Developing Simple Tools for Measuring and Evaluating Students' Works with a Smartphone

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Abstract. In this study, we developed a simple set of tools for a teacher to efficiently and easily evaluate and measure the accuracy of the result of students' craft works. This tool is developed for running on a smartphone, and has three functions; 1. Measuring the flatness of surfaces, 2. Measuring the accuracy of connected parts, and 3. Taking photos of the working process and final result. The result of the evaluation is sent to LMS (Learning Management System) and stored. It works as a part of an integrated management system. Despite only having three functions, this tool can solve chronic problems and drastically reduce the workload for general Japanese teachers. Without this tool, one teacher is solely accountable for checking and evaluating a vast number of students' works in a very short period of time.

Keywords: Smartphone · Technology education · LMS (Learning Management System) · Evaluation of flatness of material surface · Evaluation of joint angle

1 Introduction

Japanese teachers are required to manage many kinds of school affairs. They must not only teach classes but must also guide students, manage club activities, organize committees, prepare teaching materials for the next class, and conduct evaluations. Generally, there is only one teacher who teaches the Technology Education class in a given school. Therefore, the teacher is expected to check and evaluate all of the students' craft works. A typical class in Japan consists of about 28 students on average [1]. Additionally, it is assumed that there is an average of five classes in a grade, and three grades in a school. This means the teacher needs to manage the results of 420 students in a short period. Moreover, even if the teacher only checks five parts; e.g., two parts of the angle and three parts of the flatness of a craft work as shown in Fig. 1, it means that the teacher has 2100 points to check and remark. A teacher usually only evaluates craft works by observation and records findings on a sheet. However, this traditional way takes a long time and it is difficult for the teacher to remain consistent. In addition, non-digitized data is not compatible with the LMS. Moreover, inaccuracy is a prevalent issue with this method. If there are tools that could more

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accurately record the interface between results of students' works and a teacher's evaluation, these problem would be solved. Therefore, this research aimed to develop new tools for an application where a teacher is able to evaluate and record students' craft works with more accuracy, efficiency, and ease. We decided to use only a general smartphone, which was equipped with some basic sensors. Considering the application will be used daily, it was necessary to choose a common device for our application.

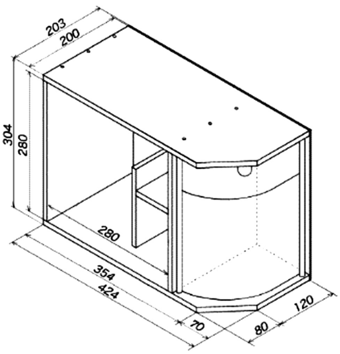

Fig. 1. Example of a design drawing [2]

As we mentioned earlier, a Technology Education teacher tends to be very busy because he/she is required to objectively rate students' works in addition to preparing materials and so on outside classes. It takes a teacher a very long time to evaluate the result of a lot of students' works (Fig. 2), plus it requires his/her sense of touch and sight.

Fig. 2. A sample of situation that there are a lot of students' craft works made in a Technology Education class.

In recent years, in Japan, there are a lot of parents who are highly concerned with the quality of education in schools. Teachers are often requested by students' parents to provide student grades and evaluations. If teachers have the resources to provide objective data, they can be relieved from bearing the accountability to provide explanations. Nowadays, smartphones are frequently used for various purposes in our everyday life. In 2007, it was proposed in the educational field that a teacher could record students' score and remarks by using a cellular phone [3]. However, it was just the input device and it did not have measuring and evaluation functions. It was not until recently that the use of smartphones was implemented to manage a student's skill practice. In this study, our research questions are as follows; 1. Can our new application for a smartphone accurately measure students' craft works? 2. How can the application make a teacher's evaluation and workload accurate, efficient, and easy?

In this paper, our purpose is to develop a simple new tool for measuring and evaluating, which can work on a smartphone to reduce a teacher's workload and allow him or her to check students' craft works more easily and efficiently.

2 Outline of Our Method

2.1 Outline of Our Approach

Figure 3 shows an outline of our approach. Our developed tool consists of three functions. The first is a function of measuring angles, the second is a function of measuring flatness and contortion, and the third is a function of taking photos. These three simple functions are assembled as an integrated system.

