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360° Time Lapse - A New Leap in Time Lapsing with Rotation

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ABSTRACT: Time Lapse is an art of capturing a slowly occurring event in nature and summarizing the events to a shorter duration. This enables an individual to have the capability of witnessing a long occurring event in a shorter duration. This paper presents an embedded system design that adds a great leap in the technology of Time Lapse by adding a rotation component to it. Rotation is very good for capturing Time Lapse in horizons and cityscapes. It adds depth to the produced video by adding the rotation. The design presented in this paper also uses intelligent algorithms and provides rich user interface (UI).

KEY WORDS: Time Lapsed, embedded systems, 360° Time Lapse, DSLR, TFT

I. INTRODUCTION

Time is a relative parameter. It is perceived differently by different aspects in nature based on the circumstances of the perceiver. In general every human being has a limited time frame of living called as life span which can comprise of few thousands of hours. However, nature has a very unique way of perceiving time. A second can be too short for us when compared to a decade. Nature treats all the events in equilibrium. As human beings have advanced, the attempt to capture the changes in nature within the time span affordable by an individual becomes one of the most important desires. One of the attempts is called the "Time Lapse". Time Lapse is an art of capturing a slowly changing phenomenon in nature in samples and playing it back in a regular viewable speeds.

The concept of Time Lapse was introduced and developed by John Ott in 1930s [1]. Ott developed the Time Lapse method of photography, along with many more modern photography practices.

The Time Lapse is a technique whereby captures the photos frequently and combine all captured pictures used to make a video that would show a very slow event in nature happening at regular speed which is 24 frames per second [2].
Figure 1 shows time sampling example where the event is captured every 5 seconds [2].

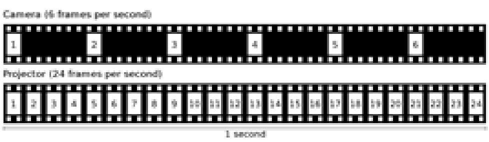

Figure 1: Time Lapse concept

For instance the action like in Figure 2 shows a photo which is captured at the rate of 1 picture every 5 seconds for 2 hours [3]. When the final output of the video is produced the event of 120 minutes would appear in 24 minutes. The video which is generated out of Time Lapse is generally rendered later in a computer. Some of the modern smart devices can support on device Time Lapse rendering. This process is also called "Time Lapse photo stitching" [4, 5].

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Figure 2: Chrysalis, a slowly occurring phenomenon in Nature [3]

There are various parameters which can directly impact the final result of the Time Lapse. Few major ones are:

- Shutter speed
- Shutter interval

Time Lapse with rotation is a simple technique which involves rotating the camera while Time Lapse shooting is happening. This would give a rich user appeal where the Time Lapse can also be seen with panning.
The camera using the angles 90°, 180°, 270° or a complete 360° can accomplish the Time Lapse with rotation. In this project the user will be provided with different options to select the different angles to choose from. The user is also given the option to select the time.

Figure 3 gives an overview of where exactly our project in this paper fits compared to the past, future and the present of Time Lapse technology. It does answer the question "what makes our device better than other devices that are available to users?"

