An Application and Hardware for Repetition Images in Special Effects Shooting

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***Abstract*—In this paper, we propose an application that can be used to take repetition images for special effects shooting in movies or television using the Bluetooth technology of smart devices. After the application saves the control data for a specific period (based on the user's selection), the proposed application can move the motors of the hardware mounted on the camera to perform the same motion several times via Bluetooth communication. We do not permit users to control the camera motors for the repeated movements, so we can keep the same start and end positions after saving the moving data. The camera motors are only moved remotely by the application's saved data. We developed the proposed application and hardware, which work with camera motors for performance evaluation. Then, we confirmed that the proposed application repeated exactly the same motion with the camera motors several times, according to the saved data. Therefore, because the proposed application can take same images by remotely controlled camera motors, it will be a useful technology for special effects shooting of movies or television.**

Keywords-special effects shooting; repeated images; smart devices; application; same-movement.

I. INTRODUCTION

With the rapid development of smart devices and wireless communication, many technologies, such as data sharing, near wireless transmission, and hardware control methods are using the communication function of smart devices. The communication technologies included in smart devices are Bluetooth, socket transmission using Wi-Fi, and Wi-Fi Direct; these are developed from control research involving robots, smart devices, Remote Control (RC) cars, etc. [1-4].

From the growth of these control technologies, equipment for broadcast shootings has been applied to remote control technologies. ARRI Co. has sold equipment and software to control the Motion Control Camera (MCC) called Scorpio Mini Head SB92 [5], and CamRanger co. has released an MP-360 tripod head that can be controlled by a smart device or computer [6]. These control technologies are set up and used in dangerous recording positions, such as high places or quickly moving vehicles, and especially in difficult-access areas. Because the MCC has a built-in memory card for special effects shooting, it can record moving shots during a two minute period and it can shoot the same motion consistently. Thus, the MCC can record the same scene with the same camera moving a dozen times. When wired controls are used for the MCC, the scene being shot through the monitor can be seen immediately, and electric power can be directly supplied to the MCC. However, when we use wireless controls for the MCC, a wireless control desk is need, and the MCC can only save four movements according to the number of built-in memory cards. Because most MCC equipment is very expensive, we cannot use it frequently. On the other hand, the MP-360 is cheaper than MCC equipment and it can be controlled wirelessly. Since the MP-360 uses a tripod, we can adjust it to making a movie or video. However, the MP-360 can make panning and tilting motions, but not rolling motions.

In this paper, we propose an application based on smart devices and hardware that can repeat the same movement consistently for special effects shooting. The proposed application and hardware have the advantages of both the MCC and the MP-360. The proposed application sends the movement data to the hardware via Bluetooth, and the hardware mounted on the video camera can repeat the same movement numerous times. The hardware is composed of four motors (one motor for the panning motion, one motor for the tilting motion, and two motors for the rolling motion), a Micro Controller Unit (MCU) board for data transmission and control, and a Bluetooth module.

To evaluate the performance of the proposed application and hardware, we developed an application based on smart devices and hardware, and we conducted a control experiment with the same movements repeated during two, three, and four minute periods. The results showed that the proposed application and hardware moved to the same position without error during the two and three minute periods. Moreover, during the four-minute phase, the error rate was only 0.18% for the rolling motion. Thus, because the proposed application and hardware can work as well as the MCC and because they do not require an extra control desk, the proposed application and hardware can replace the MCC. Since the proposed equipment can be used in dangerous regions or places people difficult for people to access, it will be useful for special effects shooting.

This paper is organized as follows. Section 2 explains some of the equipment used for special effects shooting and how to make a special effect using the MCC. In Section 3, we describe the proposed application based on smart devices and hardware mounted on video cameras. In Section 4, we describe the application and hardware that we developed, and we discuss the results of the control experiment in terms of the performance of the proposed technologies. Finally, in Section 5, we present the conclusions and our further research.