For measuring angles or flatness, we used three axes angle sensors and gyro sensors. This application is developed for general Android devices. The measured data and evaluated results are immediately sent to the LMS server, which we already developed [4]. The data and result are stored in the LMS database, thus teachers can access a student's learning history anytime.

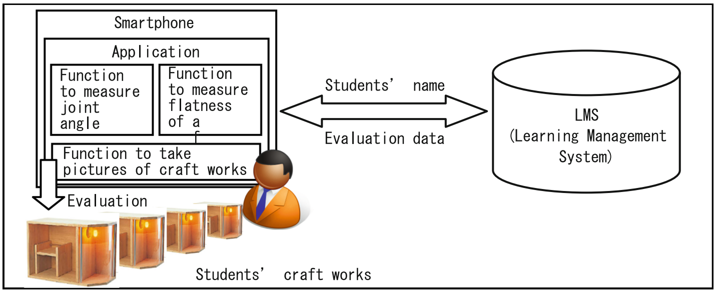

Fig. 3. Outline of our approach

2.2 Description of Functions

Both of these applications have a result view and data export function in CSV file format. Additionally, a teacher can see the rank of an evaluation as S, A, B, C, and D.

Approach 1. Flatness of Material Surface. In addition to checking if the angle is proper or not, it is also important to measure the flatness of the surface. This is especially important for cutting wood pieces with a saw. It is difficult for a beginner student to cut down correctly without any unexpected roughness. The flatness is measured by mounting a smartphone with an attachment made with a 3D printer slide on a surface that a teacher wants to evaluate. By sliding on a surface, our application measures the volume of the vibrations by using three axes acceleration sensors (Fig. 4).

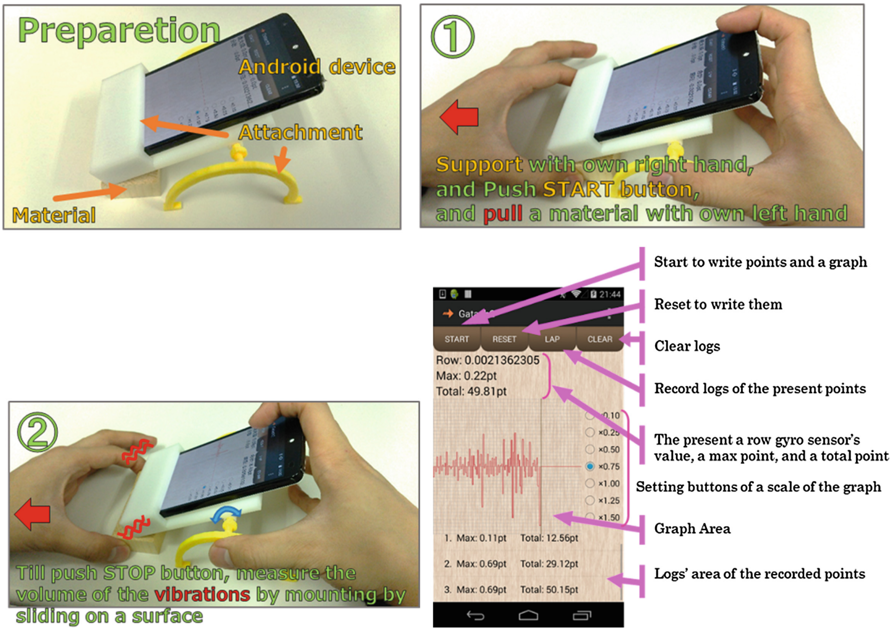

Fig. 4. Actual usage of measuring flatness of a material surface

Approach 2. Angle of a Joint. One of the most important factors for the evaluation of students' craft works is the accuracy of joint parts. For this evaluation, we developed a simple angle checker function especially for teachers. To use this function, a teacher decides the reference plane and puts a smartphone onto its surface as a calibrator. Next, a teacher puts it onto another surface to measure the angle. Lastly, the teacher should just touch the next button to save the data and proceed to the student evaluation (Fig. 5).

