SPRO3 report

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1   Introduction

Throughout history a certain industrial trend has become the most pronounced it has ever been, automation. Any and all tasks that could be automated in a financially viable way have seen at least one instance of it happening. This is due to the numerous benefits that an autonomous system can provide. In a similar vein our team also aimed at contributing to this phenomenon within the scope of the third semester project. The aim of the project was to make an autonomous intelligent vehicle.

Project work started with exploring the possible fields where such a vehicle could find sensible applications. A mindmap was used to order and keep track of various ideas. Some of these include a food and beverage delivery system both in a restaurant and home settings and some were related to various

2   Problem Formulation

In the third semester our professors assigned us a project where the focus was to be the importance of sensors and actuators with autonomous vehicles being one example. Following this lead the first topic that came to mind was logistics, more precisely forklifts. To investigate the applicability of such devices in the aforementioned field our team members conducted market research starting from two separate perspectives, one being more industrial and the other more social.

2.1   more like a problem formulation???

2.1.1   Forklift related accidents and injuries

Forklift related accidents are a common occurrence, both with solid stationery objects and moving pedestrians. According to data from "article 1" there a around 34,000 injuries from forklifts in the US every year. This results in a great number of lost work days and extra strain and pressure to make up the deficit.

Out of 143 incidents, where the collision happened with a solid object 75 of them are with stationery objects. And 53 of them are collisions between forklifts. Both of these types of incidents are related to human errors, like not paying attention to the surroundings when operating forklifts.

Out of 322 incidents involving pedestrians around 50% of them have been caused by a forklift striking a pedestrian by accident.

The safety of forklifts can be greatly increased with the use for sensors that enable the forklifts to avoid obstacles on their own, even with the human error factored in. This is similar to how safety in cars has been greatly improved in recent years.

2.1.2   Is there a market for self-driving forklifts?

Most companies are always competing to maximize the quality of the product while keeping the cost as low as possible. Many companies choose to outsource manufacturing to countries where, due to the lower average salary, they could further the aforementioned goal. This could achieve lower manufacturing prices but sometimes the quality suffered in turn. After learning this some companies choose to move manufacturing back to their origin. To stay competitive despite the higher costs, automating tasks can be a lucrative investment. For example having warehouses that can work 24 hours a day can greatly reduce certain costs. All without compromising the quality of the products.

2.1.3   Real-life applications

A research paper from a japanese university revealed that in countries with aging demographics autonomous vehicles such as an autonomous forklift are required to lighten the burden on manpower and manual labor. The authors of this paper detailed an autonomous pallet handling system for forklifts, which is able to handle pallets used for harvesting vegetables with no further human input in an outdoors environment. From a paper about aging populations it is stated that 11% of the world is over 60 years

of age and this ratio is expected to rise up to 22% in 2050. From a paper about aging populations it is stated that 11% of the world is over 60 years of age and this ratio is expected to rise up to 22% in 2050.

2.1.4   Conclusion

These four papers clearly indicate that there is indeed a market and an application of highly automated processes regarding logistics and forklifts as well. This is how our group came to the conclusion that an automated forklift would solve a relevant problem all the while fitting in the frame outlined by our professors.