II. RETATED WORK

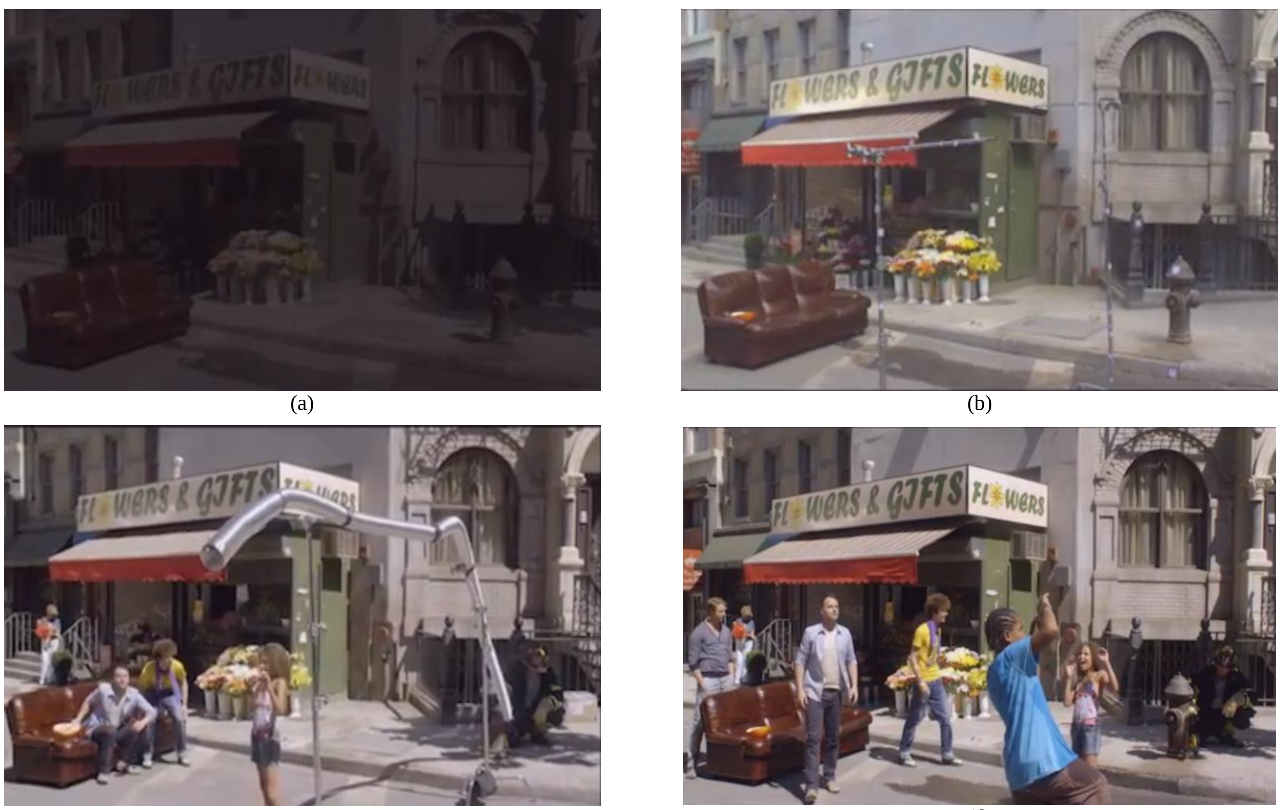
In this section, we explain some of the equipment required for special effects shooting. Many kinds of broadcast shooting equipment exist for special effects shooting and Computer Graphics (CG), such as the MCC, Body-Cam (body camera), Steadicam, or wireless controllers for lens focusing. The body-cam is a video camera attached to the body of an actor using hardware, and it can capture scenes for the first person narrative, following up the actions of the actor and creating a sense of immediacy [7]. Steadicams capture a steady scene even if the actor of the scene runs or walks [8]. While running or walking with a Steadicam, the camera operator cannot focus the lens. Therefore, when the distance between the actor and the movie camera is changed, a wireless controller is often used to focus the Steadicam lens.

For special effects shooting, the MCC is used to repeat the same camera movement though actors move differently during each take. For example, we can shoot the same motion with the same camera using the MCC, as shown in Fig. 1 [9].

