Software Design for Portable near Infrared Spectrometer based on Android System

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Abstract: A new smart-phone application (APP) based on Android platform and portable near infrared spectrometer (NIRS) was designed for detecting contents of some substances in foods, such as sugar, carbohydrates, fat, calorie, etc. The APP communicates with the NIRS through Bluetooth technology, which could realize manipulation of the spectrometer by the APP. When the NIRS irradiates food samples, the samples will selectively release or receive the light at different frequencies, and the final reflected or transmitted spectrum carries rich information of the internal composition and structure of substances. After completing a scanning process, the APP will get the spectral data information through API provided by the spectrometer manufacturer. Then the APP will automatically send data to the server for further processing, and the client will receive relevant results about 5 seconds later. Different models were built on the server for different detection objects. In the process of modeling, a large number of experimental sample data were used to train models to improve the reliability of the models. Finally, Quantitative or qualitative detection of some substances in a variety of foods was achieved by optimizing algorithms. Compared with traditional detection methods, this system has many benefits, such as it is portable, non-destructive and has the advantages of rapid detection and reliable results. More significantly, it is very wide for the range of foods that can be detected.

1. Background and Purpose

Frequent food safety problems have caused widespread concern. Food safety is directly related to the health and life safety of the masses, however, food safety incidents have occurred frequently around the world in recent years, such as baby milk scandal, industrial gelatin, problem steamed bread and so on. This endless phenomenon can be concluded into two reasons, one is the regulatory mechanism is not suitable, the other is the problems in detection means.

Traditional food detection methods include chemical analysis, chromatography and spectrometry. The first two kinds of methods are sensitive and accurate, but they are not suitable for on-site test because they have shortcomings of complex of pre-treatment, time-consumption and needing professional skills. Spectral technology, especially near infrared spectroscopy, has been greatly developed because of its advantages of high detection efficiency and accuracy. There are many studies on near infrared spectroscopy for detecting target substances. For example, Talens etc. used near-infrared spectroscopy to achieve the sweet and non-sweet taste discrimination of nectarines. Ferrer-Galego etc. used near-infrared spectroscopy to evaluate sensory parameters of grapes and so on. These examples indicated the usefulness of near infrared spectroscopy. However, traditional near infrared spectrometer is big, expensive and not portable.

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2. Concept and Idea

In order to overcome the shortcomings of the traditional methods, a new smart-phone application (APP) based on Android platform and portable near infrared spectrometer (NIRS) was designed for detecting contents of some substances in foods. The system has the characteristics of low cost, low power consumption, high performance, miniaturization and specialization. To our knowledge, there are few studies in the near infrared spectroscopy system based on smart-phone platform at home and abroad. The existing system also has the defect of single detection target, which cannot give full play to the advantages of near infrared spectroscopy technology. After a lot of experiments and algorithm optimization, the system was successfully designed to make up for the shortage of the existing systems.

technology and the API provided by spectrometer manufacturer to realize the acquisition of spectral data. All known, mobile phone processor performance limited, so all the spectral data storing and processing is on cloud server. Different models are built on the server for different detection objects. The data modeling flowchart is shown in Fig.2. Firstly, spectral data should be pretreated, which includes smoothing filtering and normalization etc. Then some algorithms are used to build models including PLS, LDA, KNN and so on. The optimal model will be selected for prediction. For example, apple soluble solids content was taken as the research object, seen from the Fig.3, when using PLS as the modeling method, LMS and SG as the preprocessing ways, the obtained result is the best (R=0.943), which indicates the reliability of the model.

Fig.1 Schematic diagram of the detection system.

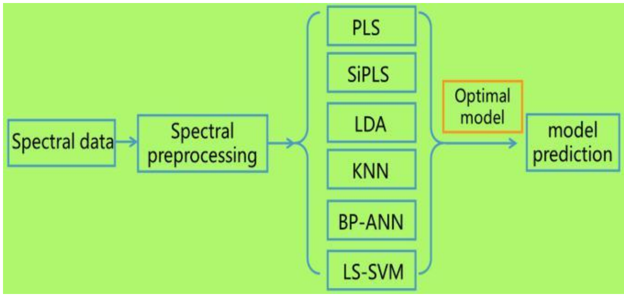

Fig.2 The modeling flowchart of the system.

Modeling method	preprocessing	Calibration		Prediction	
		R_c	RMSEC	R_p	RMSEP
PLS	RAW	0.936 3	0.597 2	0.812 2	0.921 7
	SGF	0.940 2	0.578 9	0.812 6	0.920 6
	SNV	0.876 0	0.804 5	0.800 5	0.875 6
	SLS	0.897 7	0.738 5	0.800 9	1.061 6
	SG	0.936 0	0.426 2	0.850 5	0.961 9
	LMS	0.931 2	0.619 5	0.841 3	0.825 7
	DT	0.925 4	0.615 5	0.857 0	0.942 7
	LMS+DT	0.929 9	0.615 4	0.872 9	0.848 9
	LMS+SG	0.931 1	0.441 0	0.880 2	0.531 0

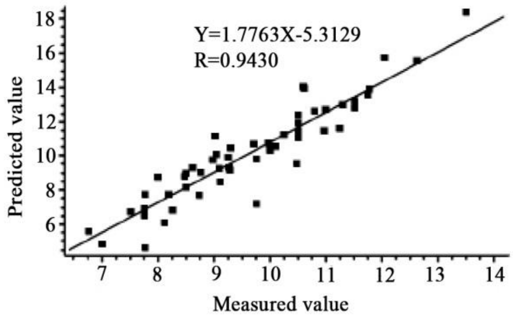

Fig.3 Correction and prediction results of apple model with different treatment methods.

3. Design and Functions

The software is based on the Android platform. The realization of the function of the system is divided into three parts: Bluetooth communication, client-server communication and data processing and modeling. The system uses Bluetooth

4. Problems and Future Work

At present, there are two problems in the system: poor graphical interface and not enough models. In future work, we will further optimize the graphical interface and build more data models to expand the scope of its detection objects.