ECE 445

SENIOR DESIGN LABORATORY

PROPOSAL

InWhat: An Intelligent System for Wardrobe Proposal for ECE 445

Team #19

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1 Introduction

1.1 Background

Many people always worry about what to wear tomorrow and waste a lot of time trying to find the cloth they want. Moreover, with the improvement of living standards, people pay more attention to how to dress better and how to choose a satisfying outfit according to different needs. To solve these problems, our group came up with an amazing solution —— An Intelligent System for Wardrobe!

1.2 Solution

To address the problem stated above, we decided to build an intelligent system for the wardrobe. Whenever a user got a new cloth, he/she can wear the cloth and show the cloth to wardrobe. The wardrobe will take a photo of the cloth and label the cloth (labels could be "jeans", "collared", "woolen", "red", etc.). Moreover, the system will automatically allocate a coat hang for the new cloth. This is achieved by attaching a "Node MCU chip" with LED and button to the coat hang. This chip can exchange info with the remote server through Wifi connection. When the system finds a suitable coat hang, it will send a massage to light up that hang so that user can hang the cloth onto that. Then user will push the button to turn off the LED and notify the remote server that the new cloth has been successfully collected into the wardrobe. Every day when the user wakes up, he/she can ask the wardrobe to recommend what he/she should wear (the decision will be based on criteria like the weather, the place user want to go to, the color matched degree etc.) After the user become satisfied with what he/she will wear today. The wardrobe will use some method (e.g., LED light) to tell the user where the desired cloth is.

1.3 Physical Design

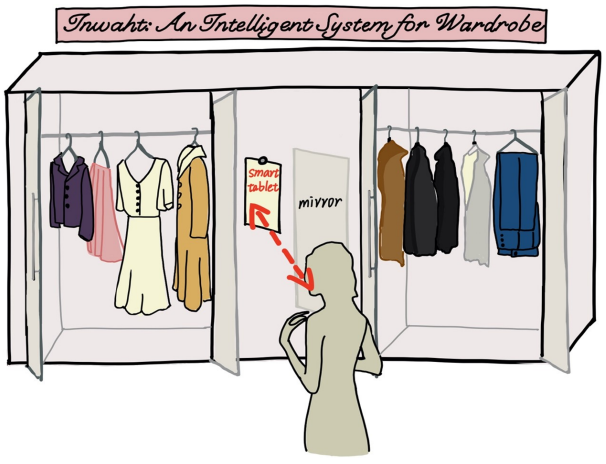

Figure 1: physical design

1.4 High-level Requirements List

- Must recognize the feature of the cloth put in with an acceptable accuracy.
- Must have a usable recommendation function that give some valuable suggestion.
- Must have a user-friendly interface.
- Must let the user easily and quickly find where the chosen clothes are.