Fig. 1 (a) is a tree plate scene: the base scene for special effects shooting. Fig. 1 (b) is a tracking plate, which includes a guideline for CG special effects. Fig. 1 (c) is a reference plate, where a silver pipe stands in for a stream of water that will be added later by CG effects. Fig. 1 (d) is a main plate that will compose the background of a scene with applied CG effects. After we combine each scene with CG effects, we can make a special effects scene, as shown below in Fig. 2 [9].

In Fig. 2, the stream of water that was based on the reference plate is now visible in the main plate, which did not show any water originally.

Recently, broadcast equipment for special effects shooting has mostly been comprised of the Remote Head series of ARRI co.; of this series, the Classic Head HD and Mini Head HD are capable of tri-axis movements [10]. However, the Remote Head series of ARRI co. requires a hand-wheel to control the head manually and a wireless control desk to control the head wirelessly. Thus, we cannot use Remote Head equipment often, and movie companies or advertisement companies use it most, because renting the hardware is expensive.



(a) (b) (c) (d)

Figure 1. Each plate is an example of how to create CG and special effects for a movie scene: (a) tree plate, (b) tracking plate, (c) reference plate, (d) main plate

Figure 2. Final shot using special effects implementation and CG

III. An Application and Hardware for Same-movement Shooting

In this section, we describe an application based on smart devices that can control hardware via Bluetooth, and we describe the hardware mounted on the video camera that can do the same movement multiple times. Wireless transmission control between the application and the hardware connects with Bluetooth pairing, and the work flow is shown in Fig. 3.

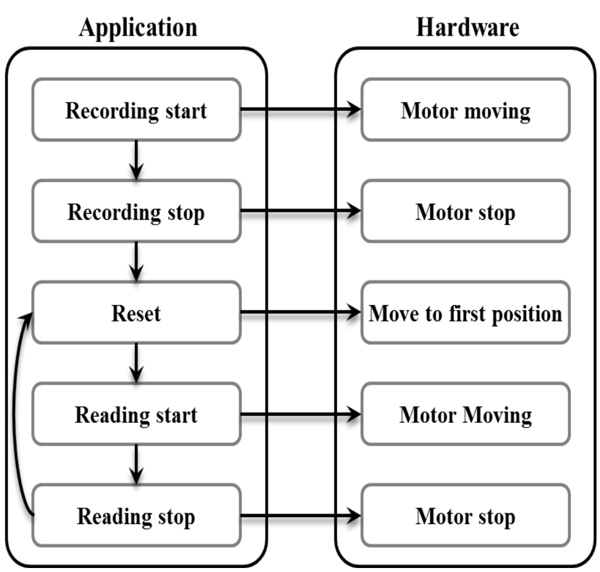


Figure 3. The work flow of the proposed application and hardware attached to the camera

As shown in Fig. 3, the hardware is not moved from shooting start to shooting end without the proposed application. When the proposed application moves the hardware after “Recording start” is selected, the application saves the movement data to built-in memory, according to the user’s control. If the user finishes shooting a scene, he or she can stop the application from recording via the “Recording stop” button, and the application finishes by saving control data. At the same time, the hardware stops each camera motor. When the proposed application executes the “Reset” function, the hardware moves to the first position recorded by the application’s movement data. Next, if we execute the “Reading start” button, the application sends movement data to the hardware, which then moves according to the movement data provided. If the application’s saved movement data ends, the application stops reading movement data and the hardware stops each motor. Then, the “Reset, Reading start, Reading stop” operating process repeats until enough scenes are obtained for CG special effects. A screen shot of the proposed application based on smart devices is portrayed in Fig. 4, and the menu of the application is categorized into three headings: Recording, Reading, and Setting.

