

Vision system for part recognition and tracking – Real time robot communication

(Οπτικά συστήματα αναγνώρισης και εντοπισμού αντικειμένων – Επικοινωνία με ρομπότ σε πραγματικό χρόνο)

Motivation of the Thesis

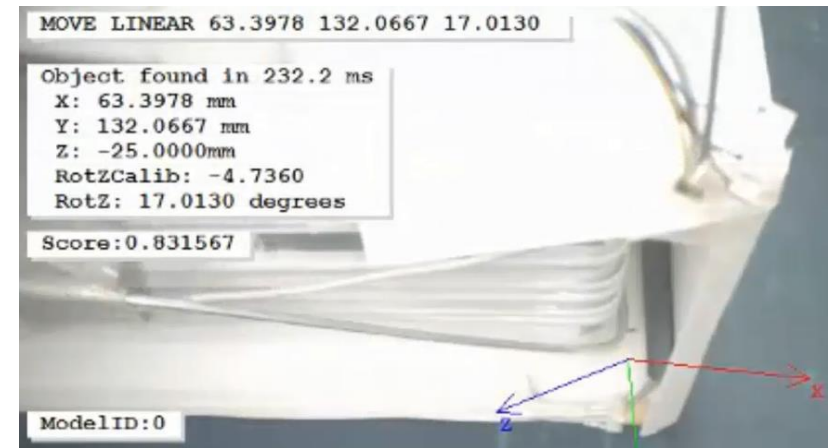
Vision systems provide innovative solutions in direction of **industrial automation**, improving productivity and quality management. More directly, these systems can be beneficial in the applications where **precise information** needs to be instantly or repetitively extracted and used. (e.g. **target tracking** and **robot guidance**)

Objectives

- Accurate and fast **3D/2D part identification**
- Accurate and fast **part measurement** in **world space**
- Accurate and fast **image processing algorithms**
- **Accurate and fast transferring of processed data to robot**
- **Point Cloud** processing

Outcome / Results

- Literature review on current approaches of **vision systems** in industry
- Develop a tool for **movement corrections of robot in assembly tasks**
- **Design and implement the method in an assembly case study.**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Human-Robot Interaction using Manual Guidance technique

(Αλληλεπίδραση χειριστή με ρομπότ με την χρήση της τεχνικής χειροκίνητης καθοδήγησης)

Motivation of the Thesis

Human-robot interaction requires physical contacts between human and robot to perform interaction, and communication needs requires a **developed system** to send and receive commands.

Objectives

- Accurate and fast **force sensing and control**
- Accurate and fast **Impedance/admittance control algorithms**
- **Safe** human robot interaction

Outcome / Results

- Literature review on current approaches of **manual guidance techniques** in industry
- Develop a tool for **manual guiding a robot in assembly tasks**
- **Design and implement the method in an assembly case study.**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Safe Human-Robot interaction using sensors

(Ασφαλής αλληλεπίδραση χειριστή-ρομπότ με χρήση αισθητήρων)

Motivation of the Thesis

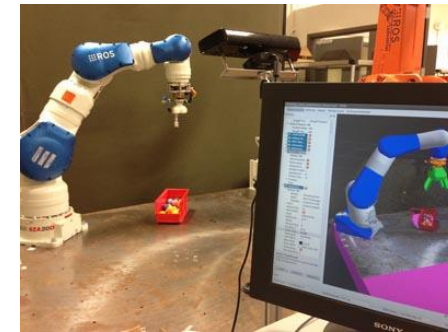
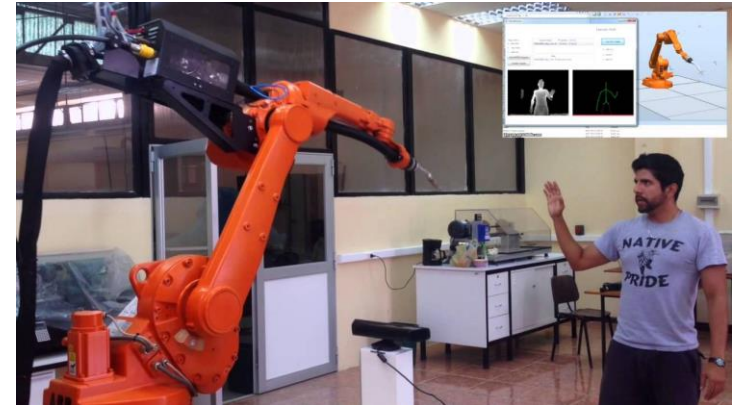
Human-robot interaction in an industrial cell requires high safety standards because any risk of injury to operators must be fully eliminated. The development of new safety technologies using sensing devices for safe human-robot interaction is the main purpose of this thesis.