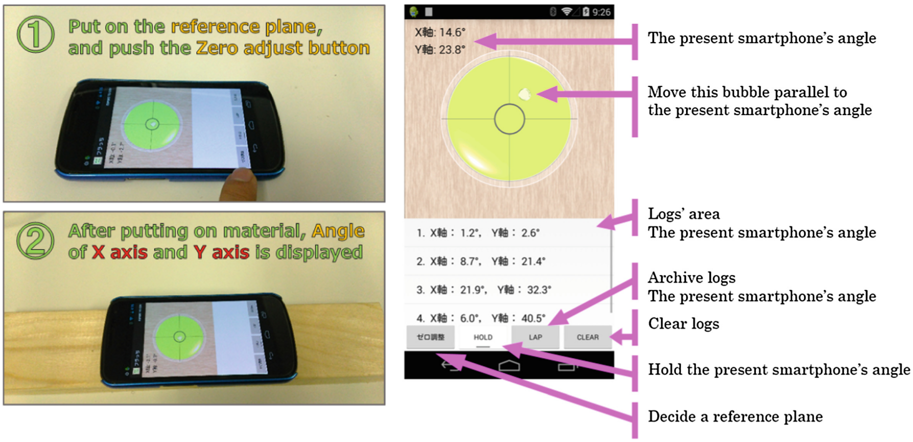

Fig. 5. Actual usage of measuring joint angle

Approach 3. Taking Photos. When a teacher should check students' achievement, it is important to record the condition of their works. Our third function is to take photos using a camera built in a smartphone and to store them in the LMS server. Using this function would help a teacher remember or recall it visually and correctly.

2.3 Validation of Our Application

Figure 6 shows the result of validation tests of measuring angle of X axis and Y axis. Using the absolute flat surface in our laboratory, a smartphone equipped with our application was put on the surface for calibration. We measured and recognized a gap between the values measured by our application and the optimal 45 degree, 90 degree measurement. As a result, there was some gap, which we fixed with correction processing.

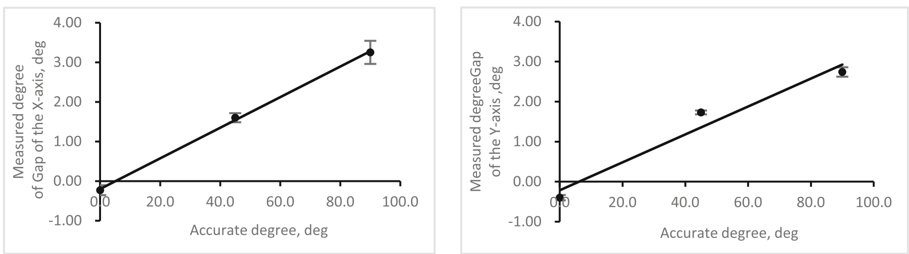

Fig. 6. Results of validation tests of measuring angle of X axis and Y axis

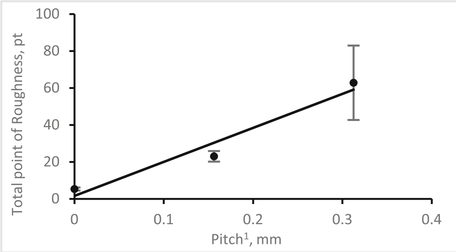

Fig. 7. Result of a validation test of measuring flatness

Figure 7 shows the results of a validation test that measures flatness. We made different pitch[1] test materials with a 3D printer for this test. We slid test materials under an attachment with smartphone equipped with our application. We measured and recognized a gap between the values measured by our application. As a result, it became clear that our tool can simply evaluate efficiently.

3 Conclusion

In this study, we developed a new simple application using a smartphone especially for a technology education teacher. The application consists of three functions; 1. Measuring flatness, 2. Measuring angle, 3. Taking photos. It is expected to reduce a teacher's workload because a teacher can check and evaluate students' craft works easily, effectively and accurately and store the evaluation data on the LMS. Our objective is not only to use this as a test run, but to eventually put it into valid practice.

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[1] Pitch means a distance from a top to next top of the roughness are same shapes.