LAPO CARRIERI

ROBOT ENGINEERING AT UNIVERSITY OF BOLOGNA AND UNIVERSITY OF SAPIENZA

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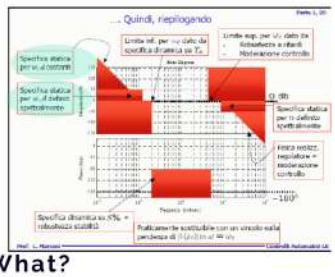
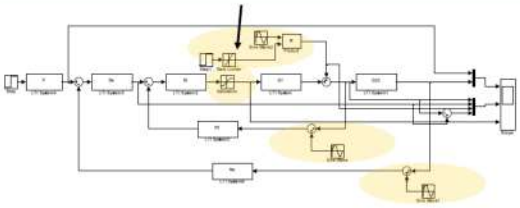
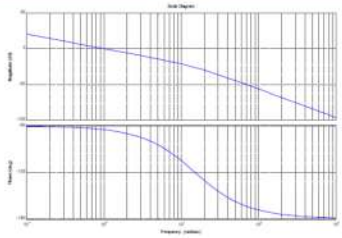
INTRODUCTION

This Portfolio contains all the main project that I have done in my University life. Every project was done alon or in group. Everyone shows up only a brief presentation of the project. To see the complete project you can take a look on my github account: https://github.com/lapocarrieri .
If you have any questions please send an email at lapo.carrieri@gmail.com .
This is the introduction of every project with the skills acquired

AUTOMATIC CONTROL PROJECT







What?

- regulate in Cascade with both open and closed loops considering static and dynamic design specifications. Everything taking into account p is an uncertain parameter.

How?

- To solve the problem we tried multiple possibility using PID cancellation and other techniques.

Results

- System controlled using respecting the threshold and the limitations

INTELLIGENT DECISION SUPPORT SYSTEM PROJECT

What?

- The project consists in the creation of a movie recommender system on a web interface to suggest movies based on topic or filtered selection

How?

- using word2vec and Cosine TFIDF Movie Description Similarity in order to develop a website user-friendly to choose the movie. With word2vec_model.ipynb the summaries of the movies is taken into account to find a movie that is similar to the chosen one, with Movie_reccomander_tfIDF.ipynb instead it is possible to choose the movie considering the reviews of the similar users.

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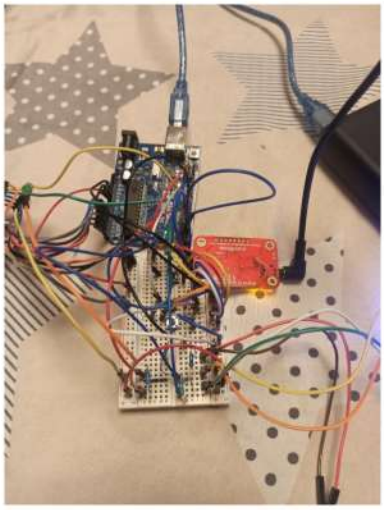
MATH ROBOT WITH ARDUINO



What?

- Design and fabricate a device that listens math question and answer
- Develop a Transformer and make it work in Arduino to understand the speech of people and Arduino code to handle the hardware part