2 Design

2.1 Block Diagram

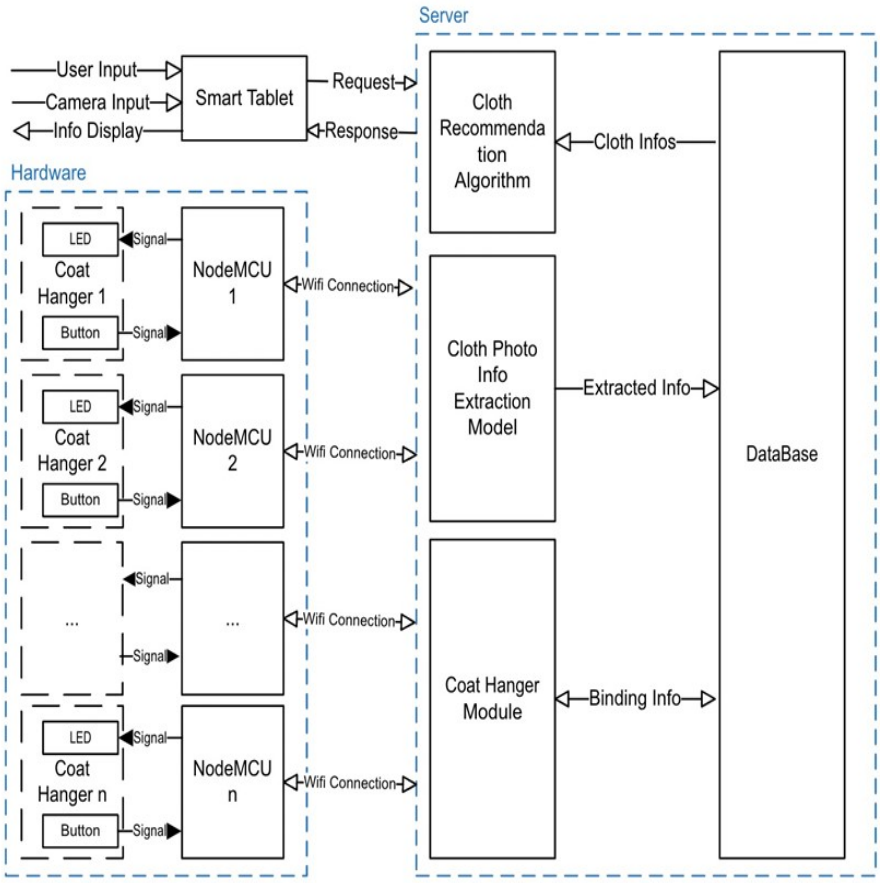

Figure 2: block diagram

2.2 Subsystem Overview

2.2.1 Coat Hanger

This subsystem is in the form of coat hanger. When a pair of clothes is registered, a unique clothes ID is bound to the hanger ID and recorded in the database. After a certain pair of clothes is selected by the recommendation unit, the back-end server will broadcast ID information to the hanger through WIFI. The corresponding hanger needs to be activated and passes sound or light that indicates the location of the clothes.

Requirements This subsystem works as a hanger, should be strong, light and corrosion resistant. Different from those traditional hangers, we need to provide areas for the placement and certain protection of WIFI module, acousto-optic module and power supply module.

2.2.2 Clothes Photo Info Extraction Subsystem

This subsystem serves as one of the core algorithms in our project, running in the back-end processor. The goal of this algorithm is to first achieve clothing parsing and segmentation to get bounding box and category information for each clothes detected from user's registered clothes. The second task here is to predict clothes attribute such as floral, striped or knit. For each category of clothes, we will simply to several attributes. To build this algorithm, we will mainly use the mmfashion[1], which is a fashion analysis toolbox developed by Multimedia Lab, CUHK.

Requirements This subsystem should be able to detect and generate bounding box of each single pair of clothes, a relatedly high detection accuracy is required. The attributes need to be adapted to our application scenario. The overall detection and prediction time should be limited to a short period of time to prevent users from waiting too long.

2.2.3 Outfit Recommendation Subsystem

This subsystem serves as another core algorithm, takes clothes image, category and attribute as input. Some ConvNets will be tried for image encoding and GloVe for attribute encoding[2]. We plan to Construct a three-dimensional graph structure, with similar (category, function etc.) clothes placed on the same layer, each node serves as one pair of clothes. A attributes-based distance function will be designed to determine the distance between each node. For the connectivity between different layer, we seek the advice of some fashion experts and establish rules, for example, evening dress and backpack are not suitable to use together. When generating an outfit, we use the idea of heuristic searching, for each layer we first find the several best matching items, then do the recommendation in the small group of graph structure.

Requirements This subsystem should be able to give high quality recommendation, which require us to give effective expert rules. For some of our potential customers, those who have too many clothes and need some advice on, the whole recommendation process should not take too long. Multiple recommendations need to be given to the user to choose from.

2.2.4 Interactive Subsystem

This subsystem is used for human-machine interaction. We will use Django for web and database control, A website will be designed for user accessing and database to store all the algorithm data and hanger-clothes pair information. Using our website, users can upload new clothes by taking photos, a virtual wardrobe feature helps users manage all their clothes, and an actionable display page of recommended clothes is for user to choose the one outfit to trace.

