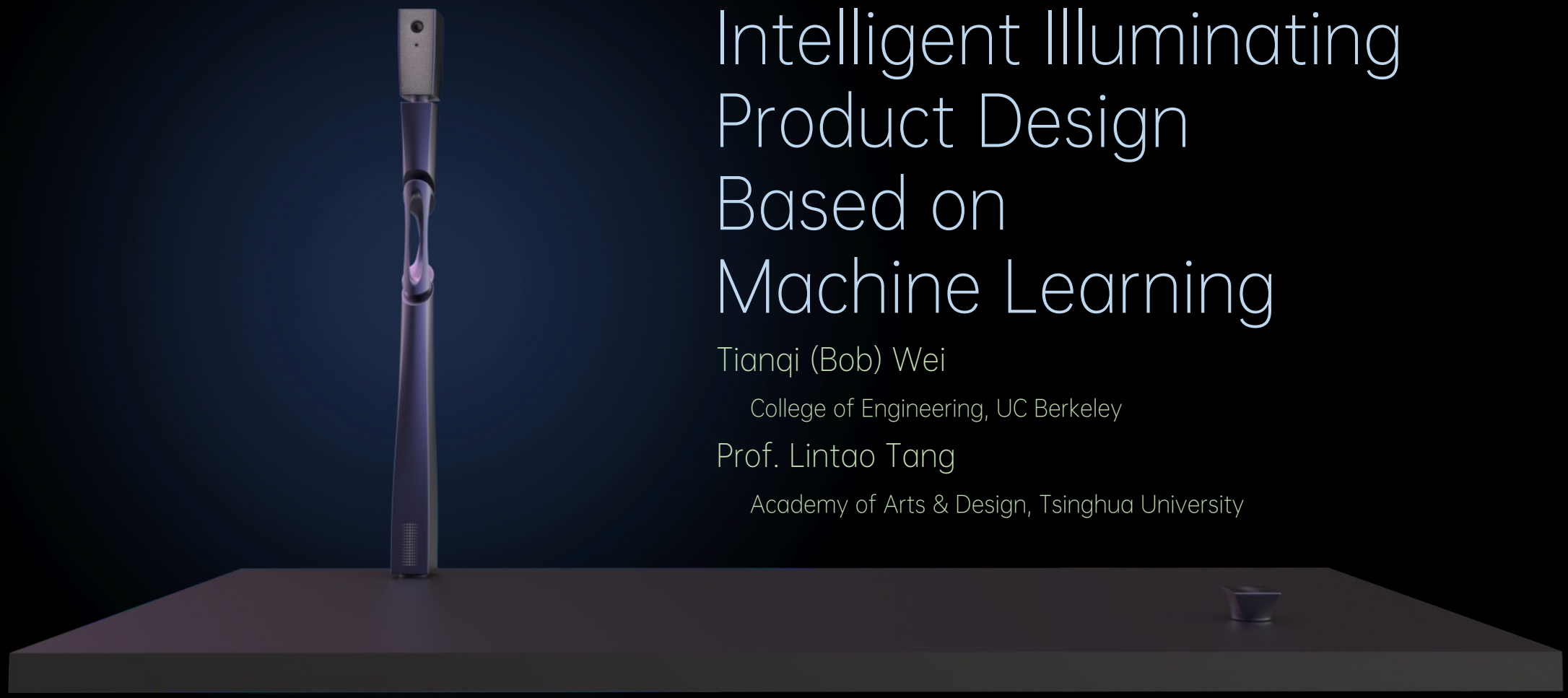

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10/2023

Intelligent Illuminating Product Design Based on Machine Learning

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Background and Reasons for the Topic

Current State of Smart Homes:
Automated Programs

Artificial Intelligence:
Dynamically Adjusting Results Based on Changing Data

Artificial Intelligence → Smart Homes
↓
Capable of Learning Human Behavior for Improved Service
Automatically Providing Optimal Lighting Solutions in Different Scenarios

Adapting to Nature (Nature Demanding Human Adaptation through Light Patterns)
↓
Breaking Away from Nature and Rebuilding Human Order
(Society Forcing Conformity to Order)
↓
Intelligence: Treating Humans as Fully Respected Entities
(Letting Life Adapt Naturally to Individual Habits)