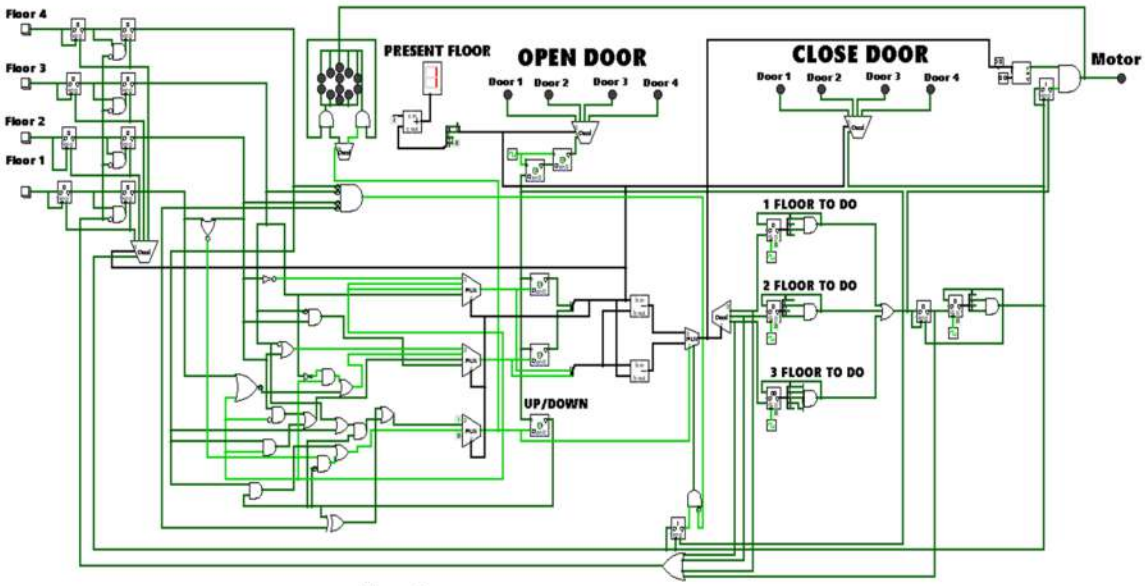
How?

- Used arduino and the Voice Recognizer
- Use pre-trained models in python.
- Manage everything programming in Arduino code

Results

- The robot answer only to precise pre-trained questions. With noise in the room it has difficulty in understanding but it replies with the precise calculation asked

LIFT-LOGICAL-NETWORKS-WITH-LOGISIM



What?

- Design of a lift electronic circuit to handle calls from 4 floors in a a logical-network world.

How?

- A clock is used to handle the time in the circuit,
- Some buttons store the signal 1 until the lift is free, then the call of the precise floor is taken into account based on priority and comfortable in respect to the direction of the elevator. All the logic is handled by ANDs, ORs and Flip Flops

Results

- Through the use of leds and a led arrow it is possible to see that the code work perfectly in every situation and handle every type of call waiting for the people going out

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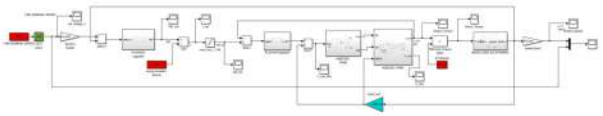
Simulink scheme of an electric drive

What?

- Simulink code to control an electric drive with cascade loops for the electronic and mechanical part

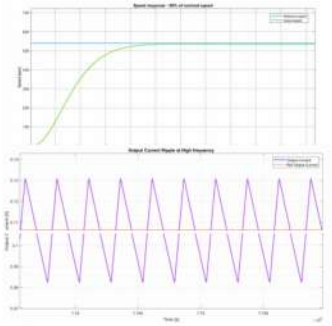


How?

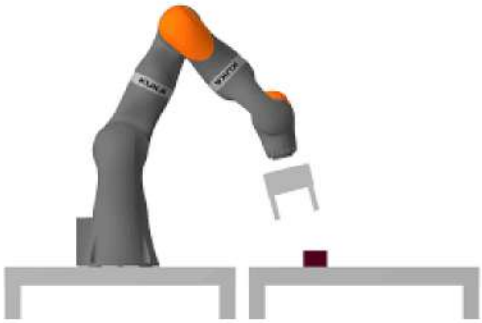
- Use of nested blocks with PID controller calibrated in order to have a good response

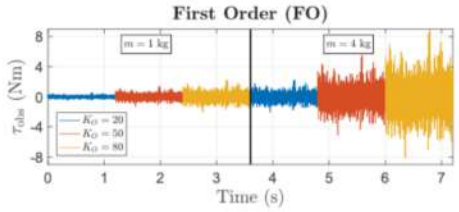
Results

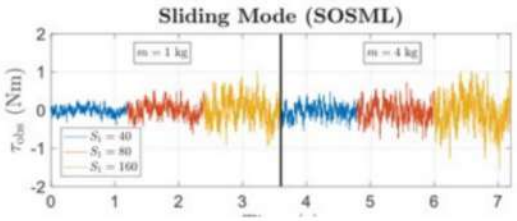
- The results are pretty good and the error oscillate inside the threshold



ROBUST COLLISION DETECTION AND ISOLATION







What?