Requirements This subsystem should be easy to use for our users. The database should be supported by the basic function of CRUD. Security considerations need to be taken care of, and user data should be kept properly.

2.2.5 NodeMCU Subsystem

This subsystem is used for us to achieve the communication between our hangers and back-end server based on ESP8266 Wi-Fi MCU. We use MQTT as our communication protocol which designed for sensors or control devices with limited computing power and operating on low-bandwidth, unreliable networks. For each of our hanger, one MCU will be equipped, to communicate with our remote server for message acceptance (receiving the server's clothes trace request) and message sending (telling the server that the user has hung up his clothes).

Requirements This subsystem should be able to achieve the communicate between our server and hangers, the delay between them should not be too long and all messages send round trip should not miss their order or being dropped.

2.3 Risk Analysis

2.3.1 Failure of detecting attributes of the clothes accurately

Failure of detecting attributes of the clothes accurately. Fashion attribute detection is not an easy problem in the area of computer vision. Therefore our detection accuracy might not be too high. To deal with this, we should carefully select the attributes we want to detect and could allow use to aid the system to make some decisions.

2.3.2 Failure of the implementation of the hardware communication part

Since we have no EE student in our team and have no experience with Node MCU chip and Wifi communication, we may encounter some issue during the implementation of this part. To deal with this, we need to start the implementation of the hardware part as soon as possible to avoid encountering some trouble at the last second.

3 Ethics and Safety

3.1 Ethics

According to the ACM Code of Ethics, term 1.6 "ensuring the accuracy of data, understanding the provenance of the data... The retention and disposal periods for that information should be clearly defined, enforced, and communicated to data subjects..." [3], computing professionals should always take special care for privacy when merging data collections. For our project, to train our intelligent system and make it to recognize the characteristics of clothing, we must use a huge data set. The data set we want to use in our project collected by MMLAB (The Chinese University of Hong Kong), which is available for non-commercial research purposes and whose images are obtained from the Internet. Therefore, this public data set can be obtained for educational and research purposes and it is reliable and accurate to use.

Secondly, by the IEEE Code of Ethics, Section I Policy 5, " to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others."[4] Our group team welcome all the different opinion and criticism from all kind of groups such as sponsors, teaching assistance and classmates.

Moreover, if our group can successfully build this intelligent system, we should pay more attention to copyright issue. From the ACM Code of Ethics, term 1.5,"Computing professionals should therefore credit the creators of ideas, inventions, work... respect copyrights, patents... and other methods of protecting authors' works."[3] To protect the intelligent property of this project, we will save our work carefully and turn to legal protection if necessary.

3.2 Safety

The IEEE Code of Ethics, Section I Policy 1 "To hold paramount the safety, health, and welfare of the public... " is important when considering the use of some electrical devices. For example, for our battery use, which is mounted on NodeMCU, operates at about 3.3V and it is generally safe to use in our daily life. Moreover, the Wifi-enabled part of NodeMCU will not interfere with the operation of other wireless devices nearby.

References

[1] X. Liu, J. Li, J. Wang, and Z. Liu, "MMFashion: An Open-Source Toolbox for Visual Fashion Analysis," in *ACM Multimedia 2021, Open Source Software Competition*, 2021.

[2] Y. Li, L. Cao, J. Zhu, and J. Luo, "Mining fashion outfit composition using an end-to-end deep learning approach on set data," *IEEE Transactions on Multimedia*, vol. 19, no. 8, pp. 1946–1955, 2017. DOI: 10.1109/TMM.2017.2690144.

[3] ACM. "ACM Code of Ethics and Professional Conduct." (2018), [Online]. Available: https://www.acm.org/code-of-ethics (visited on 03/09/2022).

[4] IEEE. ""IEEE Code of Ethics"." (2016), [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html (visited on 02/08/2020).