Project Proposal: Smart Gate System with License Plate Recognition and Environmental Controls

1. Introduction

This project aims to develop a smart access control system for a parking garage that automates the opening of a barrier gate and a garage door based on vehicle recognition and environmental conditions.

Core Functionalities:

- **License Plate Recognition (LPR):**
  A camera module captures images of incoming vehicles. Using image processing and machine learning, the license plate is recognized and matched against a list of authorized plates.
- **Barrier Gate Control:**
  Upon successful recognition and authorization, a servo motor opens the barrier gate automatically.
  PIN Fallback: If the plate is unknown or not in the system, a PIN can be entered to open the gate as a backup method
- **Password Fallback:**
  If the vehicle is not recognized, a local interface allows manual password input to request access.

- **Garage Access Management:**
  - A button has to be pressed in order to gain access to the garage.
  - A distance sensor detects whether the garage is currently occupied.
  - The garage door will not open if the parking spot is already taken.
  - A short flex sensor ensures no vehicle or object is under the door while closing or opening.
  - the garage door can be closed with a button inside the garage or maybe the short flex sensor sends a close-request after 30 seconds (if the car is parked more than 30 seconds)
  - The garage-door could also be closed automatically, when the safety short flex sensor hasn't been triggered once after 1 minute.
- **Light Automation:**
  A photocell sensor detects darkness and if the camera registers motion, an exterior light turns on.
  The light remains on until no motion is registered for a certain time period.
- **Web Interface:** A simple GUI visualizes:
  - Real-time system status: "Gate Open", "Garage Occupied", etc.
  - A log of the last few detected vehicles.

3. Project requirements

We have 5 different sensor-actuator combinations which are each implemented by one group member.

First, we have a camera that checks if the license plate is permitted to enter the property. We want to handle this by using a simple machine learning technique. If the license plate is recognized a motor will be notified to open the gate.

Another member will implement that if the license plate is approved to enter, the garage is checked by a pressure sensor, if a car is already parked in the garage. If this check is true, the garage will not open if a car parks. If no car is parked the garage should open and the car could park in there. The garage door can be closed simply by pressing a button inside the garage (maybe the pressure sensor sends a close request if a car is parked for more than 30 seconds).

Another member will implement another pressure sensor or a light barrier, located at the gate. This sensor should stop the gate to close while a car is in the way.

Another member will implement a gate opening system. This means a panel will be placed next to the door. If someone wants to open the gate from inside he can enter a pin-code to signal a motor to unlock the gate.

