A Tea Brewing Service Device with the Added Value of Increasing Tea Drinking Quality in Our Leisure Life

Sung-Tsun Shih[1], Chin-Ming Hsu[2], Chian-Yi Chao[3]

[1]Department of Electronic Engineering, Cheng Shiu University, Kaohsiung, Taiwan
[2]Department of Information Technology, Kao Yuan University, Kaohsiung, Taiwan
[3]Department of Electronic Engineering, Kao Yuan University, Kaohsiung, Taiwan
stshih@csu.edu.tw

Abstract: This study proposes a loose-leaf tea brewing service device with the added value of increasing tea drinking quality in our leisure life. The proposed device with multi-infusion timing control and user friendly interface characteristics utilizes AT89S51 programmable microcontroller to detect the input signals and trigger the corresponding outputs. The input signals come from a power switch for turning the controller on/off, three push buttons for setting the brewing time, and two other push buttons for controlling initial/extra brewing time setting and start/stop time control. The corresponding outputs include a power LED for indicating whether the controller is working or nonworking, a buzzer for reminding the completion of timing, and three 7-segment displays for showing the remaining time. Conclusively, the proposed microcontroller-based tea brewing service device can remind users remembering pour the water out timely, allow users to reset brewing time based on personal favorite tastes, and allow users to make the second or third rounds of tea infusion time for each individual setting. Therefore, the tea taste quality can be guaranteed.

[Sung-Tsun Shih, Chin-Ming Hsu, Chian-Yi Chao. **A Tea Brewing Service Device with the Added Value of Increasing Tea Drinking Quality in Our Leisure Life.** Life Science Journal. 2011; 8(4):923-928] (ISSN:1097-8135). http://www.lifesciencesite.com.

Keywords: Leisure life quality, loose leaf tea, infusion, timing controller, and microcontroller.

1. Introduction

With the increased life expectancy and the developed technology, diet and health are intrinsically linked for healthier aging based on a scientific understanding of the health benefits related to the diet. Tea, a non-alcoholic caffeine-containing beverage, has replaced high-calorie beverages and is one of the most popular beverages in the world. Nowadays, it is widely cultivated in China, England, India, Indonesia, Japan, Korea, Taiwan, et al. According to the literatures stated by Lian and Astill [1] and Hamer [2], drinking tea can provide many beneficial effects, such as relieving thirsty, maintaining clear mind, keeping clear vision, enhancing judgment ability, eliminating toxins, helping digestion, and prolonging the life. Some scientific evidences proved that tea leaves has catechins and flavonoids dietary resources and can against coronary heart disease [3-4]. In addition, Epidemiologic and experimental studies have shown that tea leaves have protective effects on chemically induced tumors in rats' gastrointestinal tract, liver, and mammary epithelium [5-6]. Ramos [7], Doss et al. [8], and Marchand [9] have proved that tea catechins and flavonoids can reduce the risk of chronic diseases, such as lung cancer, breast cancer and prostate cancer, and can provide health benefits on immune function with potential resistance against infections.

Commonly, there are three main types of teas, Oolong (half fermented), Green (not fermented), and Black (entire fermented) teas, consumed in the world and two kinds of tea packages, in bags or in loose leaf forms, sold in the markets. Tea in teabags usually referred to as "dust" does not consist of leaves and is generally made from low quality leaf. The bagged tea gives users the advantage of a quick cup of tea but loses its flavor quickly. Because of its fine siftings, bagged tea produces the infusion with more caffeine than loose leaf tea; and brewing bagged tea is cloudier and far more quickly than brewing loose leaf tea. In addition, Peterson et al. [10] stated that tea variety, weight of tea, and brewing techniques all affect estimates of flavonoids intake. Malinowska et al. [6] also found that brewing time (5, 10 and 30 min) does increase the fluoride content and most of the antimutagenic components were released from teas within 1–2 min of brewing. Under the identical brewing condition, green tea is significantly more effective than black tea for their anti-oxidant properties. Hicks et al. [11] indicated that the overall average caffeine released in the first through third tea brews were 69%, 23%, and 8%, respectively. The literature on the website [12] stated that tea brewing time and temperature affect their taste and smell; the tea quantity and the immersion time are generally in reverse proportion. Moreover, teas are better when infused 2-3 times; if the water is too hot, it will "cook" the leaves and make the tea taste bitter.

