

Power Line Communications을 이용한 IT/ET, IT/BT 컨버전스 기술에 관한 연구

Investigations on IT/ET and IT/BT Convergence Technology Using Power Line Communications

박미경, 허영, 오상기

한국전기연구원, 융합기술연구단, 생체전자센서전문연구팀

Mikyoung Park, Young Huh, Sang Ki Oh

Electro-Bio Sensor Lab. Korea Electrotechnology Research Institute

Abstract - Due to enhanced high IT (information technology) development, IT-based technology convergences such as IT/ET(electric technology), IT/BT(biology technology) and IT/NT(nano technology) are actively merging trend and their applications spread wide. In this paper PLC (power line communication), one of the merging IT, is investigated as one of the potential IT candidates for IT/ET and IT/BT convergence technology for DLC (direct load control) or bio-medical engineering such as ubiquitous health cares or D2H2 (distributed diagnosis and home health care).

Key Words : PLC, IT/ET, IT/BT convergence technology

1. Introduction

The advantage of PLC is no necessity of additional lines of communications as the power or utility lines are used as it is. Several companies from USA, Spain and Korea have developed PLC technology with a speed of 20Mbps and are going for 200Mbps. In the case of DLC applications^{[1][2]}, communication speed of 20Mbps can be fast enough for controlling some of the home appliances, whereas others such as audio and video equipments need much higher communication speed. For D2H2 applications PLC technology with higher speed is required to get more data at a time without losing any informations from patients.^[3] are away from hospitals or doctors.

2. IT and ET Convergence technology

2.1 PLC and DLC

DLC is introduced by the utility to control the load of the customer's demand directly depending on the power balances of the supply and demand. Recent high IT and computer system technology let the direct load control possible even for the equipments which need fast responses.

2.2 DLC system configuration

The basic structure for the DLC is shown in figure 1. It includes an EMS (energy management system) control center in the supply side (for instance. KPX in Korea), a load management center, load service entries and customers.

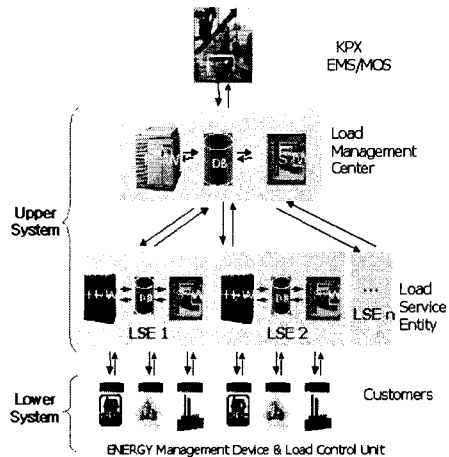


Figure. 1 Basic structure for direct load control

Up to now the communications between the customers and the EMS center achieved based on power line carrier or optic cables. But recently PLC (power line communication) is introduced to monitor and control the power flowing through buses of the customers. Once the PLC technology is introduced actively in

저자 소개

- * 박미경 : 한국전기연구원 생체전자센서전문연구팀
- ** 허영 : 한국전기연구원 생체전자센서전문연구팀
- *** 오상기 : 한국전기연구원 R&DB 정책실

power industry applications a lot of advantages are expected such as remote meter reading and information collections of system voltage, current, power factor. This is one of the very promising areas for IT/ET convergence technology based on PLC.

3. IT and BT Convergence technology

3.1 PLC and Bio-medical engineering

Change in our dietary habit creates various health problems such as diabetes, heart disease and over weight. Hypertensives who are suffering from high blood pressure need continuous blood pressure monitoring at homes or hospitals. But due to cuffs wearing and man-power requirement it is not easy to monitor the patients on line. The possibility of a cuffless and non-invasive blood pressure measuring method is investigated for the potential IT/BT convergence technology development.

3.1.1 Generals

As the world becomes an aging society and the standard of living becomes higher, there is an increasing demand for long-term vital sign monitoring outside clinical settings, triggered by the need for achieving earlier and finer diagnosis as well as improved treatment of highly prevalent diseases. For that reason the number of accessible vital signs measured has to be broadened beyond electrocardiogram(ECG) or activity at maximum comfort for the patient^[4]. Blood pressure(BP) is one of the most important vital parameters. BP is a powerful, consistent, and independent risk factor for cardiovascular disease. According to the National Health And Nutrition Examination Survey, at least 65million adult Americans, or nearly one-third of the US adult population, have hypertension. Because of the importance of BP, continuous and noninvasive BP monitoring is needed.