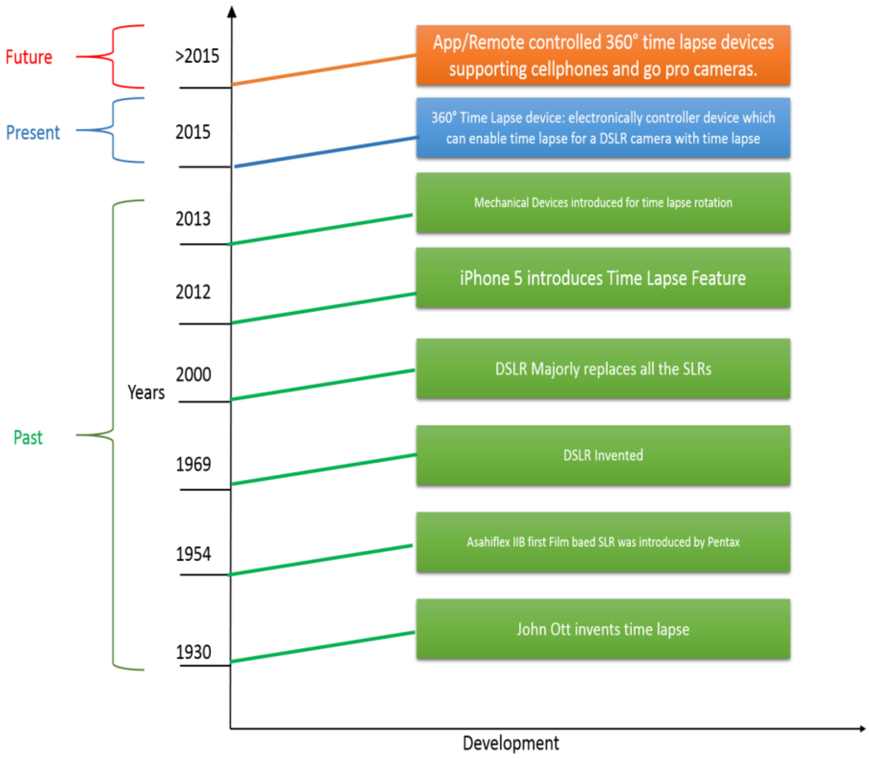

Figure 3: Time line of the state of the art of Time Lapse.

Time Lapse was manual where a user needs to click the image every 2 sec or 4 sec and perform the video processing later manually. Since the invention of the digital single-lens reflex (DSLR) and Digital Complementary metal-oxide semiconductor (CMOS) sensors the time lapsing become automated and seamless. The introduction of the DSLRs into the market during the year 2000 resulted in significant drop of prices in silicon. This price reduction resulted in bringing in the Time Lapse for the average user. Apple introduced the tome lapse feature in the iPhone® 5s and 5c during the year

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2012 [6]. During the year 2012 many Time Lapse devices supporting the rotation with Time Lapse devices started appearing in the market [7]. However, these devices were purely mechanical.
The paper is organized as follows: sections 2 and 3 will presents the overview of the 360° Time Lapse proposed system and its user interface. Section 4 will present the hardware architecture for the 360° Time Lapse proposed system. Section 5 will present the software design and implementation of the 360° Time Lapse system and section 6 will present the conclusion.

II. THE 360° TIME LAPSE SYSTEM

The 360° Time Lapse system introduced in this paper is made of the following components:

- a stepper motor, which is used to rotate and mount DSLR camera,
- a thin-film transistor (TFT) as a front, and
- a graphical user interface for the user to interact with the system.

The hardware (camera) gets connected to a stepper motor and a DSLR Camera shutter release. Figures 4 and 5 shows an overview of the components of the project presented in this paper as well as the time lapsing screen. Figure 4 shows the connection from the device (camera) to the shutter release.

Figure 4: The connection from the camera to the shutter release.

Figure 5: Time lapsing screen.

User selects the angle and time required by using the TFT. Once user hits the start, then the Time Lapse session starts. Stepper motor rotates step by step based on the angle and time selected by the user. When the session starts, the TFT gives the user a feedback that Time Lapse session with a progress bar completion status. Once the Time Lapse completes, then the screen changes back to the main screen and Time Lapse session stops. In time lapsing screen the user is also provided with an option to cancel the time lapsing session. When the user hits the cancel button the screen goes back to the main screen and stepper motor stops.

User can setup the device in the desired location and start the device. User need not be present monitoring the device but the device keeps giving the feedback to the user about the status of the time lapsing. Also, once the Time Lapse is complete the device returns to its previous state.

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III. EASE OF USE

The user interface is easy to use since as it contains a touch screen which provides convenient user experience. The device consists of a simple power switch and when the power is on ten the user can start directly interacting with the device. When the system boots up it shows the main screen. The following is more details about the screens:

A. Main Screen

This screen is the home screen of the human machine interface (HMI) interface which was developed for this system. This screen contains basic parameters for the user to select. User can use the slider to select the time required for the lapse. An angle selection drop down is provided to enable user for selecting the degree of rotations desired. Once the user completes making these selections then the user can click on the start button to start the Time Lapse session. Figure 6 provides an over view of the main screen.

Figure 6: Main screen lay out.

B. Time Lapsing Screen

This screen is the second screen which is enabled once the user selects the time lapsing session to start as shown in Figure 7. The screen is a dynamic which can provide visual feedback to the user. The screen contains a progress bar which shows the percentage of Time Lapse completed. The only user interaction available in this screen is the cancel button. There are two exit strategies available from this screen. The user can manually override and select cancel. This screen times out when the time lapsing session ends. The time lapsing session time out is calculated by the parameters selected in the main screen.

IV. HARDWARE

The overall hardware has been be divided in to two parts:

- iMx6 [8] side for GUI/HMI
- SAM3x8E for driving Synchronous Transport Module, (STM) and camera shutter

Figure 7 gives an overview of the overall hardware architecture of the project.