Conclusively, as stated by Heinrich and Prieto [13], a mentally and physically healthy ageing will require us to look at the dietary habits and how this impacts on health, to integrate this knowledge and to apply it in all sectors of food production and preparation.

Several references [14-19] have discussed the influences and effects of tea drinking based on the tea types and different preparing methods. Keenan et al. [14] discussed the L-theanine contained in cups of tea, such as green tea and black tea, and the effects of various preparation factors on the amounts of L-theanine extracted. The preparation factors include water temperature, brewing time, and materials added like sugar or milk. The research found that brewing time was found to be a major determinant of the amount of L-theanine extracted, while the addition of small amounts of milk and sugar made no significant difference. Moreover, a standard (200 ml) cup of black tea was found to contain the most L-theanine (24.2 ± 5.7 mg) while a cup of green tea contained the least (7.9 ± 3.8 mg). In the El-lethey and Shaheed [15] experimental report, it stated that drinking black tea definitely has a beneficial influence in impeding Na-F-induced reproductive toxicity in rats. Karak and Bhagat [16] traced elements in tea leaves, made tea and tea infusion. The trace elements in different tea infusions are such as aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), fluoride (F) manganese (Mn), and nickel (Ni). The experimental results showed that the presence of trace elements in green tea is lower than the black tea in most cases. Komes et al. [17] investigated the effect of different extraction conditions and storage time of prepared infusions on the content of bioactive compounds of green teas. The findings of this investigation suggest that maximum extraction efficiency of studied bioactive compounds from green tea is achieved during aqueous extraction at 80℃, for 50′ (powder), 15′ (bagged) and 30′ (loose leaf). Moreover, Suteerapataranon et al. [18] discussed the Caffeine in Chiang Rai tea infusions based on the considerations of tea variety, type, leaf form, and infusion conditions. Caffeine in Chiang Rai tea infusions was found to be dependent on infusion conditions (water temperature and infusion time), and leaf form but independent to different tea types. For tea leaf samples, the higher the water temperature and the longer the infusion time, the higher the caffeine concentrations in tea infusions. Lin, Liu, and Mau [19] investigated the effects of different brewing methods on antioxidant properties of steaming green tea. The extracts were prepared from cold or hot brewed steaming green tea at different concentrations (2, 6, and 10%). The experimental results showed that the hot water extracts were significantly more effective than the cold water extracts in antioxidant activity.

By examining current tea brewing techniques, two main disadvantages exist: (1) tea brewing depends on personal experience to make a pot of tea; therefore, the tea quality is unguaranteed. (2) the existing alarm for tea brewing time control only can be set once for each individual setting and there is no human friendly device specifically used for loose tea brewing service. In order to achieve the wishes in demanding good tea quality and keeping the body and life in good health and joyfulness, people nowadays would drink a pot of good tea while at works, self meditation, or chatting with friends. Therefore, this paper aims to build a multi-infusion timing controller used for loose leaf tea brewing service. The proposed microcontroller-based tea brewing service device can remind users remembering pour the water out timely and allow users to make three rounds of tea infusion time for each individual setting. In the following, Section 2 describes loose leaf tea brewing controller. The experimental results are shown in Section 3. Finally, the conclusions and future works are summarized in Section 4.

2. Loose Leaf Tea Brewing Controller

A multi-infusion timing controller with user friendly interface for loose-leaf tea brewing service consists of two parts: designing hardware control circuitry and programming software control codes. The hardware control circuitry includes an AT89S51 microcontroller, five push buttons, and three 7-segment displays, which provides the advantages of small size, easy use, good extendibility, and low cost. The software control codes are programmed and downloaded into the AT89S51 chip to control the hardware circuitry. The following describes their detail functions and design methodologies.