Objectives

- Accurate and fast **human detection** in the cell
- Accurate and fast **robot movement detection**
- **Sensors** for human robot collision detection/avoidance
- **Safe** human robot interaction

Outcome / Results

- Literature review on current approaches of **safety in Human robot collaborative industry environments**
- Develop a tool for **sensing the operator and the robot during assembly tasks**
- **Design and implement the method in an assembly case study.**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Design of a flexible gripper for the grasping and manipulation of commercial goods

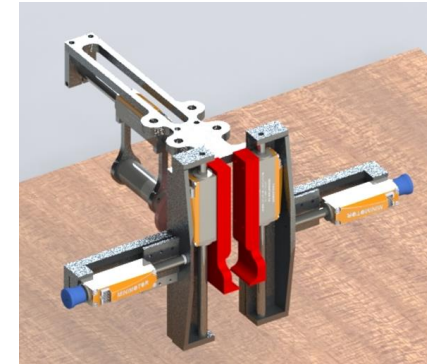
Σχεδιασμός ευέλικτης αρπάγης για τον χειρισμό εμπορικών προϊόντων

Motivation of the Thesis

The increase demand of **handling and manipulating product variety's** that slightly differ leads to the development of **flexible grippers** to allow simple and efficient pick and place operations. A **universal design** to support a variety of products needs to be performed.

Objectives

- Design of a flexible gripper to support product variations
- Design of an algorithm that will determine the grasping and releasing posture.



Outcome / Results

- Literature review on **robot grasping** and **releasing methods**
- Design and implementation of the flexible gripper using CAD tools (CATIA, SOLIDWORKS, etc.)
- **Integration** on **simulation tools** (DELMIA or Process Simulate)
- Implement this application in a **consumer goods line paradigm**

Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Design of a flexible gripper for packaging operations using suction cups

Σχεδιασμός ευέλικτης αρπάγης για δραστηριότητες πακεταρίσματος με την χρήση βεντουζών αναρρόφησης

Motivation of the Thesis

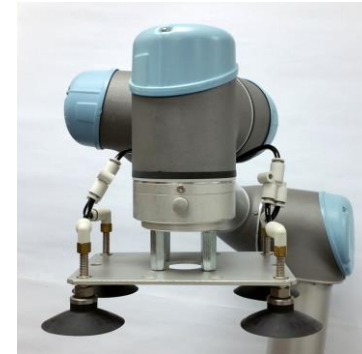
The packaging operations require delicate handling and differ according to the manipulated objects. A universal design of such a pneumatic gripping device to support such object variations needs to be designed and implemented.

Objectives

- Design of a flexible pneumatic gripper using suction cups to support product variations (boxes, trays, etc.)
- Design of an algorithm that will determine the grasping and releasing posture.
- Readjustment of the suction cups according to the manipulated object

Outcome / Results

- Literature review on **robot** pneumatic **grasping** and **releasing methods**
- Design and implementation of the suction gripper using CAD tools (CATIA, SOLIDWORKS, etc.)
- Design and implement the method in a **consumer goods case study** using **programming tools**



