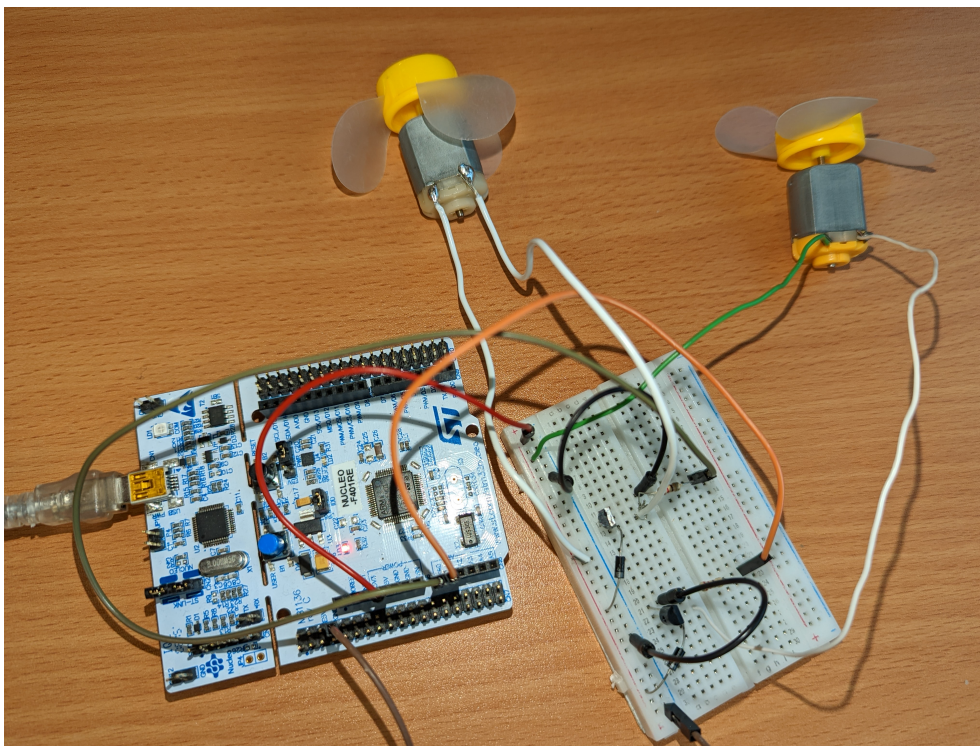


FLIGHT CONTROL UNIT PROTOTYPING AND SENSOR INTEGRATION OF MINI-BEE PROJECT



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1 Introduction

CY TECH is a French engineering school part of **CY Cergy Paris Université** based in Cergy-Pontoise. The goal of this school is to form the new generation of engineers who are more related to the management issue but still able to do all the tasks an engineer is supposed to do.

EISTI has been involved since the 90s and it became CY TECH in 2020 as part of **CY Cergy Paris Université**. Each year, older courses are replaced by new courses who are more useful to the future engineer.

This project has been realized by 3 student during their 3rd year of engineer degree in the INEM (Embedded Computing or Informatique Embarquée in French) option alongside several other schools. The purpose of this project is to **prototype the Flight Control Unit and to integrate sensors** of a bigger project : Mini-Bee. In addition to the class, we also have projects provided by companies such as this one, Mini-Bee which is provided by Technoplane and Xavier Dutertre, our supervisor within the company.

Mini-Bee is a new kind of aircraft, a hybrid between a lot of means of transport. The take-off is vertical, just like a helicopter, it can be controlled with a stick just like a plane, and with a steering wheel just like a car. It's smaller than a helicopter and can transport 2 people. It's purpose is to be a rescue intervention tool that doesn't cost as much as helicopters. It should be easily assembled and disassembled.