Human Utilization of Light has Experienced These Two Phases

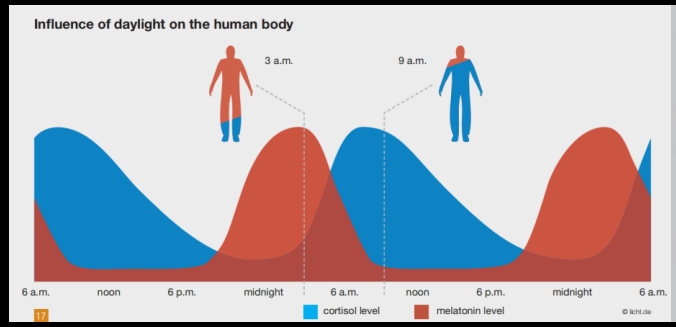
The Future of Human Utilization of Light

Enabling Smart Home Products to Proactively Learn and Adapt to Human Lifestyles

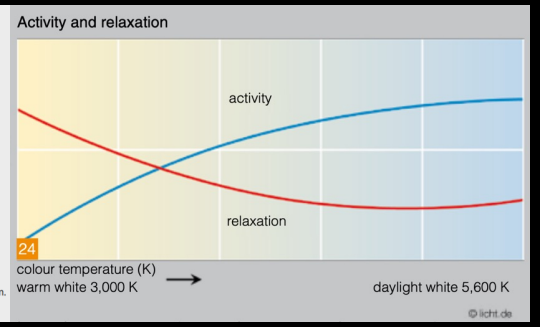
I aim to leverage design to advance artificial intelligence in better serving humanity.

Topic Area: Biologically Effective Lighting

Light Impact on Hormone Levels in the Human Body—Proper Lighting Contributes to Health and Quality of Life.
Light Influences Mood and Work Efficiency.
Biologically effective artificial lighting plays a crucial role in stabilizing human circadian rhythms.



The Effect of Sunlight on Cortisol and Melatonin Levels in the Human Body. Indoors, lighting with non-visual effects can replicate the impact of natural light. It particularly plays a vital role in stabilizing human circadian rhythms.



The Impact of Different Color Temperatures of Light on People. From a biological perspective, warm white light has a relaxing effect on the body, while daylight white light promotes activity.

Issues Identified and Proposed Solutions

· Lighting Affects Health and Work Efficiency

Lighting that does not align with circadian rhythms has negative effects on health. Good lighting promotes both efficient work and health.

· Machine Learning Technology Can Help Intelligent Lighting Products Promote Health while Adapting to Individual User Needs

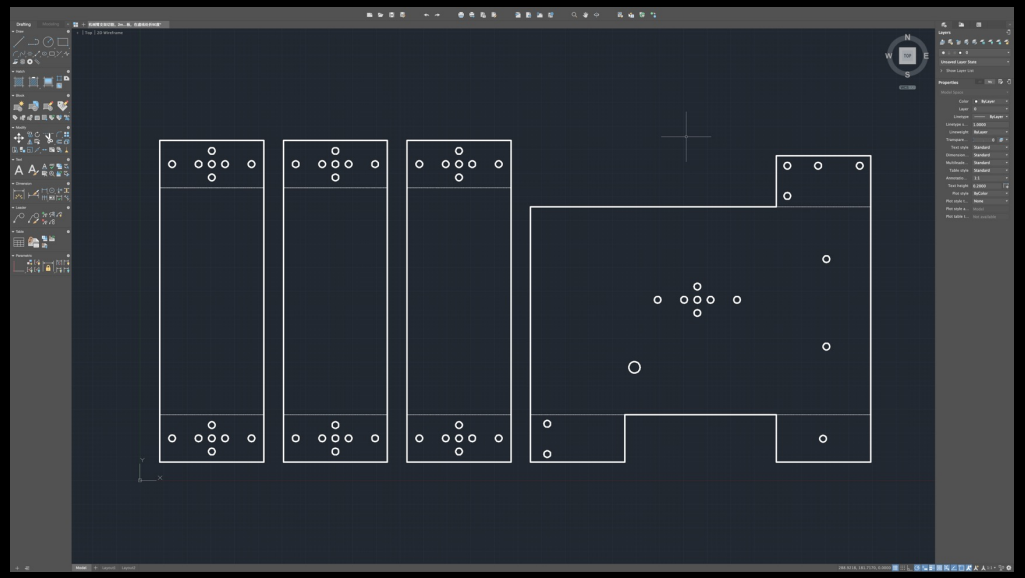
Existing smart home products lack the ability to learn from user data and improve results. I aim for intelligent lighting to adapt to users' biological clocks rather than making users conform to the lighting product's circadian rhythms. Provide healthy lighting tailored to users' habits for every type of task.