2.1. Hardware Control Circuitry

Figure 1(a) shows AT89S51 pin functions. Figure 1(b) is the fundamental circuitry connections for activating an AT89S51 chip. Figure 1(c) gives the block diagram of loose-leaf tea brewing controller. As shown in Figure 1(a), an AT89S51 with total 40-pins has four 8-pin I/O ports named P0, P1, P2, and P3. As shown in Figure 1(b), there are four parts of basic circuitry connections to activate AT8951 single chip: (1) connecting the 20th pin to ground and the 40th pin to power +5 Volts; (2) connecting the 31th pin to power +5 Volts; (3) resetting circuitry (pin 9); and (4) oscillating circuitry (pin 18 and 19). As shown in Figure 1(c), three I/O ports, P0, P1, and P3, are connected to three 7 segments for displaying the remaining time; P2 is connected to a buzzer (P2.0) for reminding the completion of timing; three push buttons are used for time setting (P2.1 for minute

digit, P2.2 and P2.3 for second digits) ; one push button (P2.4) is used for controlling extra infusion time setting; another push button (P2.5) is used for controlling start/stop timing process.

2.2. Software Control Codes

Figure 2 shows the flow chart of the software control codes. The main functions of the software control codes include:

- Setting parameters: P0 and P1 are used for displaying second digits and P3 is used for displaying minute digit. P2.0 controls buzzer; P2.1, P2.2, and P2.3 control the time setting of three digits; P2.4 controls the extra infusion time setting; P2.5 controls start/stop timing processes.

- Setting infusion time: three 7-segments displays one increment whenever P2.1, P2.2, P2.3 push buttons are pushed, respectively.

- If P2.4 is trigged, the timing controller starts counting down. When it counts to zero, the buzzer sounds. If P2.5 is triggered, the buzzer shut off and the controller resets to the initial time setting in which the initial time setting is stored in the memory for the next brewing process.

The following is the procedures of brewing loose leaf tea in a teapot.

Step 1: Power on the timing controller and set the initial brewing time *Ti* and extra infusion time *Te*.
Step 2: Add loose leaf tea in the tea pot.
Step 3: Fill the teapot with hot brewing water.
Step 4: Cover the teapot and let the tea be steeped
Step 5: Start tea infusion by push the start/stop button of the timing controller.
Step 6: When buzzer sounds, stop tea infusion by pushing the start/stop button of the timing controller.
Step 7: Pour the brewed tea into your teacup through a strainer to filter out any tea leaves.
Step 8: If your brew is particularly strong, you may try a second or even a third infusion by repeating step 3 to step 7 processes.

