The Utilization of Automatic Load Weighing Sensor to Improve the Accessibility of Drying Machine Based on Arduino Application System

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Abstract. Generally, drying can be done directly by utilizing exposure to solar energy radiation. However, this condition poses a risk to bacterial boards. This research experimented drying without utilizing solar energy, but instead using an electric heater as a power used. In order to increase the efficiency of energy use, the drying system will be carried out by adding an Automatic Load Weighing Sensor to increase the effectiveness of energy use. The results showed that the tool can reduce excess energy used in the drying process. Apart from that, the addition of this tool can also increase accessibility because the operator does not have to wait the drying process.

Keywords: solar energy; clothes dryer; thermal energy; heater.

1 Introduction

A data acquisition system is integrated with in-pavement sensors, such as strain gauge strip sensors, polymer piezoelectric sensors, quartz piezoelectric sensors, bend plates, and load cell plates, that are positioned beneath the road, in an embedded sensor system, also referred to as an in-pavement sensor system. Nonetheless, this system's electrical sensors have limitations due to their sensitivity to the environment, electromagnetic interference, short lifespans, and minor measurement errors [1].

The quality and freshness of food utilised in the food cooling or drying process are greatly influenced by temperature [2]. It appears that raising a machine's energy efficiency is necessary while using extremely high temperatures, or heat energy. In the agricultural, housing, and industrial sectors, where the heat energy needed in the drying process is largely utilised [3].
One element that influences how quickly the drying process happens is humidity. A system's humidity level has been lowered in a number of ways to hasten the drying process. Guan et al [4] indicated that desiccants can be utilised in both liquid and solid phases to improve energy efficiency and lower carbon emissions. Two types of desiccants are distinguishable: liquid and

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solid desiccants [5]. The most popular kind of desiccant for enhancing drying performance is solid [6].

Dryer dehumidification is a feasible method to produce air with low humidity values and determine the factors of dehumidification performance [7]. According to the type of dryer, air drying systems can be divided into liquid-based cooling systems and solid dryer-based cooling systems. Recently, tremendous efforts have been made by many researchers to develop desiccant dehumidification [4]. A desiccant can be used for air drying; dry air is defined as having minimal water vapour in it. To lower the amount of water vapour in the air, the amount of water vapour present must be reduced. The adsorption method of decreasing water vapour is an alternative that can be employed. Due to the fact that some adsorbent types have particular qualities and can only absorb particular substances, the type of desiccant employed in the adsorption process must be modified to the nature and condition of the substance being adsorbed [8]. Reduction of relative humidity can be done by using an adsorbent dehumidifer by passing air through a desiccant, then the desiccant will absorb the water vapor contained in the air, so the water vapor contained in the air will decrease [9].

By adding an automatic control system during the drying process and adjusting the desiccant positioning to speed up the drying process, this study will look at how well the drying cabinet performs. The parameter to determine the objective such as formulation and equation (1-6).

Moisture content (MC) can be expressed in drying clothes as the equation (1) [10][11][12]. Where m_w is wet weight, and md is weight after drying.

$$MC=\frac{m_w-m_d}{m_d} \tag{1}$$

The dehumidification performance can be expressed by [6];

$$\Delta\omega = \omega_{in} - \omega_{out} \tag{2}$$

Where $\Delta\omega$ stands for the transient dehumidification capacity, ω_{in} is the humidity ratio of the inlet air and ω_{out} is the humidity ratio of the outlet air, and the equation for the dehumidification efficiency (η_d) as followed;

$$\eta_d=\frac{\Delta\omega}{\omega_¿}\times 100\% \tag{3}$$

Where $\Delta\omega$ is the dehumidification capacity.

There are many strategies to determine machine performance, especially in dryers. Michael [13] believes that the main factors that determine the performance of electricity and dryers are solar radiation and photovoltaic modules. Morfi [14] wrote an equation to determine the drying rate as follows:

$$\dot{m}_d=\frac{m_w-m_d}{t} \tag{4}$$

Where $\dot{m}_d$ is the drying speed (kg/h), t is the drying process time, m_w and m_d are wet and dry clothes (kg), respectively. Furthermore, Amiebenomo [15] stated that the drying process is greatly affected by the temperature and humidity of the drying box. The performance index of the drying box is the specific dehumidification rate (SMER). SMER is the amount of water that can be evaporated from clothes when using electrical energy in one hour, or in other words, the energy required to evaporate 1 kg of water in units of kg/kWh [14]. SMER can reflect the relationship between the moisture removed and the amount of electricity consumed. Its unit is kWh/kg. It is defined as equation [16]:

$$SMER = \frac{\dot{m}_d}{W_{¿}} \tag{5}$$

It indicates the energy consumption required to remove each kilogram of water from the load. This can be expressed as an equation [17]:

$$SEC = \frac{1}{SMER} \tag{6}$$

2 Method

Arduino has been widely used to facilitate work in a variety of applications. A number of developed applications are shown in Figure 1. In this study, the drying cabinet's electrical system will be managed using Arduino. The research data recording and automated switch systems are part of the control system.