- Robust collision detection and isolation on a 3R spatial (elbow-type) rigid robot having uncertain dynamics, with various switching/robustifying terms in the momentum-based residual

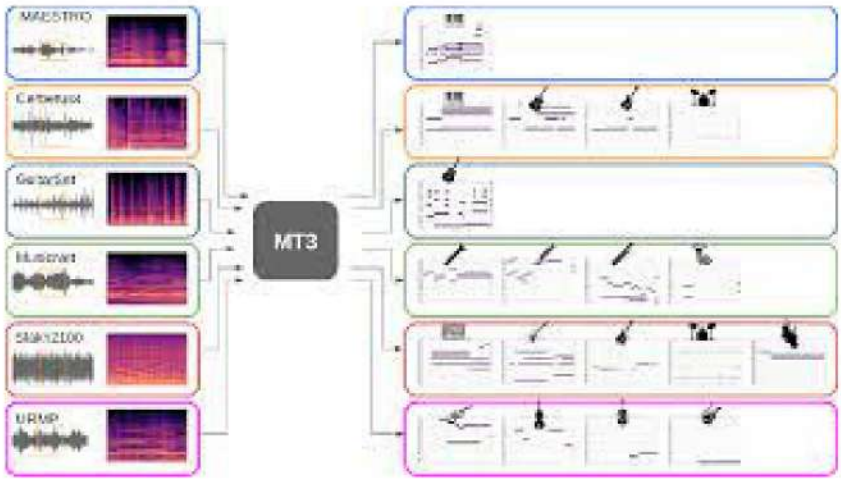
How?

-

Results

-

MULTI-TASK MULTITRACK MUSIC TRANSCRIPTION



What?

- download in the PC every possible song from the web, in particular it supports youtube. Then the downloaded mp3 file can be used to be tested in "Music Transcription with Transformers in order to get the MIDI transcription.

How?

- Used **Transformer to sample the music and transcribe in MIDI language**

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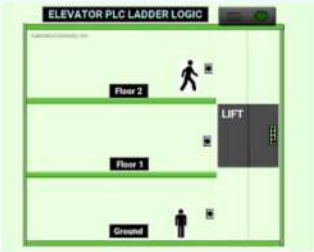
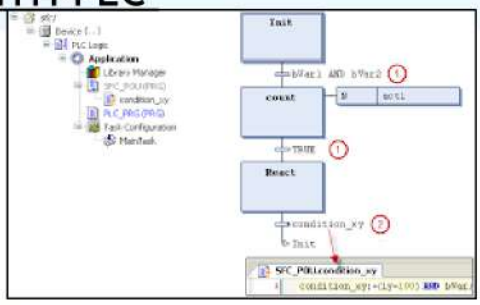
LIFT CONTROL SCHEME WITH-PLC





What?

- Control of an elevator using PLC language, The lif simulation is already given and the task is create GAs in order to handle I/O and handle the calls of the lift

How?

- GAs that control the opening of the lift and the lift speed and direction in order to handle with ST code the priority of the calls

Results?

- The elevator works perfectly and handles also faults of some of the sensors

COLLISION_AVOIDANCE-SAPIENZA_VISION_AND_PERCEPTION

What?

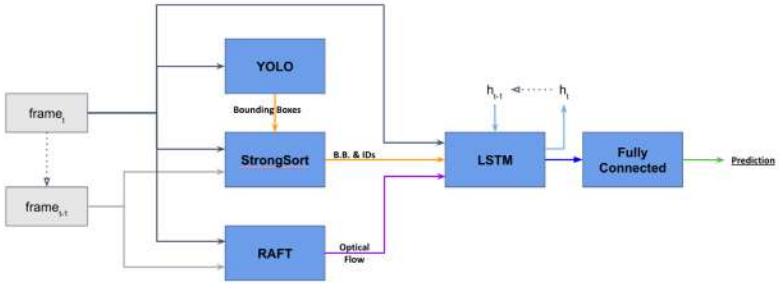
- The project is composed by many models that are combined on the final classifier that defines the probability of an accident. For the project are used images in bad weather conditions to specialize the system. The models used are a customize model of YOLO trained with images of our dataset, a re-identification model that let the bounding boxes being tracked all time for every frame, and finally a dense optical flow estimator. The last layers of the whole architecture combine all the previous results to generate a single prediction.

