

devices by creating intelligent networks which have provided communication particularly by preferring wireless connections among each device and between larger systems.

In this paper, a low-cost intelligent energy measurement device (iDev) is aimed to design in order to compute and store electrical energy consumption into a database by an embedded card, namely Arduino which measures voltage, current, frequency and power factor as shown in Fig.1. When a traditional device is connected to the proposed iDev, the device turns into an intelligent device that is remotely controllable.

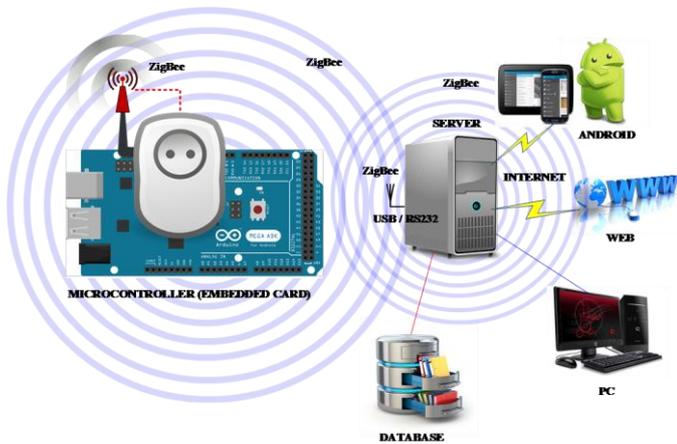


Fig.1. Schematic view of intelligent energy measurement device (iDev)

When previous studies are investigated, it is seen that wireless technologies are utilized in order to prevent new cable installation and labor costs. When compared to existing wireless technologies, because of security, low power consumption and, low cost, ZigBee / IEEE 802.15.4 wireless communication protocol has been preferred. ZigBee protocols can be used pair, star, mesh and other networking structures. Especially, mesh networking allows for reliable data transfer and it is flexibility in networking with multiple topologies. Data integrity verification and authentication are realized by using 128-bits AES (Advanced Encryption Standard) encryption algorithm at the MAC (Media Access Control) layer. ZigBee doesn't require any license for the wireless communication. Data which has 2.4 GHz ISM (Industrial Scientific Medical band) and 250 Kbps data transmission capacity can be moved between 10 meters and 70 meters. Devices which communicate with ZigBee protocol in latest emerging technologies can be communicated until approximately 42 km [5-8].

Today, the most widely used wireless communication protocol is Wi-Fi. When the ZigBee delay time compares with WI-FI delay time in lighting switch control, ZigBee has less delay time. ZigBee is about twice as fast [9].

Performances of sending and receiving data for selected embedded cards which communicate by 802.15.4 ZigBee protocol have been investigated [10]. Imote2, Mega, Telosb, Arduino, Waspnote, and Micaz boards have been examined in detail. The main goal of this study is to determine which board has the best performance. All boards have been tested with intensive data such as image and sound data. As a consequence of measurements, the communication delay time values shown in Fig.2 for a 100-byte packet. As illustrated in Fig.2, although

arduino and waspmote boards are faster than the others at in sending data, they are slower than the others at in reading data. While sending throughput values are 10 ms and 11 ms for Arduino and Waspnote, reading throughput values are 35 ms and 50 ms respectively. According to measured delay times, the best performance belongs to MicaZ.

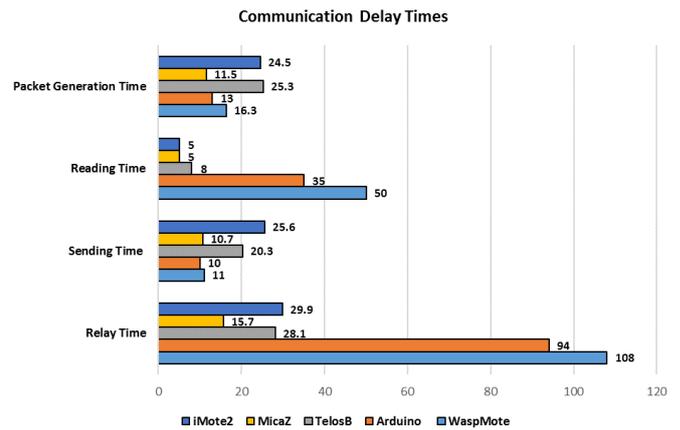


Fig.2. Communication delay times of some embedded cards [10]

When the previous studies are investigated, it is seen that the most used cards are Arduino and Raspberry Pi respectively in academic studies. In Turkey markets, almost all Arduino cards can be obtained easily. When Raspberry Pi compares with Arduino, it is second order. There are a lot of sample applications which are realized by using Arduino in literature. Because Arduino has many advantages, it has been chosen in this thesis.

II. PREPARE YOUR PAPER BEFORE STYLING

The main objective of iDev project is to develop a plug that can be controlled and monitored remotely. It is aimed to measure and record the consumed energy amount of single phase 220 V devices by developed iDev. In addition, it is aimed to control the plug by switching ON/OFF remotely. It is aimed to realize the remote monitoring and control of the plug by Windows, Web and Android based applications. Critical set values of measured values are determined and in case of exceeding these values, the energy connection of the devices are going to be automatically turned off. As a result of analyzing the recorded data, it is aimed the save energy by using energy more efficiently.

In this project, first of all, material selection is made in accordance to required properties for iDev. The implementation of material selection is done by following to perform accuracy tests of materials. It is targeted to measure voltage, current, frequency and $\cos \phi$ values while the iDev is designed. By these measured values, it is going to be possible to calculate the power consumption of the device which is plugged into the iDev. Furthermore, relay with the microcontroller is used to switching the power supply of plugged in device. The microcontroller plays a key role in the implementation of both control and monitoring functions.

Arduino microcontroller with the ATMEL microprocessor is chosen because of the ease of use, cost, and the amount of similar applications, availability from the market, and the wide range of sensors and other equipment that can be used with it.