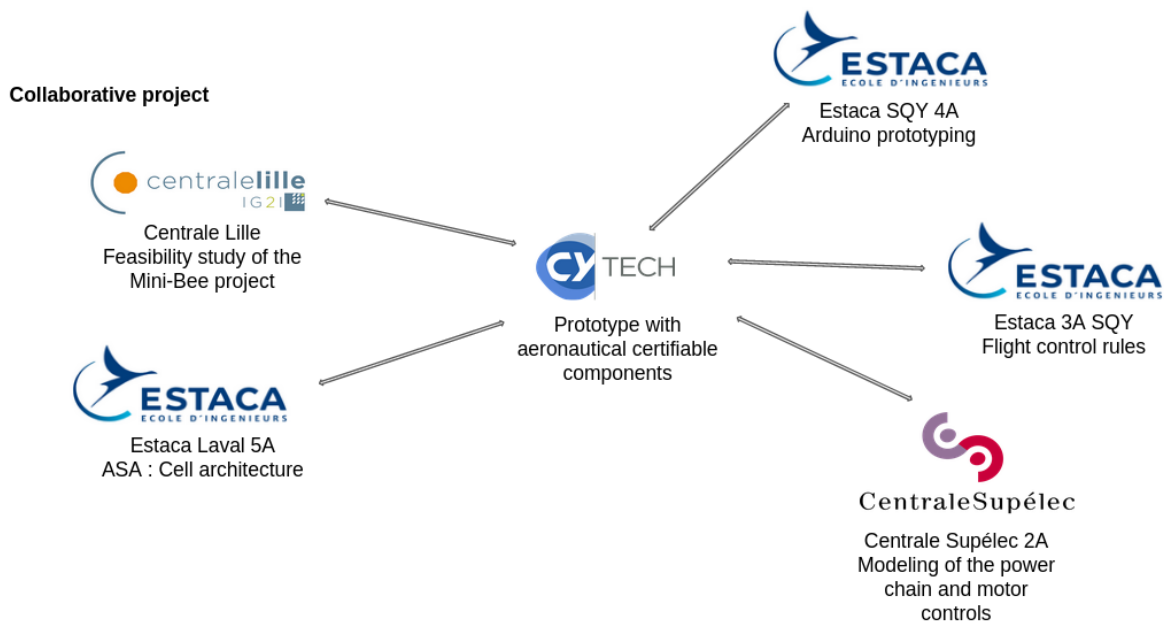


FIGURE 1 – Organization

2 Project description

Now we are going to present an overview of the project. Mini-Bee project is a lesser open source license project. Each year, the best schools in France work on it to improve the project.

This year, our CY TECH team worked on the FCU (Fly Control Unit). The FCU is what controls everything in flight, it handles all the sensors, manages the motors, the speed, the shift : it handles almost everything. This is the brain of the aircraft.

Alongside this, we had to choose the sensors that the FCU is going to control. Finally, we choose STMicroelectronics, a world wide known company that creates components that have the right qualification and are flight certified.



FIGURE 2 – STMicroelectronics

Then, we started the last part of our project, the prototyping. We choose a microcontroller, motors and coded a program that allows us to control the speed of multiple motors at the same time.

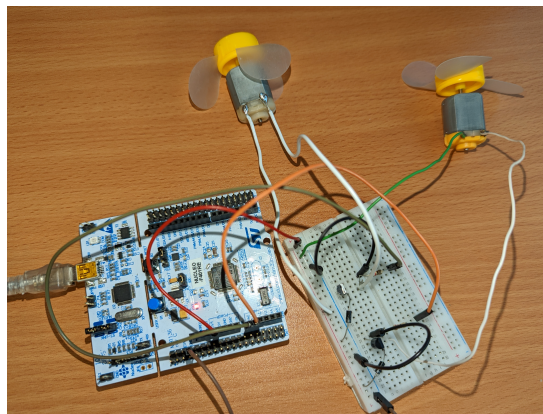


FIGURE 3 – Prototype

Composant	Fonction	Nombre
Carte STM32F401RE	Contrôler les moteurs et les capteurs	1
DC TT motor 3 - 6V	Entraîner les pales	2
Résistance 220 ohm	Lier la carte et les transistors	1
Diode rectifier 1N4007	Éviter les retours de courant	1
Transistor PN2222A6E	Gérer la puissance des moteurs avec le PWM	1

FIGURE 4 – Used components

```

while (1)
{
    // Get the state of the blue button
    stateOfPushButton = HAL_GPIO_ReadPin(GPIOC, GPIO_PIN_13);

    // Blue button not clicked
    if ( stateOfPushButton == 1 ) {
        HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_RESET);
        is_button_clicked = 0;
    } // Blue button clicked
    else {
        if (!is_button_clicked) {
            if (!strcmp(state, "do_nothing")) state = "max_speed";
            else if (!strcmp(state, "max_speed")) state = "turn_left";
            else if (!strcmp(state, "turn_left")) state = "turn_right";
            else state = "do_nothing";
        }
        is_button_clicked = 1;
        HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_SET);
    }
    if (!strcmp(state, "max_speed")) {
        i += 5;
        j += 5;
    } else if (!strcmp(state, "turn_left")) {
        i -= 5;
        i = max(i, 100);
        j += 5;
    } else if (!strcmp(state, "turn_right")) {
        j -= 5;
        j = max(j, 100);
        i += 5;
    } else {
        i -= 10;
        j -= 10;
    }
    i = min(i, 255);
    i = max(0, i);
    j = min(j, 255);
    j = max(0, j);
    HAL_TIM_SET_COMPARE(&htim2, TIM_CHANNEL_1, i);
    HAL_TIM_SET_COMPARE(&htim2, TIM_CHANNEL_2, j);

    HAL_Delay(100);
}

```

FIGURE 5 – Part of a code to make 2 DC TT motor 3 - 6V accelerate, decelerate using STM32F401RE board

3 Conclusion

To conclude, we can say that we managed to accomplish parts of the tasks we had to, our prototype is rather small but future teams that will work on the project will be able to understand what we made and to start fast into the coding part (development of the FCU). In the end, the project is a bit closer to the end, now begins the creation of a much larger prototype.