Results

- The results of our models are not so satysfying with respect to S.O.T.A. similar models.

How?

- We assemble a dataset and train a custom YOLOv5 model to recognize the objects in our dataset.
- The second step to obtain a classifier is the use of Strongsort in order to keep track of the bounding boxes and mantain the indexes of them. This improve significally the performance of the model with respect to other computer vision models.
- The last type of information used to classify a scene is the optical flow. We decided to use RAFT to get a dense estimation of the motion.
- The final step is the integration of all the modules introduced above so as to encode the current frame together with the extracted information to generate a prediction. The final output is therefore the probability that an accident occurs in the analyzed frame, taking into consideration the entire sequence of events seen so far.



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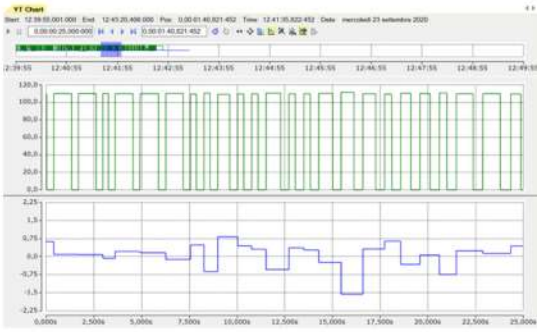
Product phasing control algorithm for conveyor belt in logistic application



What?

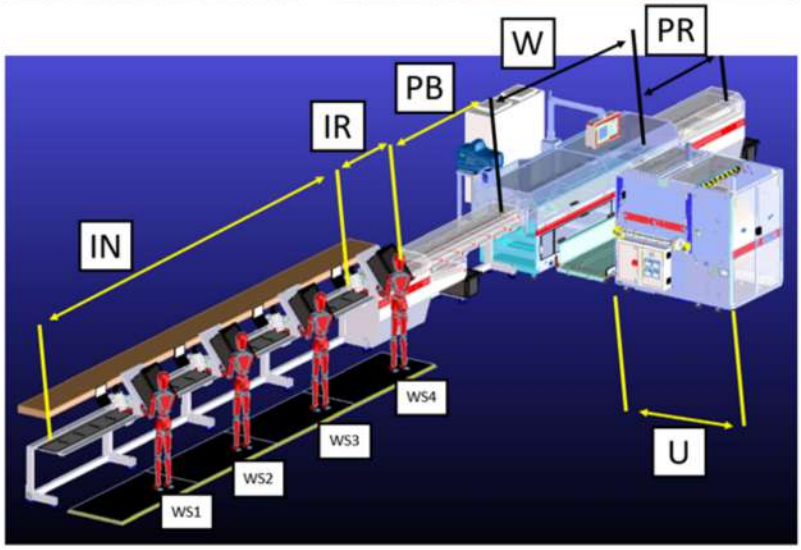
- develop an innovative control algorithm for a new version of a packaging machine,
- The task required checking 6 conveyors belts for both obtaining a constant gap of the items to be packaged, and the buffering of the latter, managing any discontinuities in the incoming flow.

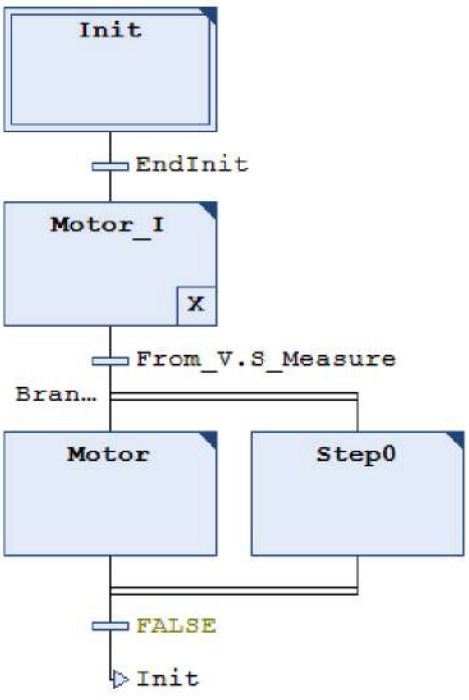
How?

