The Research and Analysis for Rear View Transmission Based on IEEE 802.11 Wireless Network

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***Abstract*—In recent years, because techniques of network communication have highly developed, the related applications has been used in many different area. IEEE 802.11 standard was formulated at 1997, and Wi-Fi alliance is formed in 1999. Today, IEEE 802.11 is the general standard in industry.**

In this paper, we use Wi-Fi as the interface in transmission to simulate that using the event data recorder with Wi-Fi interface to connect with the main center system and send the image to the screen in a car. Unlike the wired transmit solution, there is a problem that power consumption in wireless transmission. Therefore, we presented an algorithm to make the balance between efficiency and power consumption. We will explain that how to reduce the power consumption but keep real time reaction and make to optimization in following chapter.

Keywords—IEEE 802.11; Wi-Fi; Power Saving; Rear View

I. Introduction

Today, most of cars are equipped with reversing collision detection device. In these cars, some of them are even with reversing image. The common solutions that we know about reversing image transmission use wired transmission to connect with center control system. The solution with wired transmission present some advantages that are low latency, low interference, and low response time. (But if there are many wires and cables in vehicle, it make much more inconvenient if we need to repair the car.) Therefore, if wired transmission is replaced by wireless that makes vehicle more convenience to maintain in the future. For example, if there is problem in end device, vehicle maintenance provider just need change the end device without checking too much details to maintain a car. It simplify the process of maintaining a car. Thus, in this paper, we assume an event data recorder has Wi-Fi transmission interface to communicate with center control system of vehicle.

However, there are some problems using wireless transmission. First problem is the transmission delay, which will break the real time constraint. The real time issue can be ignored in event data recorder, as long as the image can be correctly recorded.

The second problem is the power consumption, because most the end devices are powered by battery. Battery can only provide limited energy. Therefore, how to make the end device consume less to extend the battery life time is an important issue. In this paper, we will focus the problem on power saving in transmission.

II. Related Works

Many power saving mechanism have been studied in previous work [4] [5] [8] [9], such as dynamic calculate ATIM Window to present longer sleep time for more energy saving, shut off the Wi-Fi interface for a period of time to reduce energy consumption. Some of them optimize the transmit protocol to make less transmission by verify the beacon interval for getting more idle time. With these mechanism the device can get more sleep time and switch into power saving mode, and thus decrease more power consumption.

III. Back Ground

A. IEEE 802.11

Nowadays, IEEE 802.11 is the most common standard used in wireless transmission. The common protocol used from IEEE 802.11 can be IEEE 802.11 is proposed for wireless local area network communication and describes the specification of media access control (MAC) and physical (PHY) layer in Fig 1. They are created and maintained by the IEEE LAN/MAN Standards Committee (IEEE 802). The base version of the standard was released in 1997 and subsequent amendments. The standard provided the basis for wireless network device for using Wi-Fi.

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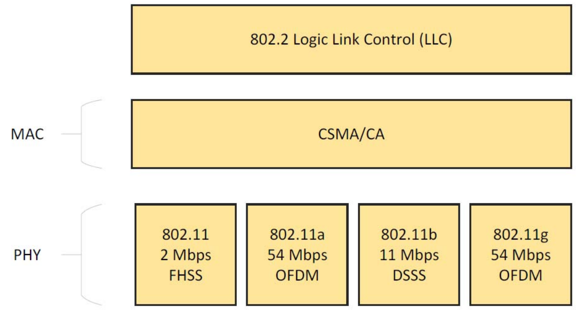

Fig. 1. IEEE 802.11 MAC and PHY [3]

B. *Wireless Local Area Network*

A wireless local area network (WLAN) links two or more devices using some wireless distribution method, and usually providing a connection through an access point to the wider Internet. This gives users the ability to move around within a local coverage area and still be connected to the network. Based on the functional requirements of IEEE 802.11 WLAN protocol, the basic structure had established the basic structure of wireless LAN system. The minimum transmission rate required in IEEE 802.11 is 1Mbps for general data transfer. For real time data transmission such as voice data and video data, IEEE 802.11 also provides a time-limited service in data transmission for real-time requirements. In order to integrate these requirements, IEEE 802.11 provides two different types of wireless local area network infrastructure as follows.