<https://www.youtube.com/watch?v=e8g-D5EIYFQ>

Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

A simplified programming method for dual arm robots

Απλούστευση της προγραμματιστικής μεθόδου για ρομπότ με δύο βραχίονες

Motivation of the Thesis

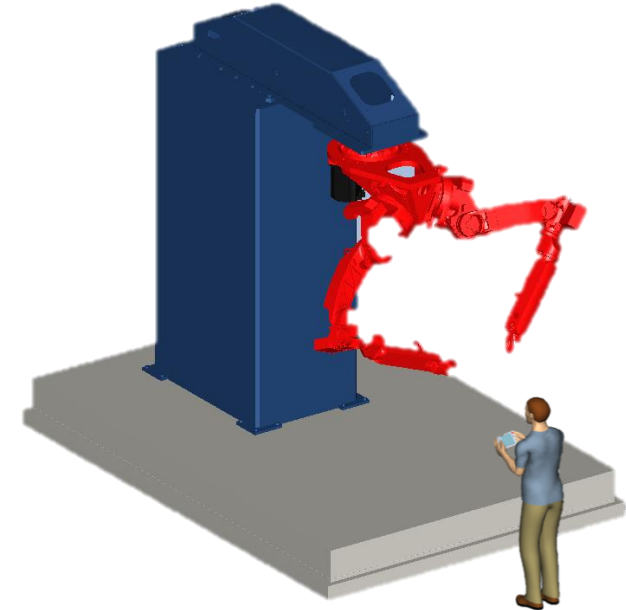
Current programming methods on programming the robots depend on the use of teach pendants and differ according to the robot brand. A universal programming method for a fast robot programming methods is required.

Objectives

- Develop an automatic solution in order to reduce programming effort and time required from the user.
- Development of programming algorithms for robot motions.
- Design of a user friendly programming interface

Outcome / Results

- Literature review on **robot programming methods**
- Programming algorithms to support dual arm robot motions
- User friendly programming interfaces



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Development of Augmented Reality Application for Operator Support in assembly lines

Ανάπτυξη εφαρμογής επαυξημένης πραγματικότητας υποστήριξης ανθρώπινου δυναμικού σε γραμμές παραγωγής

Motivation of the Thesis

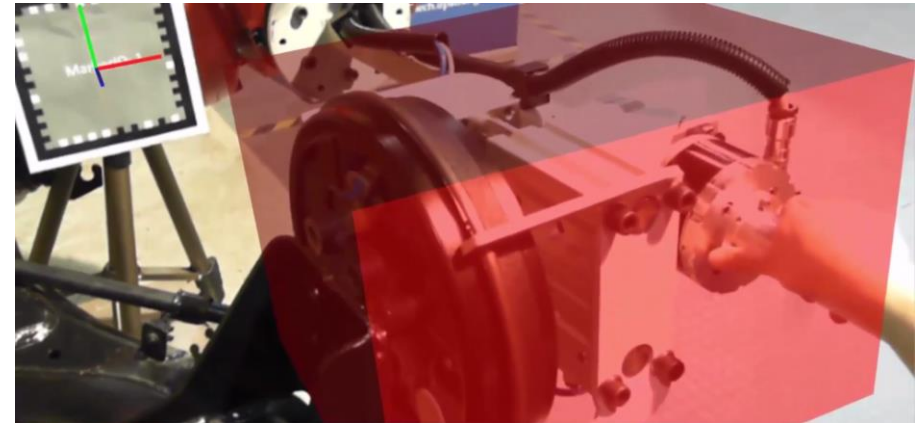
- Learning of C# programming language in a user friendly environment like Unity3D
- Working on Android technology (opt.)
- Learning of ROS technologies
- Working on a new technology that gains popularity the last few years

Objectives

- Support the operator by visualizing information
- Improve the robustness of the current technologies
- Focus on the marker less recognition
- Check different number of existing libraries

Outcome / Results

- Create AR application
- Present fundamental principles of 3D visualization of digital objects
- Present fundamental principles of IoT connectivity



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Development of Smartwatch Application for Operator Support in assembly lines

Ανάπτυξη εφαρμογής σε έξυπνα ρολόγια υποστήριξης ανθρώπινου δυναμικού σε γραμμές παραγωγής

Motivation of the Thesis

- Learning of Java programming language
- Learning of ROS technologies
- Working on on Android technology

Objectives

- Support the operator by visualizing information
- Improve the robustness of the current technologies
- Work on the improvement of the design of the user interface



Outcome / Results

- Create Android smartwatch application
- Present fundamental principles of IoT connectivity

Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Development of application for robot guiding using smart devices (tablets/smartphones)