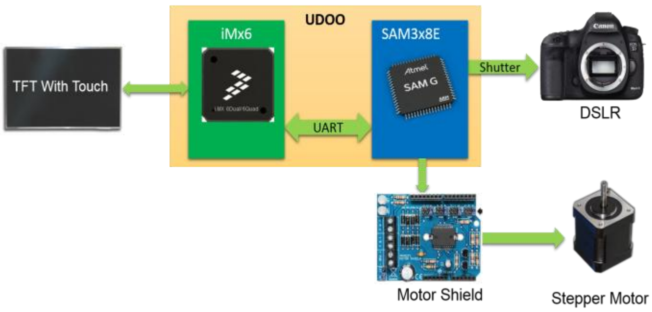

Figure 7: Hardware overview

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The reason behind using two controllers is to have a rapid development environment as this is a prototype developed to demonstrate the concept. iMx6 [9] can support the QT development environment and seamlessly drive a TFT of 7” with touch screen display. SAM3x8E is an Arduino architecture based controller which provides easy access to General purpose input/outputs (GPIOs) to drive release the shutter [10]. It also supports a commercially viable motor shield which can drive a stepper motor. The following is more details for the hardware parts used in the project:

A. IMx 6 and Display Side

IMx6 QUAD controller on a single-board computer with an integrated Arduino 2 compatible microcontroller (UDOO) board supports a standard HDMI port which can be connected to the TFT [9, 11]. iMx6 basically provides a front end interface part of the overall product. It displays the output and also acts as an input device to take inputs from the user from the touchscreen. It also uses a Universal Asynchronous Receiver/Transmitter (UART) communication with the SAM3x8E side to communicate commands from one controller to the other.

B. SAM3x8E and Motor Mount

SAM 3x8E is an Arduino architecture based controller which has simple GPIO connections to interact with the external world. In this project we are using the following GPIO ports [10]:

- PIN 13 to release the camera shutter
- PIN 8 and 9 to power the coils A and B
- PIN 10 and 11 to power decide on direction of rotation

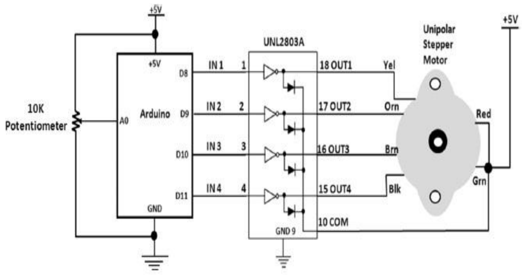

Figure 8: Overview of stepper motor interface

Figure 8 [10] gives an overview of how the stepper motor is connected to the UDOO board via motor mounts.

C. Stepper Motor

In this project we have used a unipolar stepper motor which has a step angle of 1.8° [12]. The device has 4 lead wires from it Yellow, Orange, Brown and Black. Two of them are connected to the leads of the coils inside the stepper motor. This stepper motor has an accuracy of 5% and a high accuracy stepper motor can be used in the future for the product. The ambient temperature for the stepper motor operation is in between -20 °C to +50°C. The stepper motor has two rotational direction, CC (Clock Wise) and CCW (Counter Clock Wise). Figure 9 shows a stepper motor coils with the leads arranged inside the stepper motor [12].

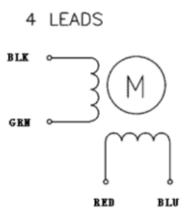

Figure 9: An inside view of stepper motor

D. TFT Touch and Interface

In this project we have used Lilliput® an OTS (Off the Shelf) TFT monitor which has a built in touch support [13]. The device also provides an access to its touch screen via USB port. The USB port can be connected to the iMx6 controller to drive the touch screen. The device acts both as input and output for the product.

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V. SOFTWARE

Figure 10 shows the software architecture diagram for the iMx6 side. The software architecture is divided into the following modules:

- HMI Module
- Angle Module
- Time Module
- BL / Calculation Module
- UART Communication Module

The modules are explained in the following sub-sections:

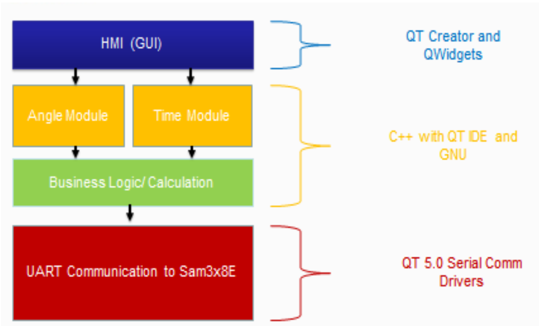

Figure 10: Software diagram for the iMx6 side

A. HMI Module

In this module we are developing the HMI screen using the QT tool [14]. To develop the HMI screen we are using QWidgets and for the business logic we used C++.