Design and Implementation of Intelligent Lighting Products

Overall Architecture of Intelligent Lighting Products: Product Form

Hardware Design of Intelligent Lighting Products: Functional Model

Microcontroller: Raspberry Pi development board
2 LED lights for desktop and ambient lighting
Camera for object recognition
Projector for focused lighting mode
Servo motor for multi-angle adjustment of the lamp arm



Drawings in AutoCAD

LED: Ambient Lighting

Projector: Focused Mode Lighting

LED: Desktop Lighting

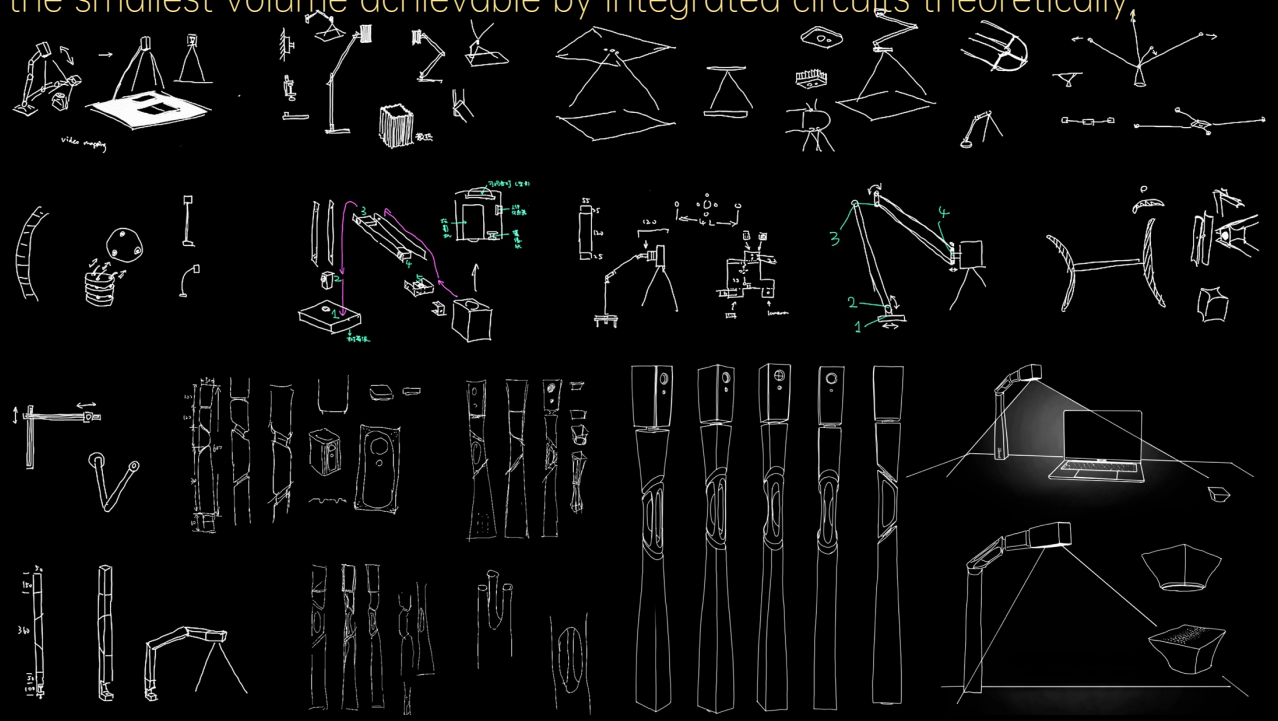
Servo: Provide multiple lighting angles

Camera: Capture desktop images

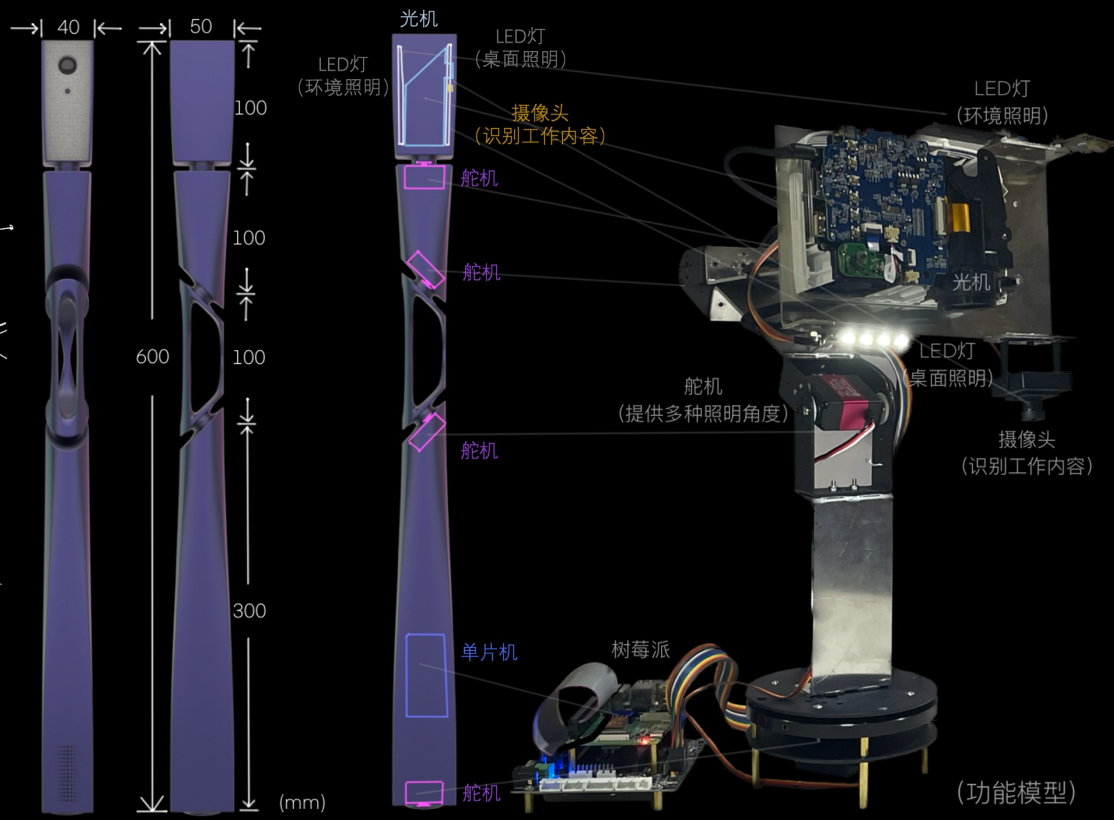
Raspberry Pi: Control hardwares

Hardware Design of Intelligent Lighting Products: Enclosure and Structure

The enclosure and structure design is driven by functionality,
Dimensions are defined based on lighting experiments and
the smallest volume achievable by integrated circuits theoretically.



