Voice tracing video camera designed for meeting recording

Project Proposal

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Table of Contents

1. Introduction

1.1 Statement of Purpose

Recording an important meeting by video frequently happens in workplaces. Under usual circumstances, a person will be hired to record the entire process of the meeting, where issues of cost, convenience and security arise. Thus we will design a system that would automatically record the meeting in a medium sized room by tracing the voice of the speakers.

Furthermore, we believe during a meeting, arguments, discusses and other forms of information exchange between different speakers are worth capturing. And we will provide a mechanism that automatically locates and records the two most important speakers in the ongoing conversation.

1.2 Objective

1.2.1 Goals:

Cameras would be placed on a 360 degrees rotational base that could be placed at the center of the table. The base is surrounded by an array of electret microphones. From which direction the sound is coming from can be decided by analyzing the received signal magnitude at each microphone. The 2 main speakers, if any, of the ongoing conversation can be determined. A micro-controller will control a motor to rotate the camera to face itself to the speaker. There would be two cameras working together and they can be rotated to different angles and record two scenes if two people are talking (e.g. one asking question & one answering). Then the information would be sent to a computer to automatically generate splits-screens. Otherwise only one camera will be recording.

1.2.2 Functions:

- 2 HD webcam that record 2 speakers.
- 2 webcams can rotate 360 degree independently.

- If two people are talking, two cameras can be rotated to different angles and automatically generate splits-screens.

1.2.3 Benefits

- Recording meeting process without cameraman and at a lower cost.
- Provide a solution to best capture information exchanges (e.g. Q&A, argument or discuss) between two people during the meeting.
- Auto-generated split-screen simplifies post production.

1.2.4 Features:

- High-quality video conferencing
- Cameras are able to rotate to the eight different directions.
- Splits- screens show two people who are talking.

