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ENEL351 Lab Design Project

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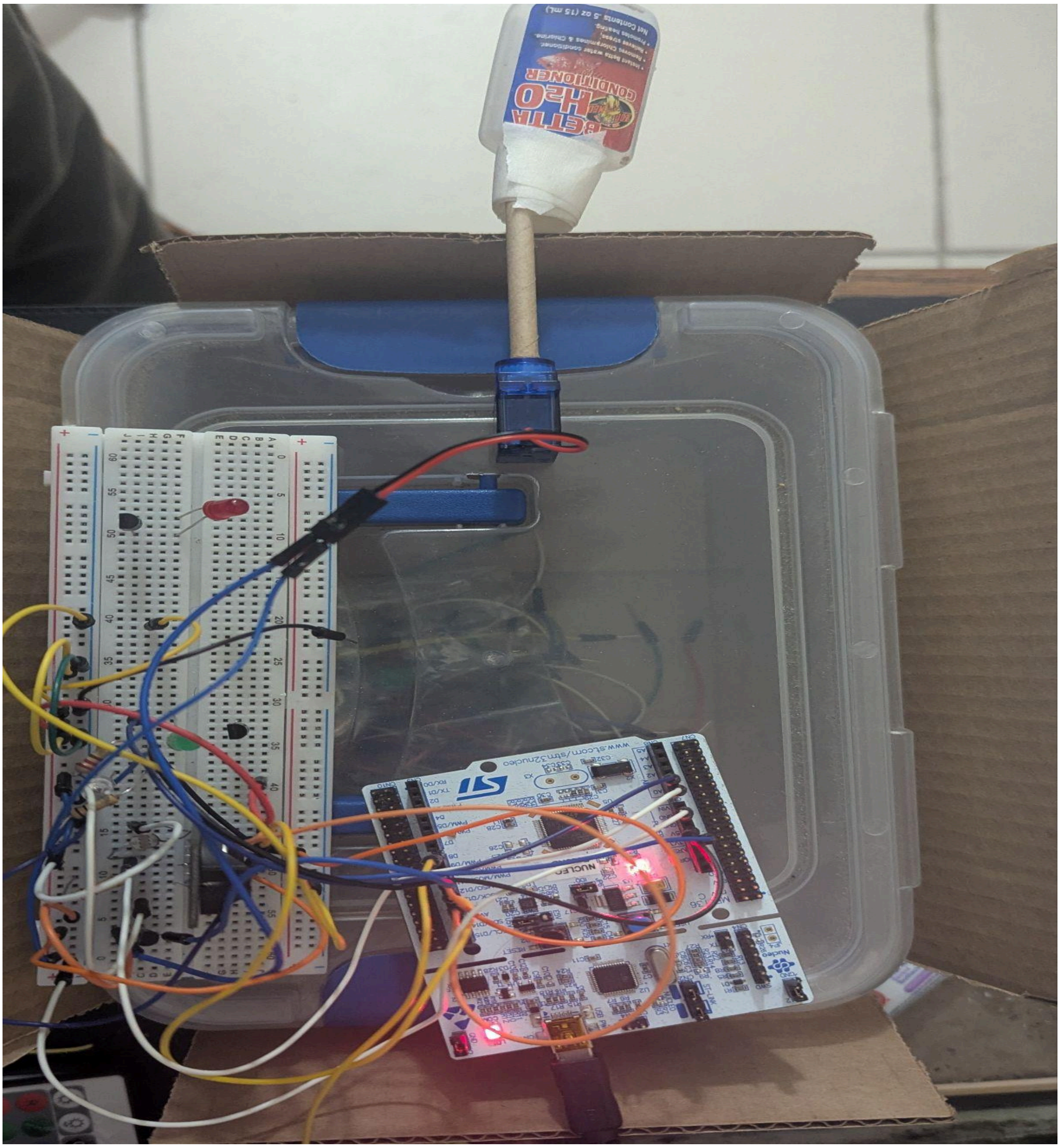

Smart Fish Feeder

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Final Project Report

Project Overview

For the ENEL351 Lab Design Project Component I decided to build a Fish Feeder System that fish owners could set up once and have it integrate seamlessly with their tank setup. System used the STM32F103RB microcontroller as its foundation. An LDR to detect ambient lighting and a servo motor to dispense food. Various visual and audio cues were planned too. Real-time data through USART serial communication which acted as a log of events and a handy debugger during the design process.