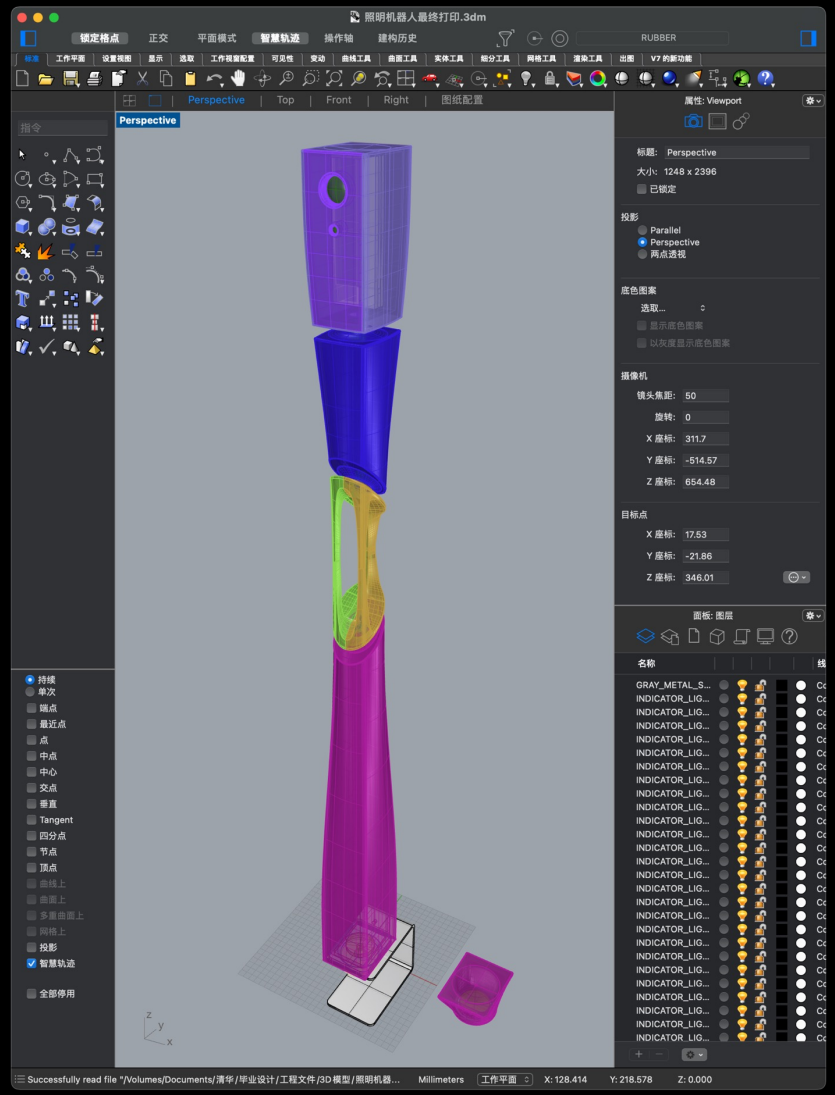
sketches



Correlation between dimensions, conceptual models, and functional model structure

Desktop lighting experiment process

Hardware Design of Intelligent Lighting Products: Enclosure and Structure



Rhino modeling

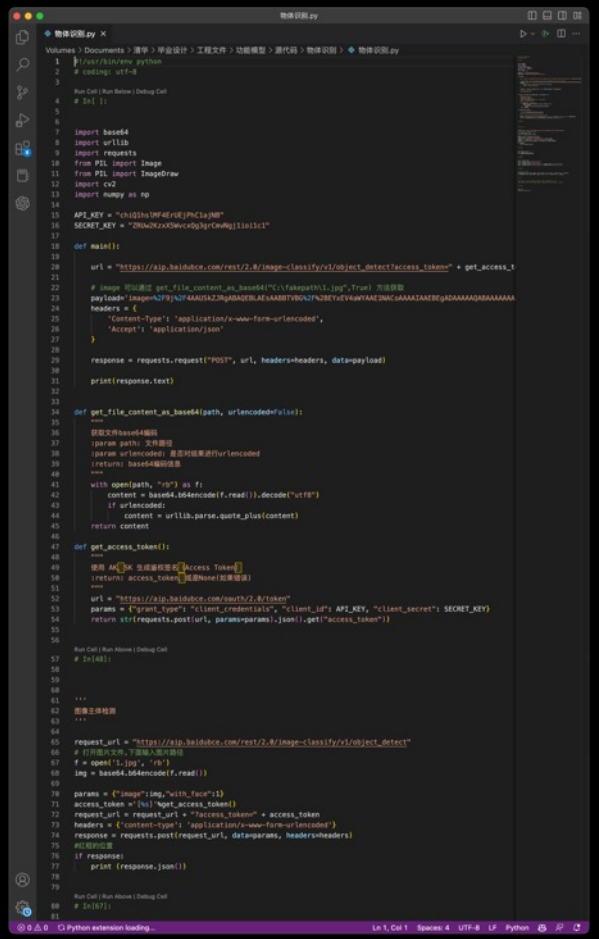
3D printing

Painting, installation of lights, and axis rotation.

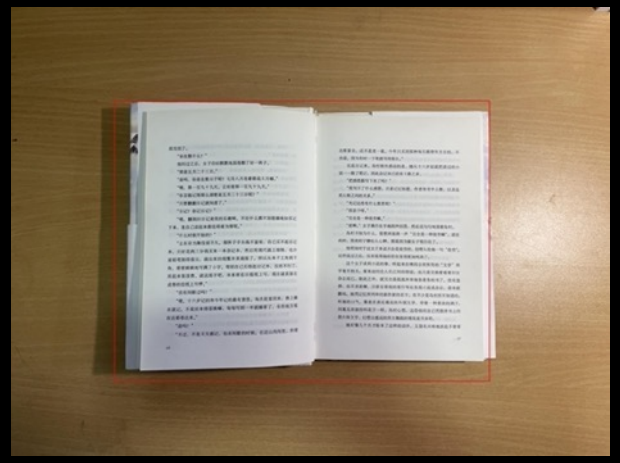
Software Design and Feature Implementation of Intelligent Lighting Products:

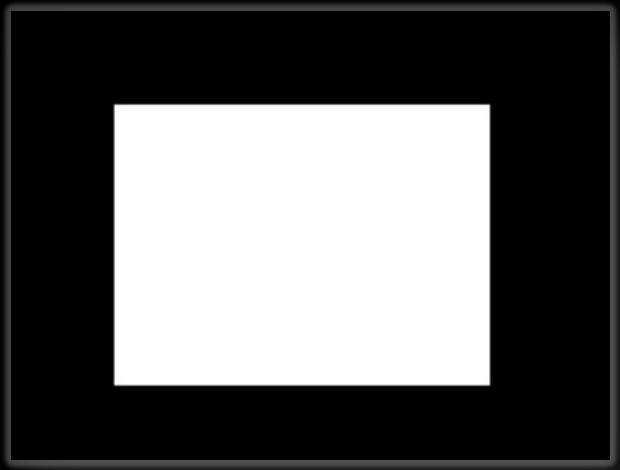
Focus Mode

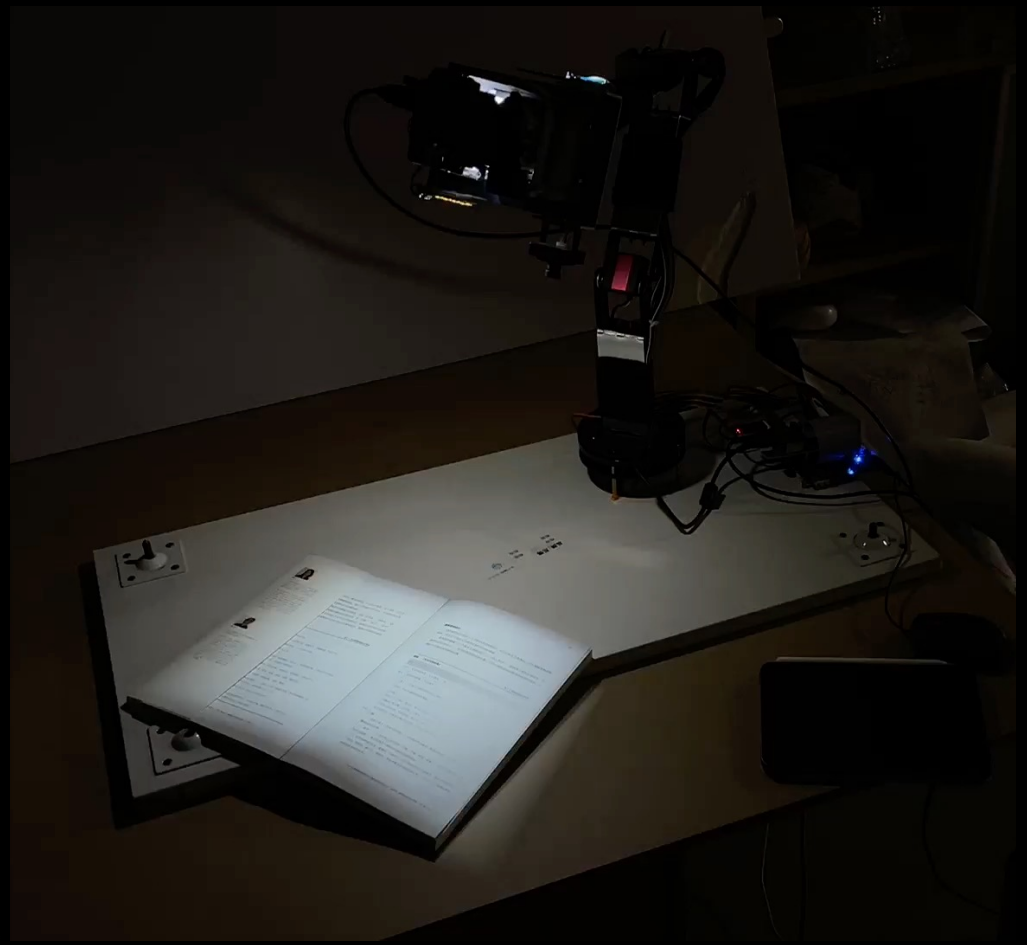
Utilizing the OpenCV library to extract contours from the desktop images captured by the camera, enabling the recognition of the book's position for accurate light projection.



```python
#!/usr/bin/env python
# coding: utf-8

# In[ ]:


import base64
import urllib
import requests
from PIL import Image
from PIL import ImageDraw
import cv2
import numpy as np

API_KEY = "chiQ1hslMF4EroEjPhC1aJ0P"
SECRET_KEY = "ZRUwZKzxX5WvcxOp3grCmvNgjiioiiC1"

def main():

    url = "https://aip.baidubce.com/rest/2.0/image-classify/v1/object_detect?access_token=" + get_access_t

    # image 可以通过 get_file_content_as_base64("C:\fakepath\1.jpg",True) 方法获取
    payload='image=%2F9j%2F4AAUSkZJRgABAQEBLAEsAADBTVBGk2f%2BEYyEV4aWYAAE1NACoAAAAIAAEBEgADAAAAAQABAAAAAA
    headers = {
        'Content-Type': 'application/x-www-form-urlencoded',
        'Accept': 'application/json'
    }

    response = requests.request("POST", url, headers=headers, data=payload)

    print(response.text)


def get_file_content_as_base64(path, urlencoded=False):
    """
    获取文件base64编码
    :param path: 文件路径
    :param urlencoded: 是否对结果进行urlencoded
    :return: base64编码信息
    """
    with open(path, "rb") as f:
        content = base64.b64encode(f.read()).decode("utf8")
        if urlencoded:
            content = urllib.parse.quote_plus(content)
    return content

def get_access_token():
    """
    使用 AK，SK 生成鉴权签名（Access Token）
    :return: access_token，或是None(如果错误)
    """
    url = "https://aip.baidubce.com/oauth/2.0/token"
    params = {"grant_type": "client_credentials", "client_id": API_KEY, "client_secret": SECRET_KEY}
    return str(requests.post(url, params=params).json().get("access_token"))


# In[48]:


'''
图像主体检测
'''

request_url = "https://aip.baidubce.com/rest/2.0/image-classify/v1/object_detect"
# 打开图片文件，下面输入图片路径
f = open('1.jpg', 'rb')
img = base64.b64encode(f.read())

params = {"image":img,"with_face":1}
access_token = '[%s]'%get_access_token()
request_url = request_url + "?access_token=" + access_token
headers = {'content-type': 'application/x-www-form-urlencoded'}
response = requests.post(request_url, data=params, headers=headers)
#红框的位置
if response:
    print (response.json())


# In[67]:
```