2. Design

2.1 Block Diagram

- Function-units data flow

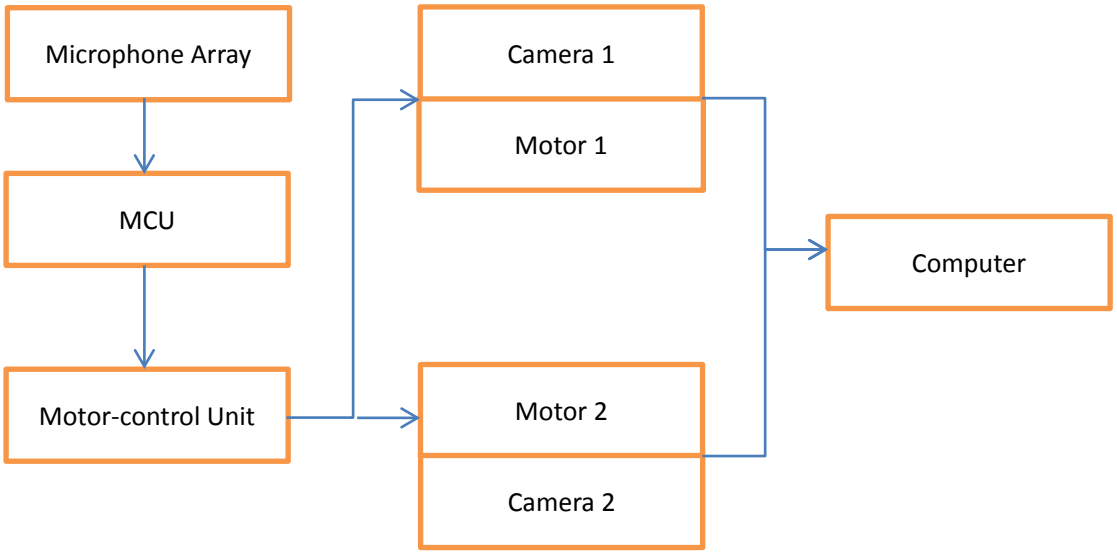

Figure 1. Data flow diagram

- power supply diagram

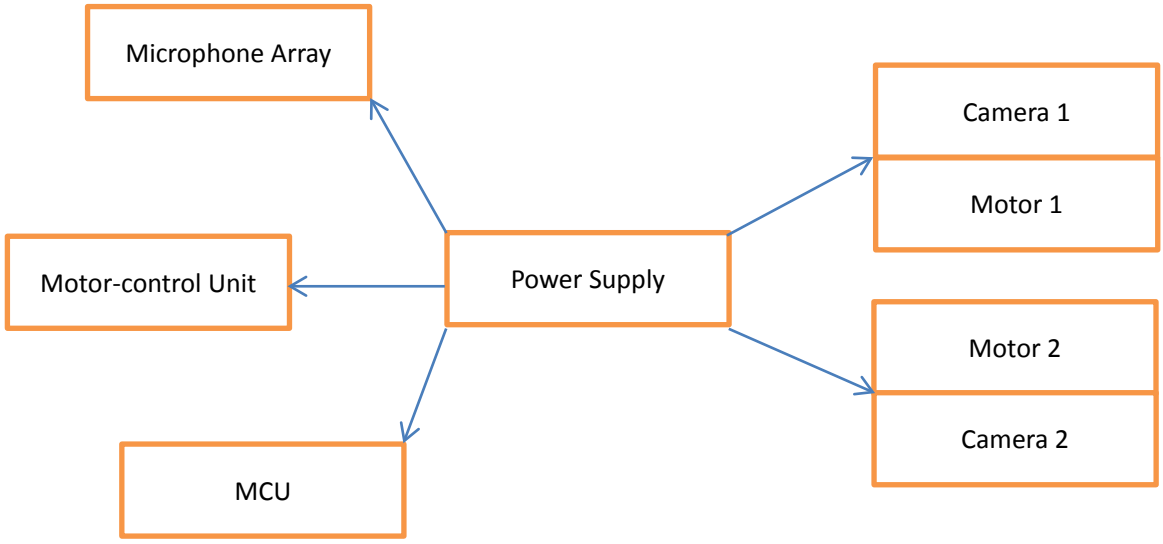

Figure2 Power supply diagram

2.2 Block Description

- Microphone Array

This module would consist of 8 microphones located around a circle separated by equal angle and distance. When a person speaks, the magnitude of sound signal received at each microphone would differ. By analyzing which microphone has received the strongest signal, we could generally figure out the direction at which the speaker is sitting around the table. The information of the Microphone Array would be collected and analyzed by the Micro-Controller Unit (the MCU module) to make the decision of the direction of the speaker.

- MCU

This module is the central control unit of the system. It collects data from the Microphone Array, decides in which direction the speaker is located, and controls the Motor-control Unit. It would tell the Motor-control Unit how to direct the motor movement. A learning algorithm will be running on the MCU to determine the main speakers (for this project, up to 2 main speaker will be located).

- Motor-control Unit

This module receives data from the MCU module and controls the two motors to move to a certain direction so that the camera would be directed at the speaker.

- Motor 1/Motor 2

This module would be controlled by the Motor-control Unit. Both motors can rotate 360 degrees as needed. They will individually carry a camera (Camera 1 and Camera 2) to direct in an appropriate direction to record the speaker.

- Camera 1/Camera 2

This module is connected with the motors. The direction that cameras are directed is decided by the rotation of the motors. Cameras will keep recording information and send data to a computer for processing.

- Computer

This module collects information from the cameras and processes the data. If two speakers are identified, it will generate a split screen automatically. If not, it will show the image of the camera that is directed at a speaker and ignore the one that is not.

- Power Supply

This module handles the power supply of the Microphone Array module, the MCU module, the Motor-control Unit module, the motors and the cameras.

2.3 Performance Requirements

- Noises, coming from sneezing and coughing, will not trigger the recalculating of camera direction. The sensor can distinguish different sound sources within a range of 3 meters.

- When there are more than 2 people participate the conversation, the two people who speak most frequently can be distinguished and recorded.

- The reaction time for the camera rotation after the microphone receiving the sound should be less than 1s

3 **Verification**

3.1 Testing procedure

-Microphone Array: The Microphone array will be tested by sounding input from different position within a 3-5 meter radius and the output will be monitored using oscilloscope.

