Design and Development Plan

Introduction

Our project involves a 360 degree camera, integrated with a NVIDIA Jetson. It can be used in the entertainment and business sectors, for capturing a variety of scenes in a 360 degree view. While other products with similar concepts exist, such as Meeting Owl Pro ($1000) or the Insta360 Pro ($5000) [1], the primary features that will differentiate this project are relatively low cost ($~500), open-source code/documentation, and the ability to stream the video live. Because it will be open-source, this project will be adaptable for various use cases. Examples include not only more immersive virtual experiences (such as VR family gatherings or long-distance business meetings) but could also be used for inventory checking, sports analytics, etc. in post-processing.

360 degree camera system from the SmartSystem Lab, [2] 7 to one USB adapter

Statement of Work

1. Identify what work is to be done during the semester. Quantify the performance specifications and/or requirements of your design.
    a. Hardware elements:
        i. Nvidia Jetson: Does the image processing to stitch the images together
        ii. PCB: USB hub chip (combines USBinformation from 6 cameras into 1 USB connection, sent to Jetson)
        iii. Camera streams must be within USB protocol bandwidth
        iv. USB portable charger (26800mAh) as power for Jetson
        v. SD card to save the video storage
    b. Software elements: should note dependencies (libraries/frameworks), languages, and build environments.
        i. USB-drivers (to combine the 6 streams into 1, output in USB format)
        ii. Stitching software (C/C++ or Python), openCV library (cv2.createStitcher)

2. List of major features / tasks / milestones, target dates for completion
    Research: Everyone
        i. Research USB chip to use to connect 6 USB cameras to one USB, and if there is an available driver (2/21) (All members contribute to research)
        ii. Research USB schematic to create custom PCB for USB chip (2/21) (All members contribute to research)
        iii. Research libraries for stitching 6 images into 1 and sample programs that stitch images together (2/21) (All members contribute to research)
    Design: Everyone

iv. Project design prototype (2/25) (All members contribute to design planning)
v. Design schematic for PCB that integrates 6 USB's into 1 (using USB hub chip) (3/10) (All members contribute to PCB design planning)
vi. Design outline of stitching program (3/10) (All members contribute to stitching program outline)

Creation: Split into hardware and software teams, see table below for members
vii. Create initial PCB for the 6-1 USB Hub (04/06) (Hardware team, see below for members)
viii. Create python program to stitch USB video information (4/06) (Software team, see below for members)

Hardware (PCB)	Software (Stitching Software + Driver)
Daniel Park	Alexander Ng
William Kirby	Carlos de Guzman
Yenessa Avalos-Maldonado	Alan Fruge

Everyone on the team is expected to contribute to each of the Research and Design tasks. Once we start creating our design project, our team will split into two focus areas while we continue collaborating with each other. The first step of our design phase is to construct the PCB and outline the stitching program.

Deliverable Artifacts

Documentation and Code: GitHub repository
1. PCB schematic
   a. This describes the PCB that will connect all of the cameras to the Nvidia Jetson
2. USB Driver
   a. This will take in the raw input streams for all of the cameras and make it readable through the USB protocol
3. Image Stitching software - This code will be run on the Nvidia Jetson.
   a. Given multiple video stream inputs the Jetson will "stitch" the overlapping videos into 1 360° video for export. This can then be displayed with provided software

Physical device:
A 3D printed pentagonal casing with 5 cameras on the sides and one camera on the top. Video will be taken from each camera, processed by a NVIDIA Jetson, and output on an SD card. Depending on time constraints, the SD card would be converted to an HDMI output that would provide live stitched video output without the need to load/store that stitched video to an SD card.

Accessibility / usability / maintenance:
GitHub repo will contain a readme on how to build the project.
Users can make pull requests on the GitHub repo for bug fixes or optimizations
Users can also add features, such as image processing software for the Jetson

References:

[1] "Insta360 store: The official store for insta360 cameras, accessories and services,"
Insta360 Store: The Official Store for Insta360 Cameras, Accessories and Services.
[Online]. Available:
https://store.insta360.com/product/Pro_2?c=364&freelist=bingmc&msclkid=00e894450ded1ba28ba3f64fd2cf95eb&X-Country=US. [Accessed: 18-Feb-2022].

[2] "Miyanuby USB Hub 3.0, USB C Charger, USB C Charger block,t-sound USB splitter for laptop, PS4 keyboard and Mouse Adapter for Dell, ASUS, HP, MacBook Air, Flash Drive, HDD, console, printer," Walmart.com. [Online]. Available: https://www.walmart.com. [Accessed: 18-Feb-2022].