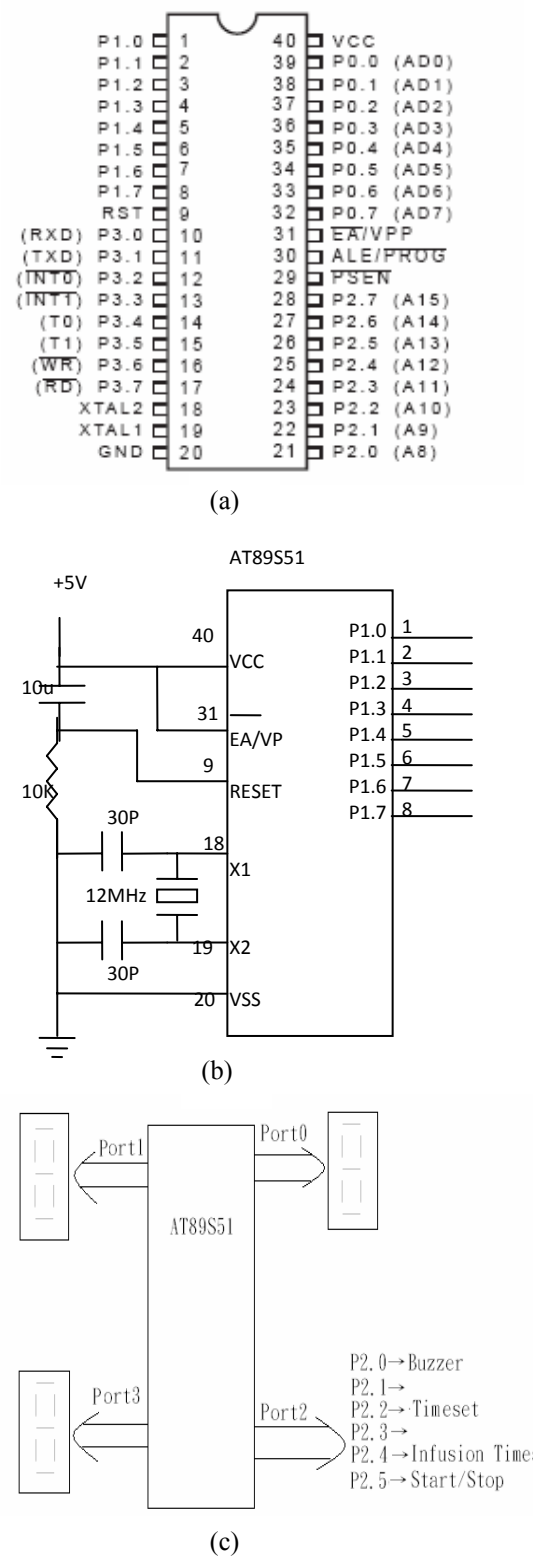


Figure 1. (a) AT89S51 pin functions; (b) basic activating circuitry connections; (c) block diagram of loose leaf tea brewing controller.

3. Experimental Results

Table 1 shows the investigation of people's favorites on oolong, green, and black loose leaf teas. From Table 1, teenagers usually don't drink loose leaf teas; about 50% of 50 people at 15-30 years old would drink black tea and green tea. For the people at the age between 31 and 50 years old, 60% of 50 people would like to drink green tea and 40% of them would like to have oolong tea. As for the people at the age from 51 to 65 years old, 20% of 50 people would choose green tea and 80% of them would choose oolong tea. Table 2 gives the recommended brewing time for oolong, green, and black loose-leaf teas.

The experiments use 12 ounce teapot and 4 ounce of tea weight. From Table 2, the first infusion time is one and half minutes, one minute, and forty seconds for black, green, and oolong teas, respectively. For the second infusion time, it takes extra 15 seconds for all three types of tea and 20 more seconds for the third infusion time. In addition, according to the experiments on teas' brewing time, we can conclude that brewing the tea for too long will "stew" the tea and produce a bitter brew. Fig. 3 illustrates the timing controller using (a) 40-pins and (b) 20-pins AT8951, respectively. The main difference of two devices is on the hardware structure. As shown in Figure 3(a), five push buttons are used for time setting and system start/stop controls whereas Figure 3(b) uses two push buttons because 20-oin AT8951 only has 3 I/O ports. Since 40-pins 89S51 has 4 I/O ports, the proposed timing controller uses three 8-pins I/O ports to control three 7-segment displays instead of using three more 7447 IC for 7-segment displays' decoding.

Table 1. Investigation of different people's favorites on oolong, green, and black loose leaf teas

Teas Ages(yrs. old)	Black Tea	Green Tea	Oolong Tea
under 15	rare	rare	
15-30	50%	50%	
31-50		60%	40%
51-65		20%	80%

Table 2. Recommended brewing time for oolong, green, and black loose leaf teas

Brewing Time Rounds	Black Tea	Green Tea	Oolong Tea
Initial	1-2min.	1 min.	40 sec.
Second (Extra)	10 sec.	10 sec.	10 sec.
Third (Extra)	15 sec.	15 sec.	15 sec.