- develop Beckhoff's algorithm in the TwinCAT environment and to debug it in a virtual environment through the commercial software ISG-Virtuos
- Using Digital Twin is a very innovative solution; it allows to improve the efficiency of the developing process in order to develop and verify the machine code in the absence of a prototype and in advance of production times.

Results

- The solution found is quite a robust code: it reaches the goal of the Product Phasing(maintenance of the products' Gap equal to the desired distance) and it supports critical cases.
- Another important goal is the keeping of the wrapper's acceleration and the conveyors' acceleration under a certain threshold.





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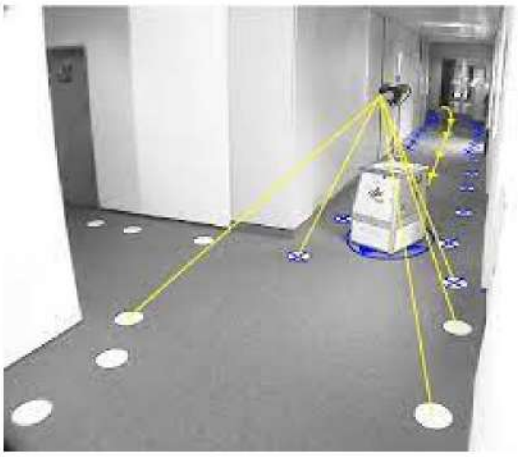
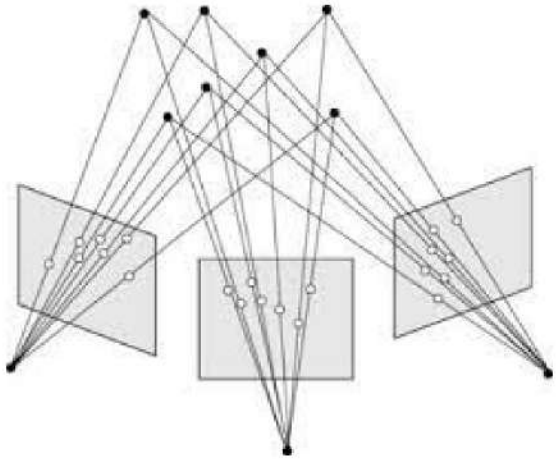
PLANAR MONOCULAR SLAM





What?

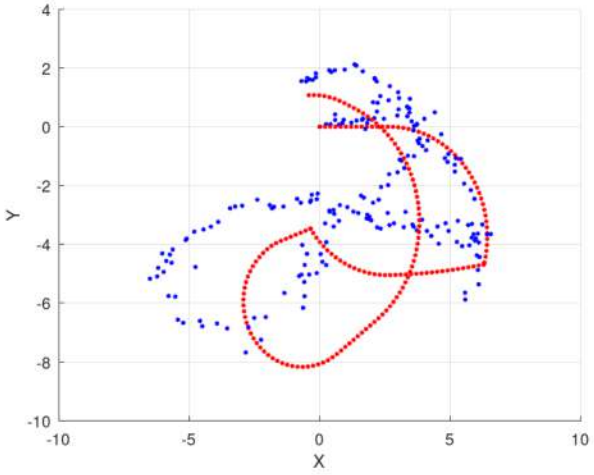
- provided a small simulator of a vacuum cleaner-ish robot that navigates in an environment collecting data from a monocular camera. The simulator can be used to generate other datasets.