## 3   Management
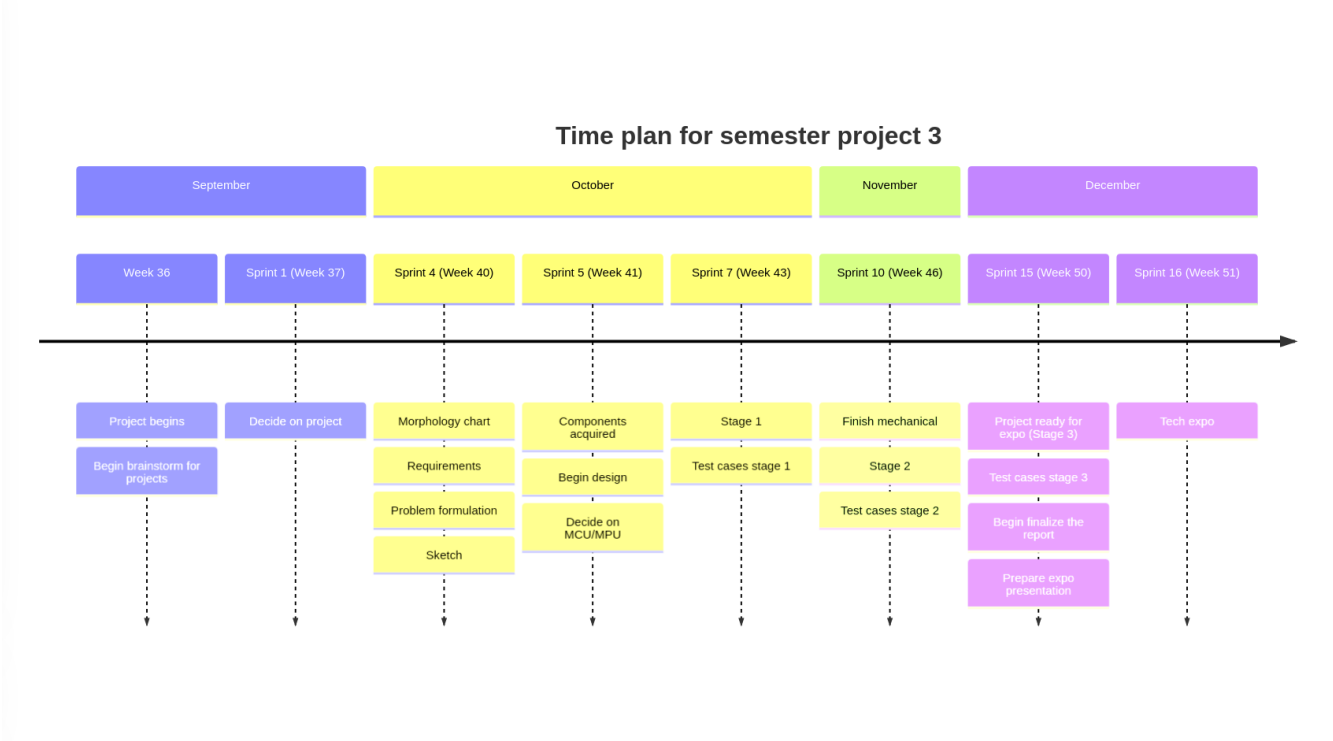
## 4   Consideration

5   Electronics

Introduction

One of the main focuses of this third semester project is analog electronics. Electronics bring the software and the mechanical part together. The software needs feedback from the analog world. It needs to know how heavy the load is and whether there is an obstacle in front. Furthermore, all the smart digital electronics need to be powered. But when powering everything from a battery the current state of the battery has to be evaluated. All these tasks are necessary to guarantee safe operations.

The tasks include the following:

- Interfacing the analog load cells
    - Loadcell PCB Design
- Power Supply and monitoring
-
    - VeroBoard Design
- Motor Drivers
    - Motor Driver PCB Design
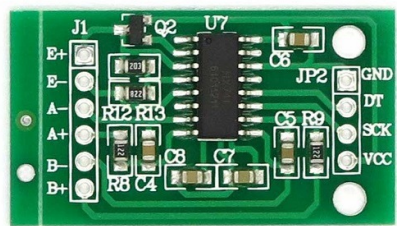
(a) HX711 Interface Module
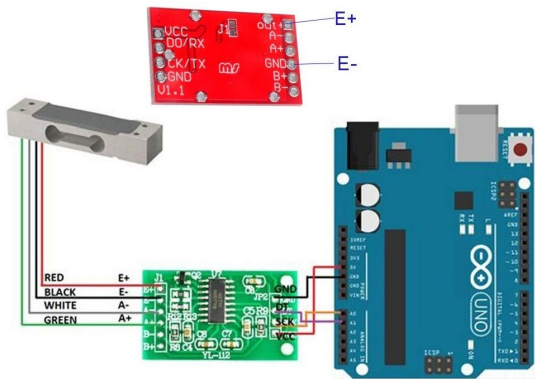
(b) HX711 Interface Module and Load cell using Arduino-microcontroller

6   Mechanical

7   Code

7.1   Why rtos

7.2   ADC

When programming the ability to use a ADC (Analog to digital converter) to read a analog value on the microprocessor is of crucial impotents. In our project the ADC is use for reading values from our infrared and load sensors. On the ESP32 a total of 18 ADC channels are available with a config resolution options of 9,10,11 and 12-bits.

7.2.1   Configuring

```
1       adc_oneshot_unit_handle_t adc1_handle;
2       adc_oneshot_unit_init_cfg_t init_config1 = {
3           .unit_id = ADC_UNIT_1,
4           .ulp_mode = ADC_ULP_MODE_DISABLE,
5       };
6       ESP_ERROR_CHECK(adc_oneshot_new_unit(&init_config1, &adc1_handle));
7
```

7.2.2   Reading

8   Testing

9   Conclusion

10   Appendix