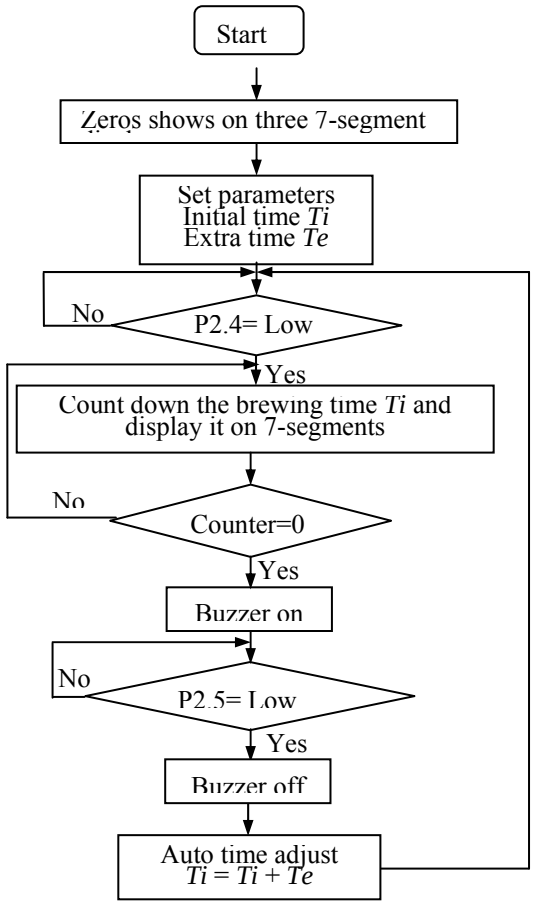
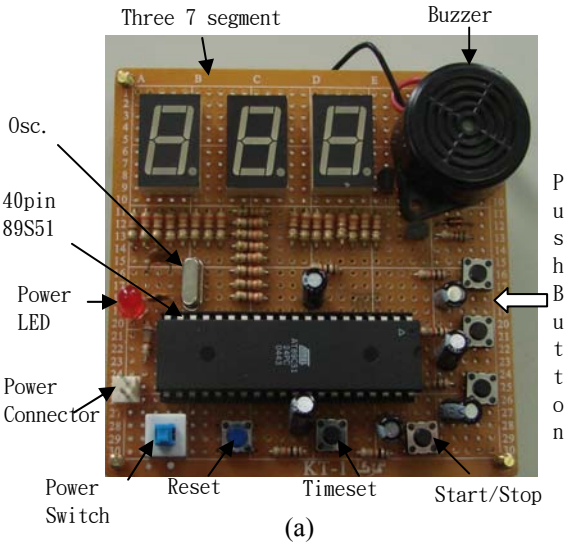


Figure 2. Flow chart of the software control codes.



(a)

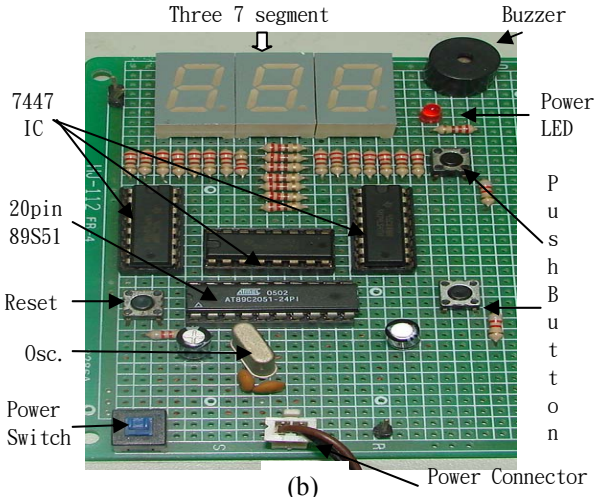


Figure 3. Timing controller using (a) 40-pins and (b) 20-pins AT8951.

4. Conclusions and Discussions

In order to satisfy people's demanding on good tea drinking quality and keeping the body and life in good health and joyfulness, this paper proposes a multi-infusion timing controller with user friendly interface for loose-leaf tea brewing service. The proposed device provides three advantages: (1) Users are allowed to adjust the brewing time and multi-round of infusion time based on personal favorite tastes. Therefore, tea quality is ensured. (2) The proposed timing controller provides user friendly hardware interfaces with the capabilities of indicating whether the controller is working or nonworking (the power LED), displaying the remaining time(three 7-segments), and reminding users to pour the brewed tea into the teacup through a strainer to filter out any tea leaves timely (the buzzer). (3) Because of its simplicity and applicability, people with fundamental microcontroller knowledge are capable of building such device with low expenses. In addition, users can refer to the authors' previous research [20] with the basic knowledge of microcontroller system designing and debugging techniques and try to built the device by selves.

Nowadays, people would drink a pot of good tea while at works, self meditation, or chatting with friends in their leisure time. Therefore, the proposed tea service device can be embedded in a tea table or a tea plate and can be developed as a consumer product in advance.

Corresponding Author:
Dr. Sung-Tsun Shih
Department of Electronic Engineering,
Cheng Shiu University,
Kaohsiung , Taiwan, R.O.C.
E-mail: stshih@csu.edu.tw

References

1 G. Lian, C. Astill. Computer Simulation of the Hydrodynamics of Teabag Infusion. Food and Bioproducts Processing. 2002; 80 (3): 155-162.