Design Process

The Fish Feeder system was designed iteratively, beginning with the core functional requirements: scheduled feeding, manual triggering, and environmental sensing.
Initial planning involved outlining feeding control using an RTC module, an OLED for display, and multiple pushbuttons for schedule interaction. However, based on complexity, component availability, and testing considerations, several hardware elements were simplified or replaced by code alternatives.

The motor control system was developed using PWM on PB6 via TIM4. Scheduled feed times were implemented using software-based timekeeping with TIM2, incrementing counters every second. Visual feedback was handled through a blinking LED on PA1 and a USART-based serial interface (PA9) provided time logging and text output monitoring through Tera Term.

Manual feeding was enabled using both a pushbutton (PC13). An LDR was added on PA0 to ensure feeding only occurred under ambient light conditions.

Testing Strategy and Procedures

A staged testing approach was used to verify system functionality:

1. Timer Verification:

- TIM2 was tested separately by toggling an LED every second to confirm accurate 1Hz interrupts.
- Timekeeping was validated by outputting clock values via serial monitor.

2. Motor Control Testing:

- TIM4 PWM output was verified using an oscilloscope and through direct motor response.
- LED blinking during motor activity was used as secondary confirmation.

3. LDR Response Testing:

- A multimeter was used to check resistance value of the LDR under bright, normal and dark conditions. A voltage divider circuit was used to get it power and connect to STM board for output.
- Feeding was allowed only when the threshold was surpassed.

4. Serial Communication Testing:

- USART1 TX on PA9 was verified through Tera Term output.

- Serial logs confirmed feed trigger events, clock updates, and debugging messages.

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Functional Changes Overview

There were a few things that I had to change from the functional spec. Here's a list of everything at the end and what changed along the way:

Initially planned Component	Planned Function	Final Spec	Rationale Behind Change
Pushbutton 1	Manual Feed trigger	Implemented	Used to feed anytime
Pushbutton 2	Increase feed interval	Implemented in software. Feeding times are adjustable	Pushbuttons would require changing time during runtime which I found too complex
Pushbutton 3	Decrease feed interval	Implemented in software. Feeding times are adjustable	Same as above
Reset Button	Reset	Available	
OLED	Show time and Set feeding times	Replaced by USART and Tera Term output terminal	After lab6, i realized debugging would be easier on tera term since I didn't need to configure a screen to get output.
Green LED	Normal Operation	Implemented	
RED Warning LED	Low food warning	Not implemented	Any sensors within the small food container would be inconvenient due to requiring a top-up of fish pellets anyway.
Servo Motor	Dispense food	Implemented	

Temperature sensor	Sense tank temperature	Replaced by LDR	Temp sensor would only be useful if it was waterproof. Since I couldn't find a part like that, and an LDR makes more sense due to early/late feeding times that could coincide with a poorly lit tank; I decided to swap out the temp sensor.

Future Work

- Mini LCD integration
- USART straight from the STM, instead of a separate cable
- Buzzer integration
- IR sensor for manual feeding

Conclusion

Completing the Smart Feeder project was both a technical challenge and a rewarding learning experience. While the original vision included features like an OLED display, live schedule adjustment, and RTC-based timekeeping, the final system evolved into something more streamlined and focused — without majorly compromising functionality.

The project also highlighted how sometimes the most reliable solutions are the simplest. From implementing PWM control for the motor to blinking LEDs as indicators, every feature was tested thoroughly, and refined based on real feedback during development.

I'm proud of how the system came together — from idea to working prototype — and it feels good knowing this is a project that can be realistically built, utilised, and even improved upon in the future.