Fig. 4 shows the control functions of the “Recording” menu, which allows the user to move the hardware via many directional buttons, such as Panning (Left, Right), Tilting (Up, Down), and Rolling (Left, Right). These buttons can move the hardware even if the “Recording Start” button is not executed. When the user wants to save a hardware movement, the user touches the “Recording Start” button. Then, the “Recording time” increases, and the application saves the camera movement data. Simultaneously, the application moves the hardware via Bluetooth, and the user can take a shot needed for special effects shooting via the Panning (Left, Right), Tilting (Up, Down), and Rolling (Left, Right) buttons. When the shooting is ended, the user touches the "Recording Stop" button, and the application stops to save the camera movement data. The camera movement data is saved in the built-in memory of the smart device, and we can see the saved data from the application's "Reading menu" (shown below in Fig. 5).

Figure 4. Main screen of the proposed application for control MCC

Figure 5. Main screen for repeat movement of camera

In Fig. 5, the hardware's position should be moved to the first position, because the position of hardware is the ending position after shooting is finished. Thus, the hardware goes to the first position as the user touches the "Reset" button in the "Reading" menu. If the user does not touch this button but touches the "Read Start" button, the application shows an alert message and the hardware does not move. When the user touches the "Read Start" button after touching the "Reset" button, the application sends movement data to the hardware in consecutive order, and the video camera attached to the hardware takes another shot of the same scene. The color of the control message line changes to red when a control message exists, and it changes to green when no control message exists. Next, the "Setting" menu has three slide bars to regulate the control speed, as shown in Fig. 6. As shown in Fig. 6, each slide bar ranges from 1 to 10; the chosen value can increase or decrease the motor speed of the hardware. If the value is low, the motor speed is slow and the hardware will move slowly. Conversely, if the value is high, the motor speed is fast and the hardware will move quickly. The "Remaining Time" switch sets how the "Read time" of the Reading menu will be displayed. If the switch is off, the "Read time" shows a time counter. If the switch is on, the "Read time" shows the remaining time.

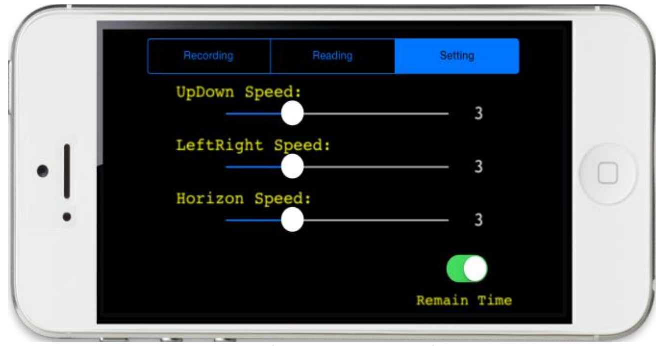


Figure 6. Setting screen for speed control of camera movements

Finally, the composition of the hardware mounted on the video camera is shown in Fig. 7.