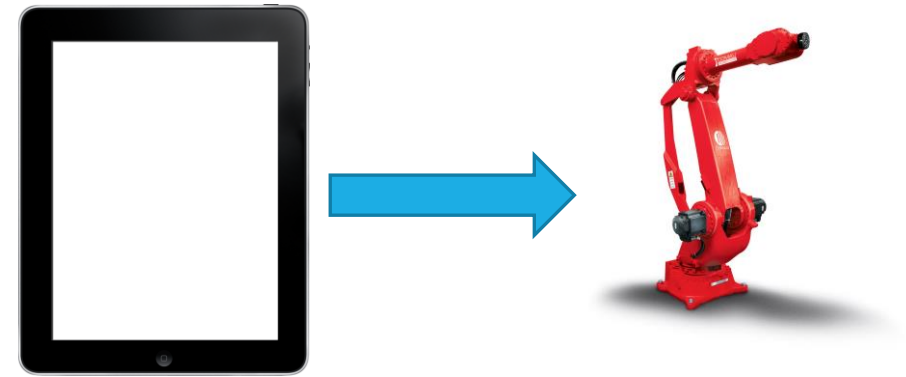
Ανάπτυξη εφαρμογής χειρισμού ρομπότ από έξυπνες συσκευές

Motivation of the Thesis

- Learning of C#/Java programming languages
- Learning of ROS technologies
- Learning of robotic language (PDL)
- Learning the basics of QR codes scanning and recognition

Objectives

- Create an application to “replace” robot’s remote controller
- Make a robust application that can easily work with any robot



Outcome / Results

- Create Android application
- Present fundamental principles of IoT connectivity
- Present fundamental principles of robot dynamics

Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Development of obstacle detection application for mobile robots using sensor data

Ανάπτυξη εφαρμογής εντοπισμού εμποδίων από αισθητήρες για κινούμενα ρομπότ

Motivation of the Thesis

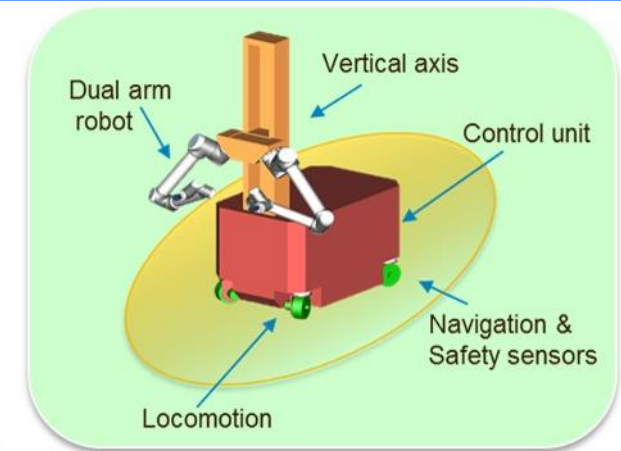
- Using different tools and libraries for obstacle detection
- Learning of ROS technologies
- Searching for existing applications, usage of the available tools and go beyond

Objectives

- Navigation avoiding randomly shaped and placed obstacles
- Usage of different type of sensors
- Develop fuse techniques to combine input data

Outcome / Results

- Create obstacle detection application running on mobile robots
- Present the fundamental principles of object detection and avoidance
- Present fundamental principles of IoT connectivity



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Development of human detection application for mobile robots using Kinect sensor data

Ανάπτυξη εφαρμογής εντοπισμού ανθρώπων από αισθητήρες τύπου Kinect για κινούμενα ρομπότ