3.1.2 Cuffless and non-invasive BP measurement

The conventional BP measurement using cuff is not appropriate for consistent patient care and monitoring because of the periodic cuff inflation and deflation. Recently, cuffless BP measurement techniques (based on pulse transit time^{[5][6]} and wavelet transform^[7]) have been studied. Although the techniques have a potential capacity for predicting BP, they have a couple of drawback: the techniques have to measure multi-points of the body to predict BP and therefore patients could feel uncomfortable. Also, the conventional techniques need both the ECG and the photoplethysmography (PPG) and consequently the accuracy of these techniques depends on that of two devices of ECG and PPG. Therefore, an improved technique which needs only one point of the body and one device is necessary. Therefore we developed a cuffless and noninvasive measurement technique of blood pressure using tonometric pressure sensor. With observation that the maximum value of a pulse pressure is not obtained at mean arterial pressure (MAP)^{[8][9]}, we have figured out MAP based on the physiological characteristic including the elasticity of wrist tissue, the depth of blood vessel.

Through an analysis of 198 clinic data, we have induced the regression equation (1) of the MAP.

$$MAP = 73.2 + 4.03 \times EC - 0.0078D + 0.169AP_w \quad (1)$$

The probability of the elasticity, depth and APM to explain MAP was 92.1%. The mean difference and the standard deviation between the MAP predicted from the regression equation and the MAP measured by commercial cuff type BP meter were -3.183 mmHg and 5.133mmHg respectively. Comparing the results with the American National Standard for Electronic or Automated Sphygmomanometers, we could conclude that the results are quite reliable and promising^[3].

Even though sensors and systems using PTT^{[5][6]}, PPG^[7] and physiological characteristics like elasticity of wrist tissue^[3] allow long-term and continuous BP monitoring, power consumption problem and wireless sensor network and home network construction problem still remain. One of the solutions to these problems is PLC.

3.2 Home network system configuration based on PLC

Figure. 2 depicts the convergence home network image, together with some information transferred through the network.

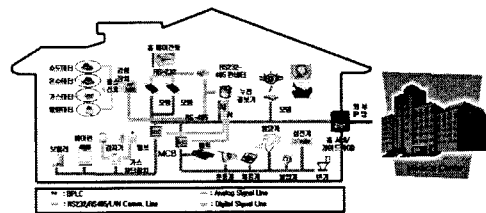


Figure. 2 Convergence home network image, together with several kinds of information

Vital signs like BP, heart rate, ECG, weight, body temperature and body movement should be measured everywhere in the house to do continuous health monitoring. After monitoring these vital signs, they should be transmitted to Medical Center.

Figure 3 shows one of the data forms for BP measurement. These data were obtained at radial artery by applying different five pressures on same spot.

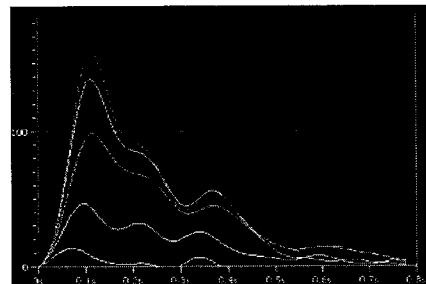


Figure. 3 Data form for BP measurement

Constructing totally new network to transmit vital signs needs an astronomical expenditure inducing medical services between cities and rural communities or developing countries and developed countries. The PLC technology with the advantage that it needs no additional lines of communications is a proper solution for home network.

The test bed diagram based on the BPLC(broad power line communication) for digital appliances and home health care is shown in Figure 4. This test bed comprises a variety of technologies including different wired and wireless technologies^{[10][11]}.

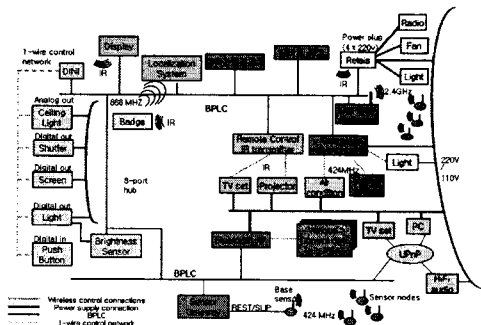


Figure. 4 Test Bed Diagram based on BPLC

IT/BT convergence technology base on PLC is expected to accelerate ubiquitous home health care.

4. Conclusion

The potential applications of PLC (power line communication) for IT/ET and IT/BT convergence technology have investigated. IT/ET convergence technology has a great potential as the technology development of the IT-installed electric-power equipment are aggressively progressed. IT/BT convergence technology is also believed to have a very high potential in the field of ubiquitous health care with the merging of high speed PLC and sensor technology. Both technology will contribute to enhance the living standards for industrially advanced countries and underdeveloped countries.

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