Camera captures image → Contour extraction → Output illuminated area.

video

Software Design and Feature Implementation of Intelligent Lighting Products:

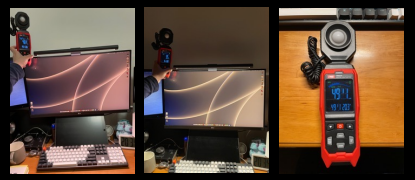
Intelligent Lighting Tailored to User Work Habits and Needs

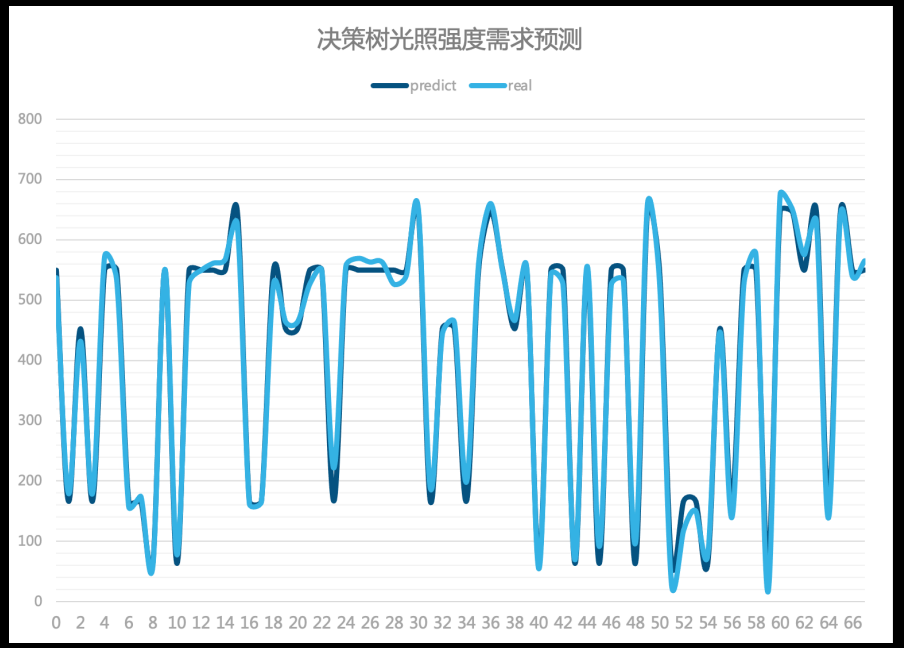
By utilizing the object recognition function of an AI open platform, the detection of objects on the desktop is carried out, collecting data on corresponding objects present on the desktop under various user behavioral patterns. This data is then used for training machine learning models.
A CART (Classification and Regression Tree) tree model is employed to fit the collected user data. With the accumulation of data and continuous training, the model should be able to provide the best lighting configuration in various scenarios.