- Infrastructure Wireless Local Area Network.
- Ad-Hoc Wireless Local Area Network.

As mention above, the infrastructure is using the existed wired distribution system as a base platform, there are one or more access point (AP) in this network architecture. AP can also called a base station, and it is used to apply to wired LAN and wireless LAN as a convert and bridge. The main function of an AP is to import one or more of wireless LAN and the existing wired network connection through distribution system so that they can access internet resources in wired distribution system. Ad-Hoc Wireless Local Area Network is mainly provided for using in real time construction and connect wireless network. In this architecture, any two or more users can communicate directly or indirectly.

C. *Wireless Local Area Network*

In wireless ad-hoc network, the power save protocol can allow workstation to determine whether to close radio transceiver. In other words, the power save protocol can make workstation into sleep mode to save energy saving. However, a workstation in a sleep mode cat not receive the message from other station. Therefore, a main challenge of power save protocol is allow workstation enter sleep mode without causing package transmission delay. Most protocols let the workstation synchronize the time to each other in the design. Therefore, workstations can wake up at a specific time to wake up transmit or receive data to or from other workstation.

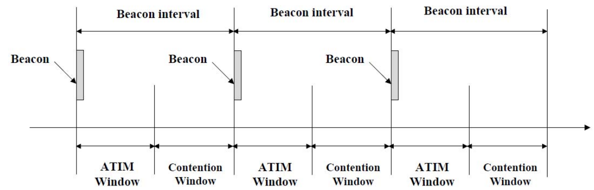

Fig. 2. ATIM Window and Contention Window [1]

In Fig 2, the power management mechanism of IEEE 802.11, requires mutual cooperation between the workstation. The waked workstation will temporary frame for the workstation that in sleep mode. After the workstation is awake then try to notify them to send data. Workstations in sleep mode will wake up periodically to check whether there are other notification message sent from other awake workstation. Therefore, the workstation will send a beacon in a period time that called by beacon interval. At the beginning in duration, the workstation will send a beacon frame that include an information named Traffic Indication Map (TIM). When the end device connect to the AP, it will get an Association ID (AID) from AP. When the AP receives traffic belonging to an AID, if the AID is in sleep mode, will be issued in the next beacon, and have to wait to receive a list of AID buffered data sent out through the TIM. But you can check the list from TIM AID in the user awake, if you send poll data waiting to receive a message to AP, in order to reclaim their own data. In addition, AP regulations every few TIM, there will be a DTIM (Delivery Traffic Indication Map), when to DTIM time, all clients must be sober, because AP will all broadcast or multicast frames that once gave all clients. But in Ad-Hoc mode without point coordinator exists, the beacon interval is divided into ATIM (Announcement Traffic Indication Messages) window and competition window, as Fig 3,

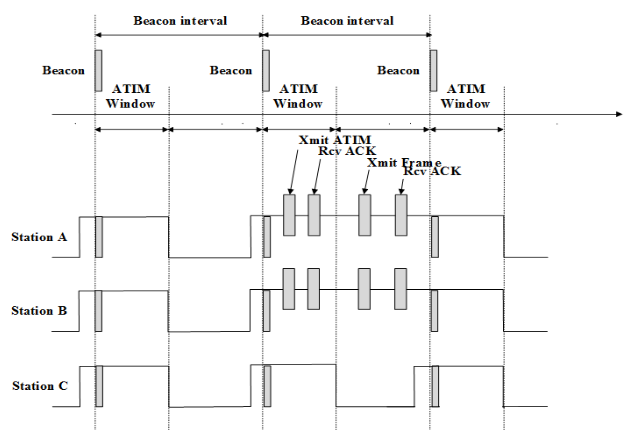

Fig. 3. Beacon Interval for power saving [1]

all dormant workstations will be agreed in the ATIM window we all have to wake up. When the data can't be transmitted ATIM window frames, and can only send beacon frames, RTS, CTS, ACK and ATIM frames, so if A wants to send data to B, it will send ATIM frame to inform B has information to give him, B will reply ACK to A. The department belongs to the transmitting or receiving ATIM window in the competition will go to sleep.