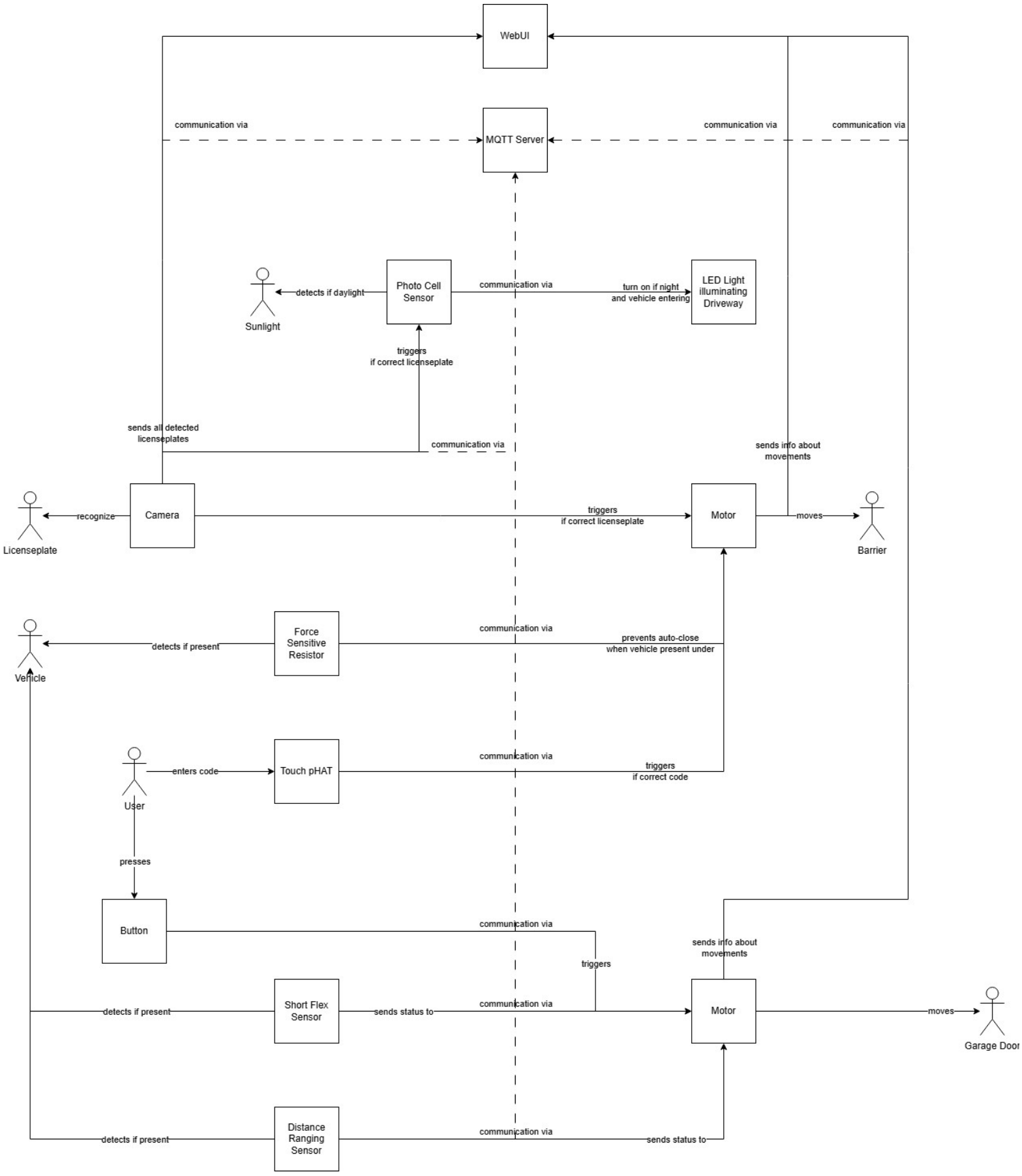
The last member will implement that a will turn on a light outside if two conditions are met. First, if the camera recognizes some kind of motion. Second if the daylight sensor recognizes that it is night time. This light will stay turned on till no motion is recognized for 30 seconds.