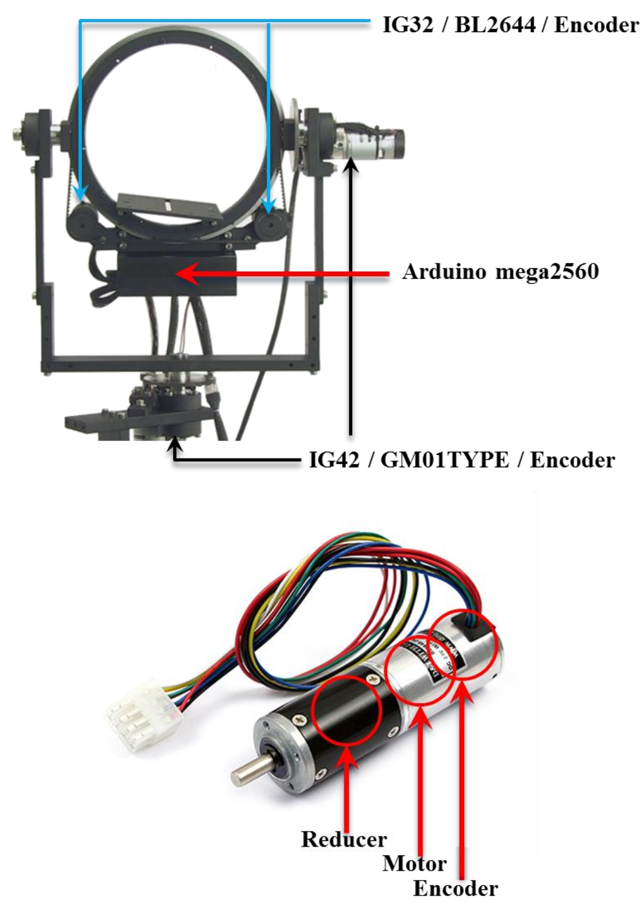


Figure 7. The composition of the proposed hardware to be attached to the camera

In Fig. 7, each motor is composed of a reducer, a motor, and an encoder. For rolling movements, we used two motors that are composed of an IG 32 reducer, a BL2644 motor, and a dual channel 26-pulse encoder. We used a 5GT type pulley and pulley belt to connect these two motors. For panning and tilting movements, we used one motor for each. This motor is composed of an IG42 reducer, a GM01-Type DC motor, and a dual channel 26-pulse encoder. Next, MCU and

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communication modules for controlling each motor are shown below in Table 1.

TABLE I. THE CONTROLLER COMPOSITION OF THE PROPOSED HARDWARE

Equipment	Model name
MCU	Arduino mega 2560
Communication	BLE Shield SLD09041M
BLDC driver	NT-BL3V
DC driver	NT-VNH20SV1
Power	5V for Board, 24V for BLDC

MCU not only controls all motors from control data via Bluetooth Low Energy (BLE) but also supplies information about current motor status and position to a computer for experiment and analysis. The BLE shield is a module for communication between the smart device and the hardware, while the Brushless DC (BLDC) driver controls the BL2644 motor and retrieves its position information. The DC driver is meant to control the GM01-Type motor and to get its position information, and power equipment is to supply additional electric power to MCU and each motor.

IV. EXPERIMENTS AND EVALUATION

This section explains the experiments and evaluation of the proposed application and hardware. The aim of the experiments was to verify how well the wireless application and hardware worked and how exact (i.e., without error) the position of the hardware was throughout its repeated movements. Fig. 8 shows how the user can control the proposed application and hardware according to the user's purpose.

Fig. 8 illustrates the user touching the "Left" button of the proposed application for left-panning. The hardware was turning from right to left in the following order: (a), (b), (c), (d), (e), and (f). We tested not only panning movements but also tilting and rolling movements, and the proposed application and hardware worked as well for all movements as movement of left-panning.

Next, we did an experiment about whether the hardware maintained the same position after being moved several times to shoot the same scene. We could check the position value of each motor from a PC via USB serial communication, because we used Arduino mega 2560 as MCU and motor driver to get the position value of each motor. We saved movement control data in the "Recording" menu, and we checked the start position and end position values of each motor at the "Reading" menu at 5, 10, and 20 repetitions. At these times, the setting speed of the panning, tilting, and rolling movements was three and the control duration of the hardware was two minutes, which was the maximum saving time of MCC of ARRI co., three minutes, and four minutes. The results of this experiment are presented in Table 2.

The value of each cell is the error rate of the hardware's end position value via the proposed application. In Table 2, the error rates for panning and tilting movements were 0% at two, three, and four minutes, though the hardware was moved several times. In contrast, the error rate for the rolling movement was 0.18% at four minutes, even though the error rates were 0% at two and three minutes. A possible explanation is that we used a 5GT type pulley and pulley belt to connect the two motors for the rolling movement.