IV. DYNAMIC POWER SAVE ALGORITHM

As method before, there are many ways to save power. For example, dynamic ATIM Window, save the energy by reducing transmission power consumption. In this paper, we present an algorithm to realize the power saving as illustrated in Fig 4.

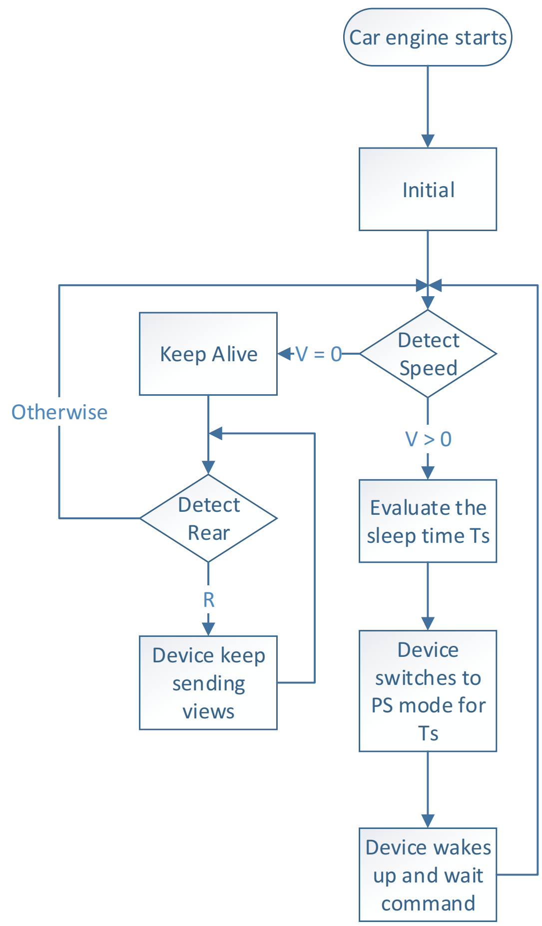

Fig. 4. Dynamic Power Saving Algorithm

According to the algorithm, the application is initialized at the beginning when the car engine has been started. After initialization, the first step is to detect the current speed of the moving car, if the speed is higher than zero, then evaluate the sleep time T_S as following equation 1.

$$T_S = T_B + T_G + T_D + T_F \quad (1)$$

Where T_S is the sleep time of the device; T_B is the time needed for braking the car smoothly; T_G is the time taken switching the shift lever; T_D is the delay time in transmission and T_F is time need for optimizing with speed. T_B is calculated by following equation 2.

$$T_B = \frac{V}{\alpha} \quad (2)$$

Where V is the speed of the car in the unit , and is the brake acceleration. According to the results in [7], if the brake acceleration is under 0.39G (Gravitational acceleration), and the driver would not feel uncomfortable during braking. Therefore, we choose $\alpha =$ 0.4G and we choose second as unit in T_B. Second step of the flow is to evaluate the time T_S, and then the Wi-Fi interface of device would be turned off for T_S period. Until the end of duration, the device wake up then enter into the process again. If the speed is equal to zero then keep the Wi-Fi interface alive to detect the rear state. When switch to the reverse rear, the device starts to send the image of rear view to the center control system and keep sending until the reversing is completed.

V. SIMULATION RESULTS

To evaluate power consumption of the proposed method, we calculated the energy consumption of Wi-Fi interface according to the model in [2] [6]. For example, for an ORiNOCO IEEE 802.11b PC Gold Card, it has three kinds of active mode which are transmit, receive, and monitor packets, and the power consumption of each mode is 1400 mW, 950 mW and 805 mW, respectively. When the card change to power saving mode, the power consumption can be reduced to 60 mW. The power consumption can be formed in TABLE I.