-MCU: The MCU will be tested with the Microphone Array. Different test cases (e.g. one people talking & multiple people talking) will be tested on the MCU. The output can be displayed on the monitor indicating the target direction of the camera.

-Motor Control Unit: It will be tested using test benches programed on the MCU. In other words, MCU will be pre-programed and will give inputs to the Motor Control Unit.

- Motor and Camera: the rotation of Motor can be tested using the input from function generator. We can use protractor to measure angle of rotation.

- Computer: only the split screen function should be tested. We can simply input two video signal and see if can generate the split screen correctly.

3.2 Tolerance Analysis

The tolerance analysis mainly focuses on:

-The error of voice source detection caused by the geometry of the microphone array and the factor of noise. The goal is to have the difference between actual source and calculated source to be within 5% (i.e. within 20 degrees), so that the camera will still be able capture the speaker in the frame if not centered in the frame. We will test the tolerance by setting up all possible scenarios:

1. Only one speaker
2. Two speakers talking simultaneously / separately.
2. Two speakers sitting close to each other / away from each other.
3. Two speakers with some noise (machine noise or noise from other people).
4. Multiple speakers.

-The error of camera rotation:

We will analyze the cause of error of camera rotation if there is any. Again, our goal is to

limit the error within 5% (less than 20 degrees) for the same reason stated above. We will measure the tolerance by feeding the motor control with pre-calculated values so we know where the camera should be pointing at after the rotation.

4 Costs and Schedule

4.1 Cost Analysis:

4.1.1 Labor

Name	Hour Rate	Total Hours Invested	Total
Qi Yang	$35.00	150	$13,125
Yuxiao Lu	$35.00	150	$13,125
Jiehan Yao	$35.00	150	$13,125
Total		450	$39,375

4.1.2 Parts

Item	Quantity	Unit Cost($)	Total Cost
Mini Webcam	2	50	100
Microphones	10	3	30
Arduino Board	1	30	30
PCB	2	50	100
Resistor,Capacitor,Inductors	?	n/a	20
DC Motors	2	4	8
Metal Station	1	30	30

4.1.3 Grand Total

Section	Total
Labor	$39,375
Parts	$318
Total	$39,693

4.2.0 Schedule

Week	Task	Responsibility
2/4	Finalize and Submit proposal	Qi Yang
	Review microphone specs and finalize selection	Jiehan Yao
	Propose voice source detection algorithm	Yuxiao Lu
2/11	Mock Design Review	Jiehan Yao
	Order MCU, microphones, motors	Qi Yang
	Finalize voice source detection algorithm	Yuxiao Lu
2/18	Finalize motor control unit design	Yuxiao Lu
	Design algorithm for voice targets selection	Qi Yang
	Finalize microphone array structure design	Jiehao Yao
2/25	Design Review, programming MCU	Qi Yang
	Testing microphone array functionality	Yuxiao Lu
	Testing motor functionality	Jiehan Yao
3/4	Finish circuit design for microphone array	Yuxiao Lu
	Finish circuit design for motor control unit	Jiehan Yao
	Testing all MCU functionality	Qi Yang
3/11	Finalize PCB design	Yuxiao Lu
	Testing input/output, identify/correct errors	Jiehan Yao
	Finish programming split screen function	Qi Yang
3/18	Order 1st revision PCB fabrication	Qi Yang
	Design/Order 1st revision rotational metal station	Jiehan Yao
	Tolerance measurement	Yuxiao Lu
3/25	Mock up demo	Yuxiao Lu
	Assemble different units on to the station	Qi Yang
	Testing overall functionality with the station	Jiehan Yao
4/1	Order final PCB fabrication	Qi Yang
	Design/Order final rotational metal station	Jiehao Yao
	Verification of specifications	Yuxiao Lu

4/8	Fix remaining bugs	Qi Yang
4/15	Ensure product completion	Qi Yang
	Tolerance analysis	Jiehan Yao
	Verification of specification	Yuxiao Lu
4/22	Finish preparing Demo	Yuxiao Lu
	Finish preparing final presentation	Qi Yang
	Finish preparing paper	Jiehan Yao
4/29	Demo / Checkout	Jiehan Yao
	Presentation	Qi Yang
	Paper	Yuxiao Lu