Fig. 1. Some Arduino applications [18]

Design of electronic control system using Arduino as shown in Figure 2. Where the sensors that used are weighing scale sensor, temperature sensor, and air humidity sensor. This control system is used to turn on and off the drying cabinet automatically based on the drying mass and temperature of the drying cabinet room.

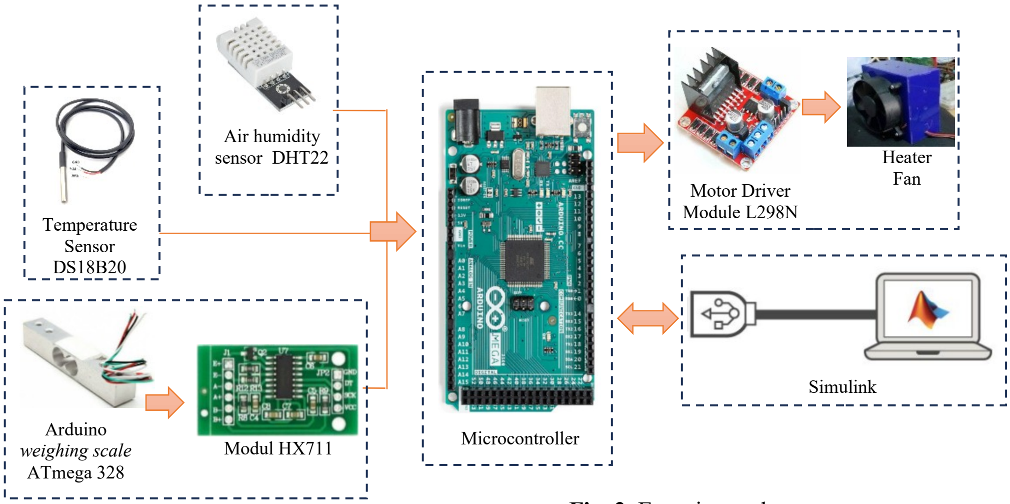

Fig. 2. Experimental set-up

3 Result and Discussion

The results of drying time are shown in **Figure 3.** as the difference number of drying process with and without desiccant. The experiment was completed in 32 minutes and automatic load weighing sensor stopped the machine just in time while the drying process achieved. The benefits of using an automatic control system can be felt when the energy usage that needed accordance to the clothes drying process. According to Kondaveeti, et al. [18], the benefits of using Arduino can be used in various life applications, especially in the drying machine box as used in this study. It is preferable to grow over 40.62 percent and avoid using a desiccant until 45 minutes have passed, such as when the volume of adsorbed water vapour reaches 22% [19]. The drying speed rate reached to 0.00125 kg/h. The drying process proceeds slowly untill the dry clothing reach the desired temperature. The moisture content is greatly decreased since there is less water in the raw material than there is in the dry matter [20].

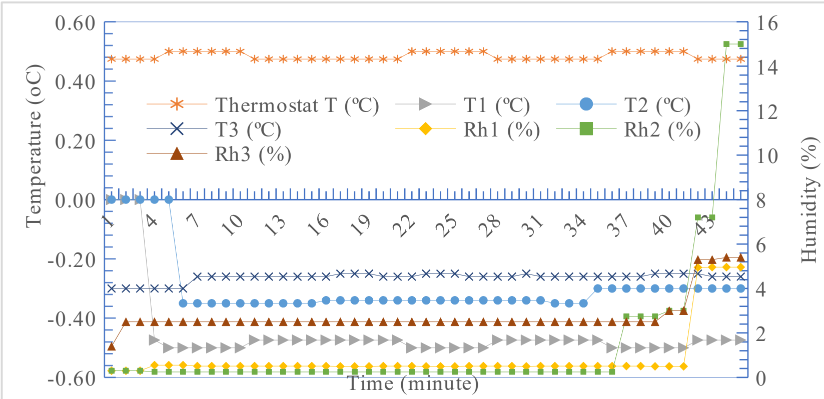

Fig. 3. Time of drying rate.

This study presents drying outcomes using the fan heater's constant air velocity. The drying chamber's air temperature and humidity, drying rate, drying efficiency, SMER, and SEC are the energy-use characteristics that are monitored. With SMER, the performance of the box dryer was examined. The amount of energy used to effectively remove moisture from dry textiles can be used to illustrate this. On the other hand, SEC is computed to ascertain the product's energy usage. Furthermore, the SMER and SEC values are 264 kWh/kg and 0.003788 kg/kWh, respectively. The drying chamber's average air temperature is 44.16°C, and its average air humidity is 31.37%. A high SMER value will lower the amount of energy needed to complete the drying process. As the drying time increases, the air temperature will rise. The air becomes relatively dry throughout this period as the humidity progressively drops. This results in a higher drying rate, which expedites the drying of clothing.

4 Conclusion

Desiccant is used in the drying process to dry 0.22 kg of clothing in 32 minutes and the machine automatically stopped by using automatic load weighing sensor. The quantity of moisture in the garments and the drying period determine how rapidly they dry. Low SEC and high SMER can be achieved with reduced energy use and a high drying speed. Increased heat transfer rates during drying are indicated by greater air temperatures. A variation in the concentration of water vapour throughout the drying process is indicated by a drop in air humidity. Steam concentrations might allow moisture to seep out of clothing.

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