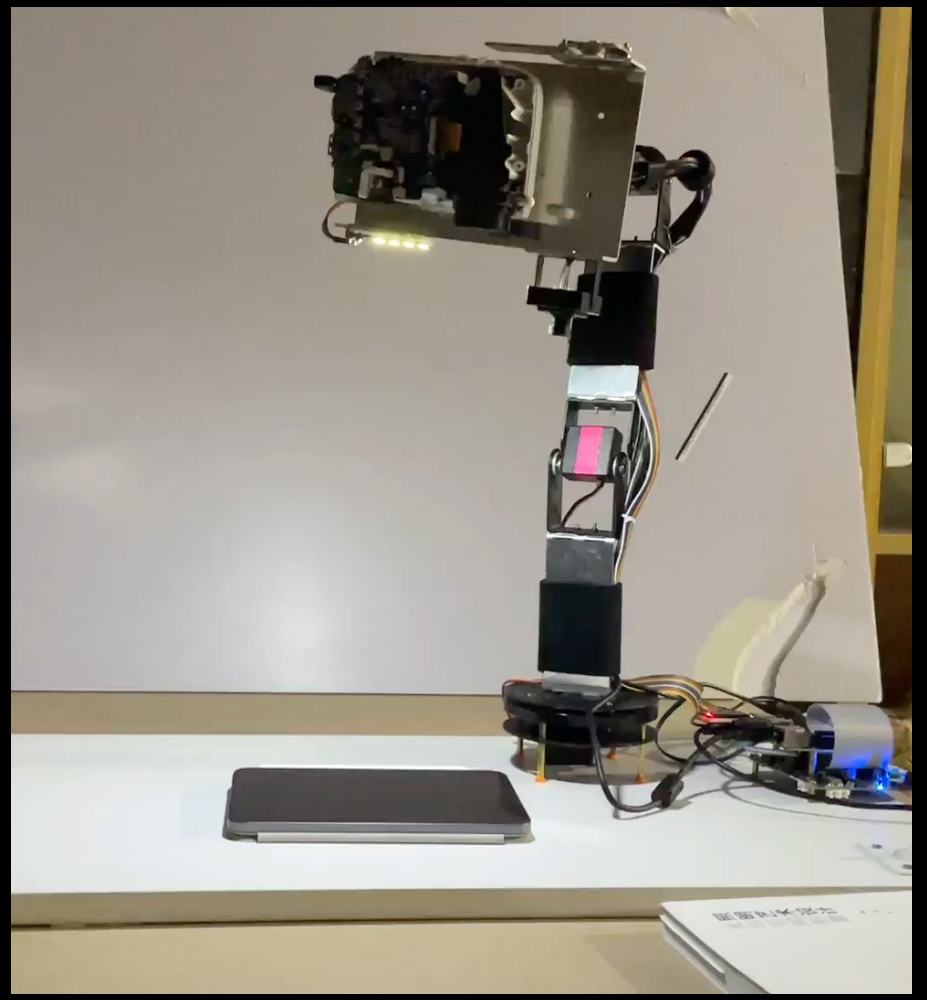
```python
#!/usr/bin/env python
# coding: utf-8

# In[32]:

#调用相关工具包
from sklearn.tree import DecisionTreeRegressor
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_absolute_error

# In[40]:

#加载数据
df = p  read_excel(r"C:\Users\admin\Desktop\l
ightdxlsx")

# In[41]:

#将数据集划分为训练集和测试集(70%训练，30%测试)
x, y = df[["situation","weather"]], df["light"]
x_train, x_test, y_train, y_test = train_test_split(x
,y,test_size=0.3)

# In[42]:

df

# In[44]:

#训练并且在测试集中检验
regr=DecisionTreeRegressor()
regr.fit(x,y)
#输出预测结果
y_predic=regr.predict(x_test)
#用绝对平均误差作为衡量标准
mean_absolute_error(y_test,y_predic)

# In[58]:

a.to_excel('excel_output3.xls',sheet_name='biubiu')

# In[57]:

a["real"]=y_test.reset_index(drop=True)
```

列名	解释
weather	包含两种情况：-1为晴天，1为阴天
situation	包含三种情况：1纸质阅读、2使用电脑、3使用手机
light	光照强度，单位为lux

The dataset is obtained from experimental collection, and the light intensity settings in different scenarios are also referenced from the standards outlined in documents from the German Lighting Association.







The machine learning code and model results (data visualization) have an average error of around 16 lux, which is imperceptible to the naked eye in terms of brightness differences.

2023 Undergraduate Exhibition
Academy of Arts & Design
Tsinghua University

Thank you!

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