Figure 11: HMI main screen

Figure 11 shows the HMI main screen for the developed static test that shows the 360' Time Lapse and select rotational angle. The Figure also shows the dynamic text menu that shows "time in minutes: 05" which depends on the slider that controls the value. Few widgets like slider, start button and combo box can also be seen in Figure 11.

Figure 12: Time Lapse screen

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In Figure 12 we have developed the static text, progress bar widget and cancel button. In Figure 11 user can select the angle which he want such as 90,180,270 and 360 and also set the time in minutes for the Time Lapse from 5 to 59 using the slider widget. Once user select the time and angle then user can click the start button to start the Time Lapse. When the start button is clicked then it will switch from Figure 11 to Figure 12. In Figure 12 user can cancel the Time Lapse or once the Time Lapse is done for the particular time then it will switch from Figure 12 to Figure 11.

B. Angle Module

When user select the angle (rotational angle) from Figure 11 then angle module will be called to calculate the stepper motor steps. We are providing 4 different angles which are 90, 180, 270 and 360. The conversion from angle to stepper motor steps is done as follows: 90 = 12 steps, 180 = 25 steps, 270 = 37 steps and 360 = 50 steps. The resolution of the stepper motor is 50 so we are equally dividing the angle to the stepper motor steps. Send converts the stepper motor steps to calculation module for the feature calculation and keep buffer value of angle in the angle module.

C. Time Module

When user choose the time for the Time Lapse using the slider widget as shown in Figure 11 then user can select the time from 5 minutes to 59 minutes. Once we receive the time from the HMI screen then we will convert the minutes to milliseconds. After that we will send the converted millisecond value to the calculation module to do the future calculation and keep buffer value of time in the time module.

D. Business Logic / Calculation Module

We receive converted angle and time from the angle and time module respectively. The time per step is calculated as follows:

Time per step = time in msec / angle to stepper motor steps

Once we get the time for each step then we run the timer to click the photos. The next step is to run the main timer to rotate the steeper motor then send the time per step and angle of the stepper motor steps to the serial module.

E. Serial Module iMx6 side and SAM3x8E side

We receive the timer per steps and angle of stepper motor steps from the calculation module. The next step is to send data to SAM3x8E to click the shutter and rotate the stepper motor. The commands have been designed so that the SAM3x8E URAT communication and QT serial port communication can communicate as shown in Figure 13. The following are some of the possible commands:

- S1 command to start the lapse session.
- R1 command to rotate the stepper motor.
- C1 command to cancel stepper motor rotation.

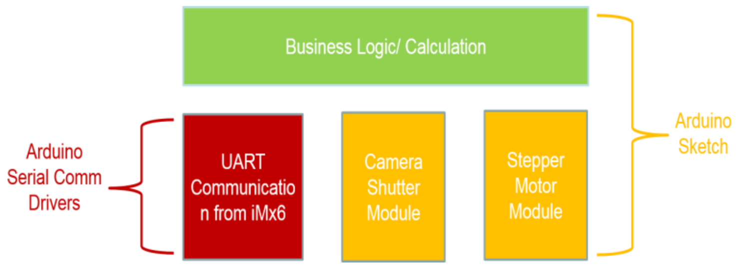

Figure 13: Software diagram for the SAM3x8E

This module receives the commands from the UART module. This module changes the commands to instructions for the camera shutter release module and stepper motor module.

F. Camera Shutter Module SAM3x8E side

This module receives command from the business logic module to release the camera shutter on pin 13 (see Figure 8). This modules runs a local timer of 200 msec as shutter intervals. This can be configurable for future use.

G. Stepper Motor Module SAM3x8E side

This module receives commands from the business logic module to make 4 pins high and low on a pattern to drive the stepper motor via motor mount (see Figure 8). This module basically acts as a stepper motor driver. It rotates the stepper motor CC or CCW by 1 step.

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H. Communication between the SAM3x8E and iMx6

The following sequence illustrates a simple use case of how a simple rotation and shutter release happens as shown in Figure 14:

- User starts the Time Lapse session from the iMx6 side and sends the command "S1".
- SAM3x8E starts a 200 msec timer and starts the shutter release every time out (200 msec).
- iMx6 calculates the rotation time interval and sends the command "R1" to rotate the stepper motor CW by one step.
- SAM3x8E receives the command "R1" and rotates the stepper motor by 1 step.
- Once the Time Lapse elapses or the user hits cancel then the iMx6 sends the command "C1".
- Once SAM3x8E receives the command "C1" it stops the 200 msec timer which will stop releasing the shutter and ends the Time Lapse session.