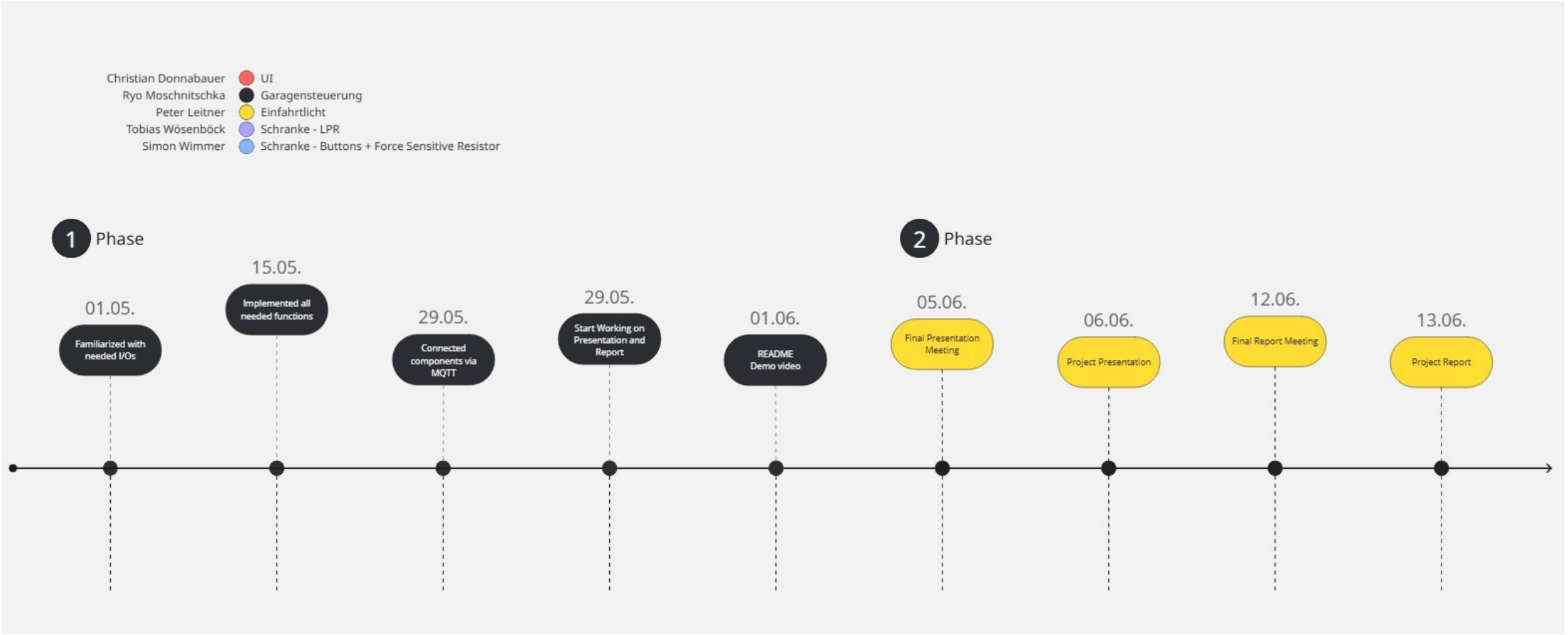
There will be many communications between two entities, for example, pi connected to the camera → other pi which is connected to the motor at the gate.

We will also create a GUI which can be accessed online. This will show, for example, if the gate is open or closed and if the light is on or off.

List of needed materials:

- Raspberry Pi 4
- Raspberry Pi Zero W Essential Kit
- Raspberry Pi 3 Model B
- Sensor pack 900
- 2x DC Motor in Micro Servo Body
- Adafruit Parts Pal
- Pimoroni Touch pHAT for Raspberry Pi Zero
- Short Flex Sensor
- Time of Flight Distance Ranging Sensor
- Raspberry Pi Zero v1.3 Camera Cable
- Raspberry Pi Camera Board v2 - 8 Megapixels


WebUI
communication via
MQTT Server
communication via
communication via
Sunlight
detects if daylight
Photo Cell Sensor
communication via
turn on if night and vehicle entering
LED Light illuminating Driveway
triggers if correct licenseplate
sends all detected licenseplates
communication via
sends info about movements
Licenseplate
recognize
Camera
triggers if correct licenseplate
Motor
moves
Barrier
Vehicle
detects if present
Force Sensitive Resistor
communication via
prevents auto-close when vehicle present under
User
enters code
Touch pHAT
communication via
triggers if correct code
presses
Button
communication via
triggers
sends info about movements
detects if present
Short Flex Sensor
sends status to
communication via
Motor
moves
Garage Door
detects if present
Distance Ranging Sensor
communication via
sends status to


Christian Donnabauer
Ryo Moschnitschka
Peter Leitner
Tobias Wösenböck
Simon Wimmer
UI
Garagensteuerung
Einfahrtlicht
Schranke - LPR
Schranke - Buttons + Force Sensitive Resistor
1 Phase
01.05.
Familiarized with needed I/Os
15.05.
Implemented all needed functions
29.05.
Connected components via MQTT
29.05.
Start Working on Presentation and Report
01.06.
README Demo video
2 Phase
05.06.
Final Presentation Meeting
06.06.
Project Presentation
12.06.
Final Report Meeting
13.06.
Project Report