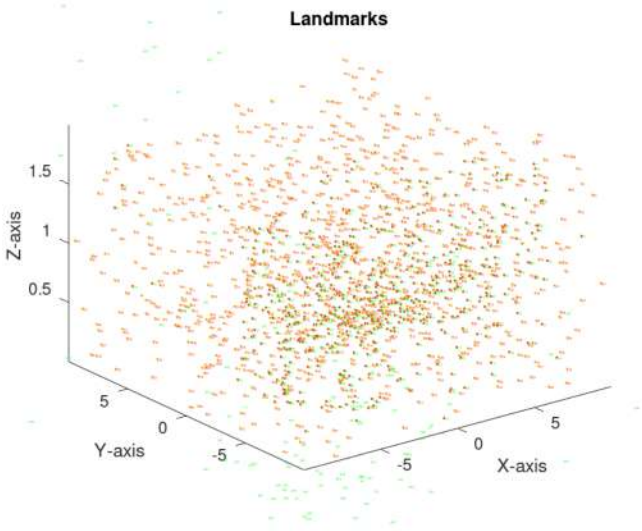
How?

- Expected Output:
- - 1. Visual-Aided Odometry:
- - instantiate the landmarks using the odometry, and perform SLAM in a bearing-only fashion
- - 2. Bundle Adjustment:
- - embed the obtained measures in a full bundle adjustment pipeline (see total_least_squares)

Results

- The results are not particularly interesting since the error is still evident after some iterations. Anyway the problem is the triangulated points that are not very precise due to the error in the odometry. Making the BA using real landamrks gives error 0 so improving the initialization it will be possible to improve the system. For the Robot position the results are good since the RMSE is small while for the landmarks it can be improved





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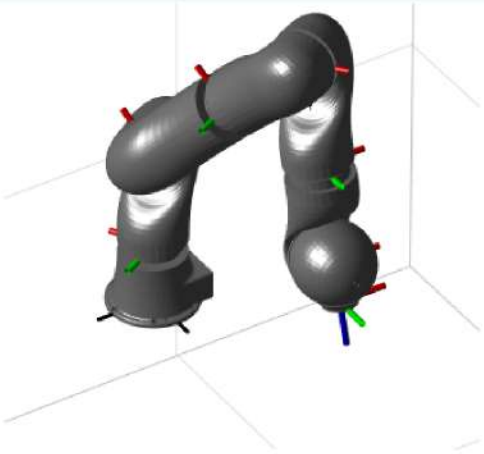
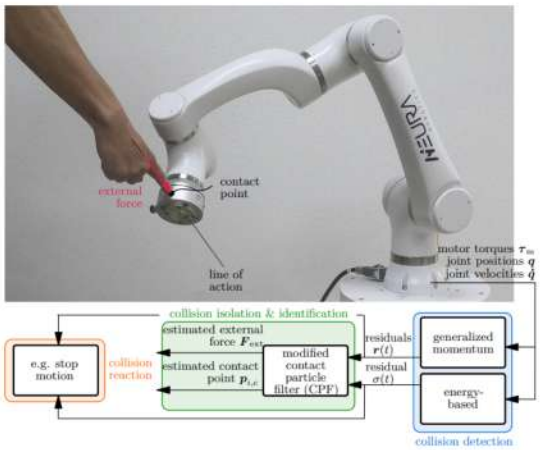
TESI POINTESTIMATION KUKALWR





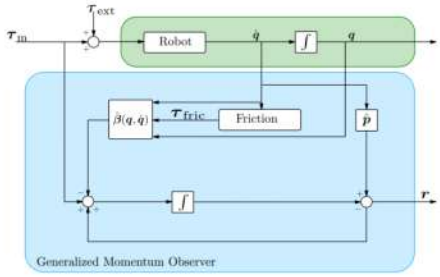


Figure 3.3. Generalized momentum schema.

What?

- Find the contact point on the robot, the task is improve the previous model of contact particle filter to be used in a Kuka LWR 4 and in particular in every link and not only in the last link so solving the problem of underdetermined system,

How?

- A residual for every link is calculated taking into account multiple sample instants and the momentum
- To initialize the Contact Particle Filter the simulator is run multiple times to create a dataset for an LSTM and understand which link is subjected by an external torque.
- Then the Contact Particle Filter is actuated and at every iteration gets close to the real point of contact

Results

- The initialization is quite good and through the particle filter and the intersection line with the link is possible to find the point of contact
-