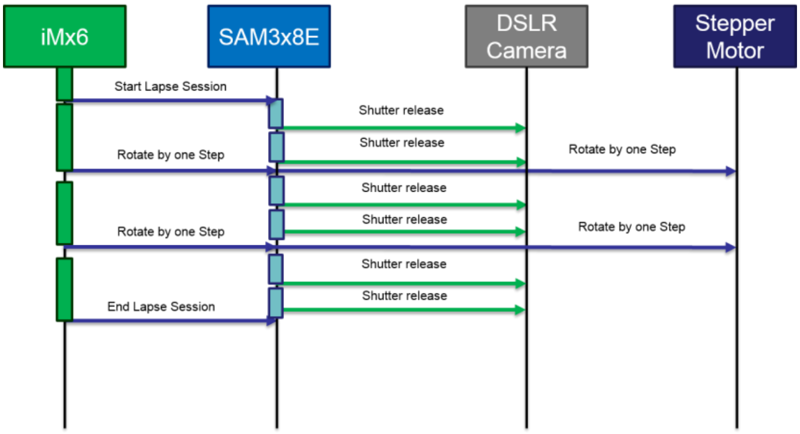

Figure 14: The sequence of events in the system.

Figure 14 provides a detailed view of the sequence of events in the system.

VI. CONCLUSION

The 360° Time Lapse designed system presented in this paper will support devices which may or may not contain Time Lapse feature. Since the 360° Time Lapse device is connected directly to the camera it can also work with the existing devices like DSLRs which does not have built-in Time Lapse feature. 360° Time Lapse device introduced in this paper can also work with the Time Lapse supported devices like GoPro® [15] and cellphones. 360° Time Lapse device can be extended to use an app or remotely controlling it from a base station. This can enable wildlife photographers with immense opportunities. To shoot Time Lapse videos from days to months without being actually present in the location. In the future the Device can be made compact and portable. It can be made more accessible and the user interface can be made even simpler.

REFERENCES

[1] John N. Ott, "My Ivory Cellar: The Story of Time Lapse Photography", Literary Licensing, LLC, ISBN: 1258787229, August 24, 2013.
[2] i.MX 6Quad Processors "Freescale Documentation" © 2004-2015 Freescale Semiconductor. http://www.freescale.com/products/arm-processors/i.mx-applications-processors-based-on-arm-cores/i.mx-6-processors/i.mx6qp/i.mx-6quad-processors-high-performance-3d-graphics-hd-video-arm-cortex-a9-core:i.MX6Q (Accessed January 2016).
[3] http://www.monarch-butterfly.com/graphics/monarch-emerging.jpg (Accessed January 2016).
[4] Mary H. Nichols, Janet C. Steven, Randy Sargent, Paul Dille and Joshua Schapiro, "Very-High-Resolution Time Lapse Photography for Plant and Ecosystems Research", Applications in Plant Sciences 2013 1 (9).
[5] Richard Szeliski, "Image Alignment and Stitching: A Tutorial", Technical Report Carnegie Mellon MSR-TR-2004-92.
[6] http://www.studioneat.com/blogs/main/15467765-how-does-the-ios-8-Time Lapse-feature-work. (Accessed January 2016).
[7] http://www.gizmag.com/camalapse-Time Lapse-video/24097/ (Accessed January 2016).
[8] SAM3X / SAM3A Series "Atmel | SMART ARM-based MCU" Atmel-11057C-ATARM-SAM3X-SAM3A-Datasheet_23-Mar-15

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

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[9] http://udoo.org/forum/threads/giving-up.2979/ UDOO OS “UDOO Documentation” © 2015 UDOO. (Accessed January 2016).
[10] https://en.wikipedia.org/wiki/Time Lapse photography (Accessed January 2016).
[11] Arduino – References “Arduino Language Reference” © 2015 Arduino.
[12] https://en.wikipedia.org/wiki/Stepper_motor (Accessed January 2016).
[13] http://www.lilliput.com/ (Accessed January 2016).
[14] QT Documentation “Open source tool” © 2015 The Qt Company Ltd. 2015. http://www.qtcentre.org/threads/11713-Qt-Tool (Accessed January 2016).
[15] www.gopro.com/cameras (accessed January 2016).