TABLE I.
POWER CONSUMPTION OF THE ORINOCO PC GOLD CARD

Mode	Status	Power Consumption
Active	Transmit	1400mW
	Receive	950mW
	Monitor	805mW
Power Saving	Sleep	60mW

In Active Mode, the Wi-Fi interface works at the full speed and consumes more than in other mode. In Power Save Mode, the Wi-Fi interface is turned off and consume less power consumption. In Dynamic Power Saving as shown in Fig 5, device consumes less energy with increasing speed.

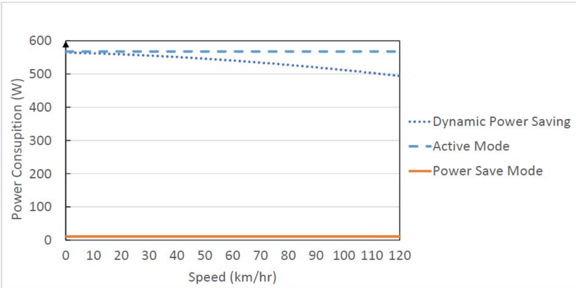

Fig. 5. Power Consumption vs. Speed, $T_F = \frac{V^2}{1000}$

The comparison of three modes is shown in Fig 5, we suppose $T_F = \frac{V^2}{1000}$ and find that the power consumption of device decreased a little with increasing speed. It verified that energy consumption can be reduced by the algorithm and shown in the TABLE II. The power consumption of device is proportional to speed.

TABLE II.
COMPARISON OF POWER CONSUMPTION, $T_F = \frac{V^2}{1000}$

V (*km/hr*)	0	40	80	120
Dynamic Power Saving (*W*)	564.8	551.0	527.5	494.0
Active Mode (*W*)	567.9	567.9	567.9	567.9
Reduced Energy (%)	0.55%	2.96%	7.12%	13.03%

Besides that, we suppose $T_F = \frac{V^{\frac{5}{2}}}{1000}$ and the result is shown in Fig 6.

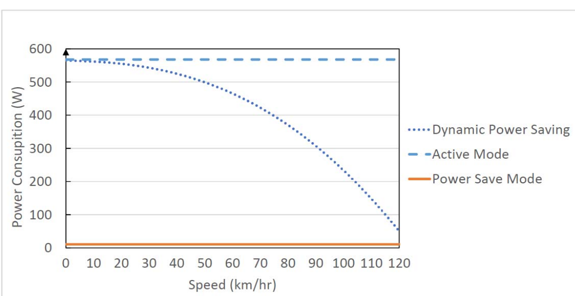

Fig. 6. Power Consumption vs. Speed, $T_F = \frac{V^{\frac{5}{2}}}{1000}$

Fig 6 shows that the energy consumption of device is significantly deceased with rising speed. The reduced energy of device is shown in percentage as in TABLE III, when V is equal to zero, the reduced energy is 0.55%. When V speeds up to 40*km⊲hr*, the reduced energy is 7.61%. When V speeds up double than last, the reduce energy is coming to 34.83%. Finally, we can see that when the speed increase to 120*km/hr*, it realized highly energy efficient in Dynamic Power Saving.

TABLE III.
COMPARISON OF POWER CONSUMPTION, $T_F = \frac{V^{\frac{5}{2}}}{1000}$

V (*km/hr*)	0	40	80	120
Dynamic Power Saving (*W*)	564.8	524.7	370.1	50.3
Active Mode (*W*)	567.9	567.9	567.9	567.9
Reduced Energy (%)	0.55%	7.61%	34.83%	91.15%

VI. Conclusion & Future Work

According to the simulation result, the proposed method save more power with increasing speed. In this paper, the main parameter is T_F that make the power consumption much more reduced in our research. We will adapt the algorithm into the power save protocol [8] in the future that may reduce the energy reduce more efficiently.

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