS AND DISCUSSION

Generally, in the previous work for all researcher they considered the distance is unity here we will introduce the normalization formula as listed in Table 1. Figure 9 shows the results of the two protocol shown the relationship between the throughput and the value of α.

Table 1: Distance of the moving relay

Case number	1	2	3
d_1	1	1	$1<d_1<10$
d_2	1	$2-d_1$	$10-d_1$

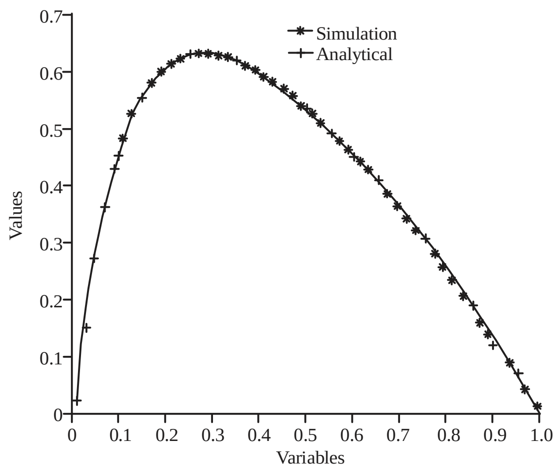

Fig. 9: Simulation results and analytical solution for the first protocol for the α factor

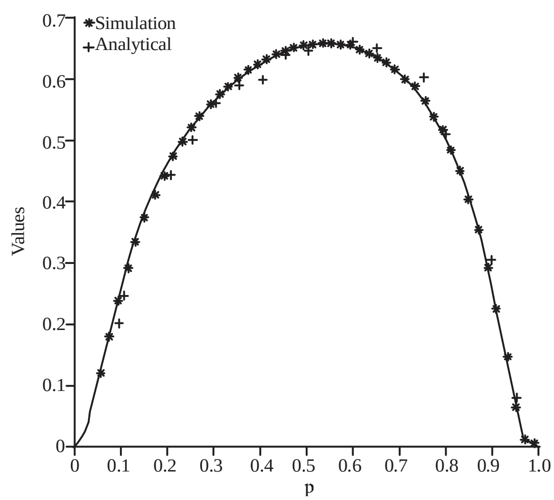

Fig. 10: Simulation results and analytical solution for the first protocol for the ρ factor

From Fig. 9, we can be seen obviously the optimal value is 0.28. Figure 9 shown the results of the throughput with respect to ρ in the first protocol. From Fig. 9 and 10, we can be seen obviously the optimal value of the $\rho = 0.55$.

CONCLUSION

Many application need more time in the sky or under the water using the RF signal to recharging the battery of the relay nodes is promising subjects. In this study, we provide the summary about all the model even we have tried to modified the most important one, we demonstrate the analytical and the simulation results.

RECOMMENDATIONS

The new future work direction will be proposed a new optimization technique (called Cramer Rao Lower Bound (CRLB)) to be providing the minimum threshold value for the parameters (energy harvesting = time, power splitting ratio, source transmission rate, source to relay distance, noise power and energy harvesting efficiency).

REFERENCES

Chalise, B.K., Y.D. Zhang and M.G. Amin, 2012. Energy harvesting in an OSTBC based amplify-and -forward MIMO relay system. Proceedings of the 2012 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), March 25-30, 2012, IEEE, Kyoto, Japan, pp: 3201-3204.

Do, N.T., V.N.Q. Bao and B. An, 2016. Outage performance analysis of relay selection schemes in wireless energy harvesting cooperative networks over non-identical rayleigh fading channels. Sens., Vol. 16, No. 3. 10.3390/s16030295

Fouladgar, A.M. and O. Simeone, 2012. On the transfer of information and energy in multi-user systems. IEEE. Commun. Lett., 16: 1733-1736.

Huang, K. and V.K. Lau, 2014. Enabling wireless power transfer in cellular networks: Architecture, modeling and deployment. IEEE. Trans. Wirel. Commun., 13: 902-912.

Kieu, T.N., L.N. Ngoc, H.K. Quoc, H.H. Duy, T.D. Dinh, M. Voznak and M. Mikulec, 2016. A performance analysis in energy harvesting full-duplex relay. Proceedings of the 2016 39th International Conference on Telecommunications and Signal Processing (TSP), June 27-29, 2016, IEEE, Vienna, Austria, pp: 161-164.

Liu, L., R. Zhang and K.C. Chua, 2012. Wireless information transfer with opportunistic energy harvesting. IEEE. Trans. Wirel. Commun., 12: 288-300.

Liu, Y., S.A. Mousavifar, Y. Deng, C. Leung and M. Elkashlan, 2015. Wireless energy harvesting in a cognitive relay network. IEEE. Trans. Wirel. Commun., 15: 2498-2508.

Nasir, A.A., X. Zhou, S. Durrani and R.A. Kennedy, 2013. Relaying protocols for wireless energy harvesting and information processing. IEEE. Trans. Wirel. Commun., 12: 3622-3636.

Popovski, P., A.M. Fouladgar and O. Simeone, 2013. Interactive joint transfer of energy and information. IEEE. Trans. Commun., 61: 2086-2097.

Zhang, R. and C.K. Ho, 2013. MIMO broadcasting for simultaneous wireless information and power transfer. IEEE. Trans. Wirel. Commun., 12: 1989-2001.

Zhou, X., R. Zhang and C.K. Ho, 2013. Wireless information and power transfer: Architecture design and rate-energy tradeoff. IEEE. Trans. Commun., 61: 4754-4767.