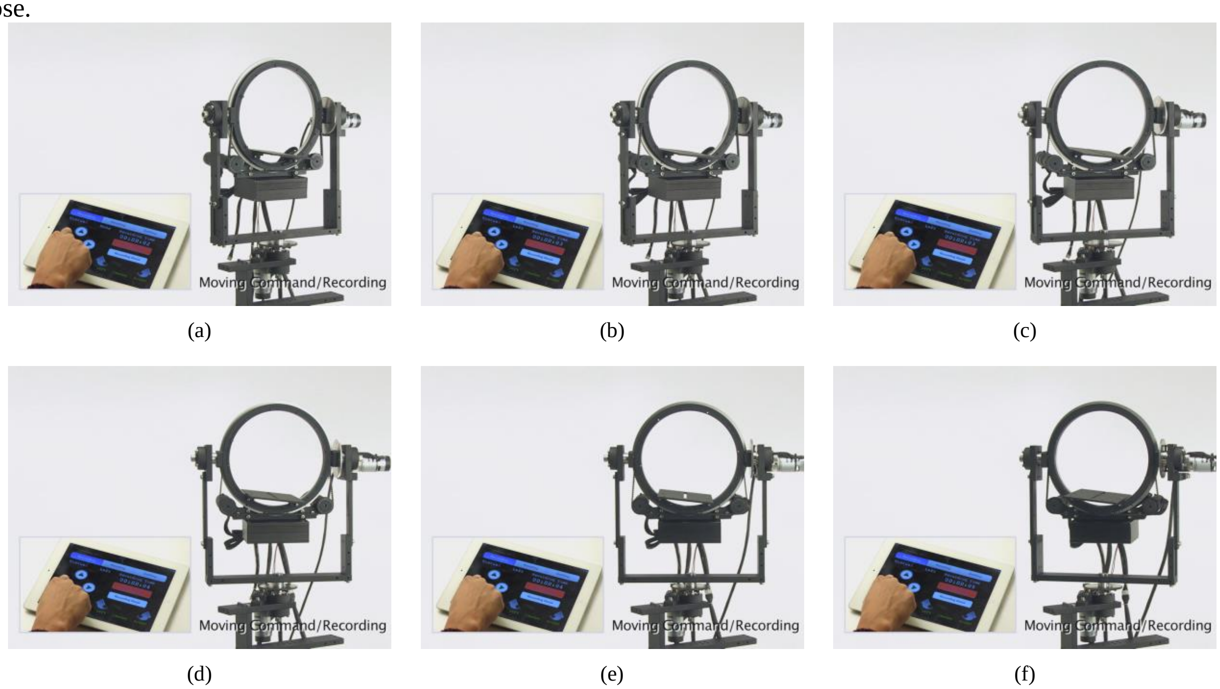

Figure 8. Images of the stages of left-panning via the proposed application, controlled by the hardware

TABLE II. THE ERROR RATES OF END POSITION VALUE OF THE HARDWARE VIA THE PROPOSED APPLICATION

	Motor direction	2 min	3 min	4 min
5 times	Panning	0 %	0 %	0 %
	Tilting	0 %	0 %	0 %
	Rolling	0 %	0 %	0.17 %
10 times	Panning	0 %	0 %	0 %
	Tilting	0 %	0 %	0 %
	Rolling	0 %	0 %	0.18 %
20 times	Panning	0 %	0 %	0 %
	Tilting	0 %	0 %	0 %
	Rolling	0 %	0 %	0.18 %

We expect that the rolling movement error occurred when the motor stopped, because the 5GT type pulley belt has a 3 mm furrow. If we had used a pulley belt that was smaller than the furrow of the 5GT pulley belt, we think we could have decreased the error rate for rolling movements. From the results of the experiment, it is clear that the proposed application and hardware worked exactly according to the user's purpose.

V. CONCLUSION AND FUTURE WORK

In this paper, we have proposed an application based on smart devices that can control hardware movements and save the movement data; we have also proposed hardware that can conduct the same movement repeatedly for special effects shooting for movies or dramas. From the experiment results, we showed that the application and hardware were working well during two, three, and four minute periods without any error for panning and tilting movements. A marginal error of the application and hardware occurred only during the four minute period for the rolling movement. Thus, the proposed application and hardware could not only work like the MCCs of ARRI co., but they also do not require any wireless control desk or extra controller. Therefore, the proposed application and hardware would be a useful technology for special effects shooting at dangerous locations and difficult-access areas.

In future research, we will look into other options to replace the 5GT type pulley and pulley belt, and we will do more experiments using these options. Furthermore, we will test whether the accumulated shots of the same hardware movement overlap exactly when we use the proposed application the hardware.

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