2 M. Hamer. The Beneficial Effects of Tea on Immune Function and Inflammation: A Review of Evidence from in Vitro, Animal, and Human Research. Nutrition Research. 2007; 27 (7): 373-379.

3 H. Wang, K. Helliwell. Epimerisation of Catechins in Green Tea Infusions. Food Chemistry. 2000; 70 (3): 337-344.

4 Y. J., Moon, X. Wang, M. E. Morris. Dietary flavonoids: Effects on Xenobiotic and Carcinogen Metabolism. Toxicology in Vitro. 2006; 20 (2): 187-210.

5 J. F. Hernaez, M. Xu, R. H. Dashwood. Antimutagenic Activity of Tea towards 2-Hydroxyamino-3-Methylimidazo Quinoline: Effect of Tea Concentration and Brew Time on Electrophile Scavenging. Mutation Research/ Fundamental and Molecular Mechanisms of Mutagenesis. 1998; 402 (1-2): 299-306.

6 E. Malinowska, I. Inkielewicz, W. Czarnowski, P. Szefer. Assessment of Fluoride Concentration and Daily Intake by Human from Tea and Herbal Infusions. Food and Chemical Toxicology. 2008; 46 (3): 1055-1061.

7 S. Ramos. Effects of Dietary Flavonoids on Apoptotic Pathways Related to Cancer Chemoprevention. The Journal of Nutritional Biochemistry. 2007; 18 (7): 427-442.

8 M. X. Doss, S. P. Potta, J. Hescheler, A. Sachinidis. Trapping of Growth Factors by Catechins: a Possible Therapeutical Target for Prevention of Proliferative Diseases. Journal of Nutritional Biochemistry. 2005; 16 (5): 259-266.

9 L. Le Marchand. Cancer Preventive Effects of Flavonoids — A Review. Biomedicine and Pharmacotherapy. 2002; 56 (6): 296-301.

10 J. Peterson, P. Jacques, W. Rand, K. Chui. Tea Variety and Brewing Techniques Influence Flavonoid Content of Black Tea. The Journal of Food Composition and Analysis. 2004; 17 (3-4): 397-405.

11 M. B. Hicks, Y. H. Hsieh, L. N. Bell. Tea Preparation and Its Influence on Methylxanthine Concentration. Food Research International. 1996; 29 (3-4): 325-330.

12 How to Brew Loose Leaf Teas? http://www.agapetea.com/about_brewingloseleaftea.php.

13 M. Heinrich, J. M. Prieto. Diet and healthy ageing 2100: Will we globalise local knowledge systems? Ageing Research Reviews. 2008; 7 (3): 249-274.

14 E. K. Keenan, M. D. A. Finnie, P. S. Jones, P. J. Rogers, C. M. Priestley. How Much Theanine in a Cup of Tea? Effects of Tea Type and Method of Preparation. Food Chemistry. 2011; 125 (2): 588-594.

15 H. S. El-lethey, I. B. Shaheed. Potential Health Impact of Black Tea against Na-F-Induced Alterations in Territorial Aggression, Sexual Behaviour and Fertility of Male Rats. Life Science Journal, 2011; 8(2):882-839.

16 T. Karak, R.M. Bhagat. Trace Elements in Tea Leaves, Made Tea and Tea Infusion: A review. Food Research International. 2010; 43 (9): 2234-2252.

17 D. Komes, D. Horžić, A. Belščak, K. K. Ganić, I. Vulić. Green Tea Preparation and Its Influence on the Content of Bioactive Compounds. Food Research International. 2010; 43 (1): 167-176.

18 S. Suteerapataranon, J. Butsoongnern, P. Punturat, W. Jorpalit, C. Thanomsilp. Caffeine in Chiang Rai Tea Infusions: Effects of Tea Variety, Type, Leaf Form, and Infusion Conditions. Food Chemistry. 2009; 114 (4): 1335-1338.

19 S.- D. Lin, E.-H. Liu, J.-L. Mau. Effect of Different Brewing Methods on Antioxidant Properties of Steaming Green Tea. Food Science and Technology. 2008; 41 (9): 1616-1623.

20 C. M. Hsu, H. M. Chao. Constructing Microcontroller Teaching Tool with the Integration of Hardware and Software Technology. Proceedings of International Conference on New Trends in Information and Service Science. 2009; 269-276. .

12/28/2011