Motivation of the Thesis

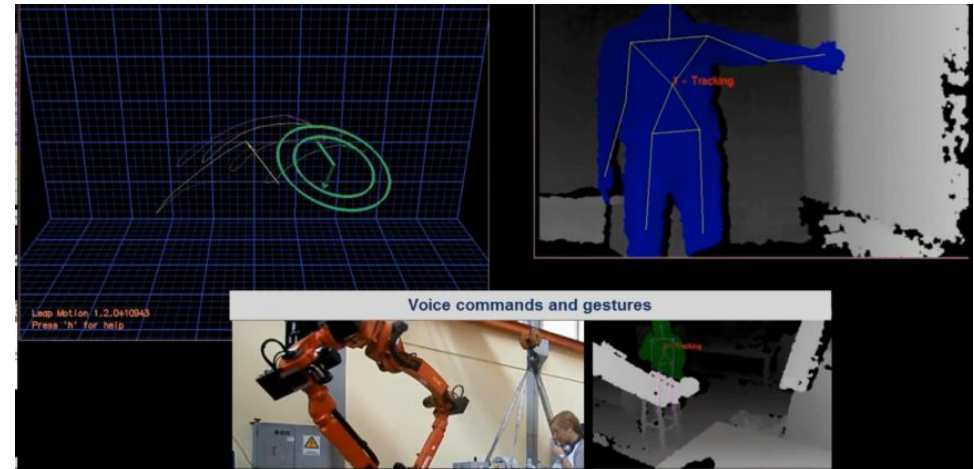
- Learning of C#/Java/C++ programming languages
- Learning of ROS technologies
- Learning working on Ubuntu environment

Objectives

- Navigation using human detection and avoidance algorithms
- Usage of different type of sensors
- Develop fuse techniques to combine input data

Outcome / Results

- Create human detection application
- Present the fundamental principles of human detection and avoidance
- Present the fundamental principles of 3D human reconstruction
- Present fundamental principles of IoT connectivity



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Development of object recognition application using simple web cameras

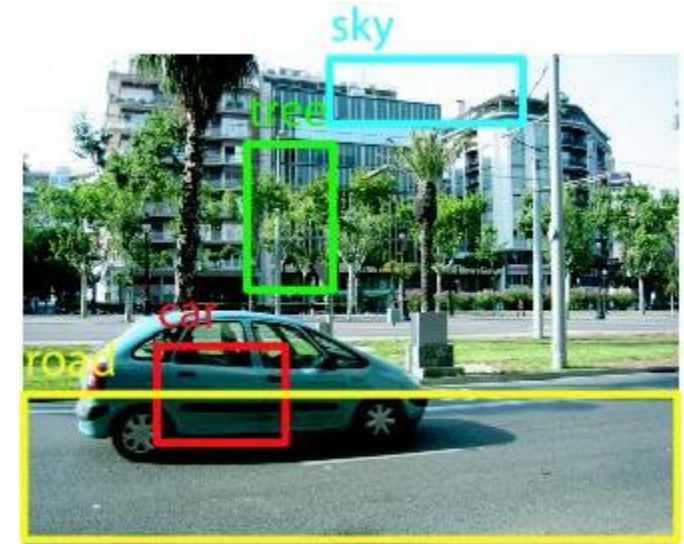
Ανάπτυξη εφαρμογής αναγνώρισης αντικειμένων από απλές web καμερες

Motivation of the Thesis

- Learning of C-family programming languages
- Learning of ROS technologies
- Working on advanced technologies

Objectives

- Recognize predefined objects
- Improve the robustness of the current technologies
- Check different number of existing libraries



Outcome / Results

- Create object recognition application
- Present the fundamental principles recognizing a predefined object
- Present fundamental principles of IoT connectivity

Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Autonomous aerial drone navigation

Αυτόνομη εναέρια πλοήγηση μη επανδρωμένου αεροσκάφους

Motivation of the Thesis

- In the last decade drones have emerged as a new and promising shopfloor automation system.
- This thesis will focus on the visual navigation of an autonomous aerial drone using only its pre-installed and open source software.

Objectives

- Make the drone operational (airborn)
- Control the drone with code running on remote pc
- Perform stable altitude hold
- Perform stable position hold over a marker
- Carry safely a package and land safe and precisely on the marker

Outcome / Results

- Establishment of an effective communication between a laptop and a drone using WiFi connection
- Control the drone using high level programming language and open source libraries.
- Safe and autonomously perform a carry task with the aerial drone



Contact: N. Nikolakis nikolakis@lms.mech.upatras.gr
Dr. G. Michalos michalos@lms.mech.upatras.gr

Convolutional neural network based object and subject recognition

Αναγνώριση αντικειμένων και υποκειμένων χρησιμοποιώντας συνελκτικά νευρωνικά δίκτυα

Motivation of the Thesis

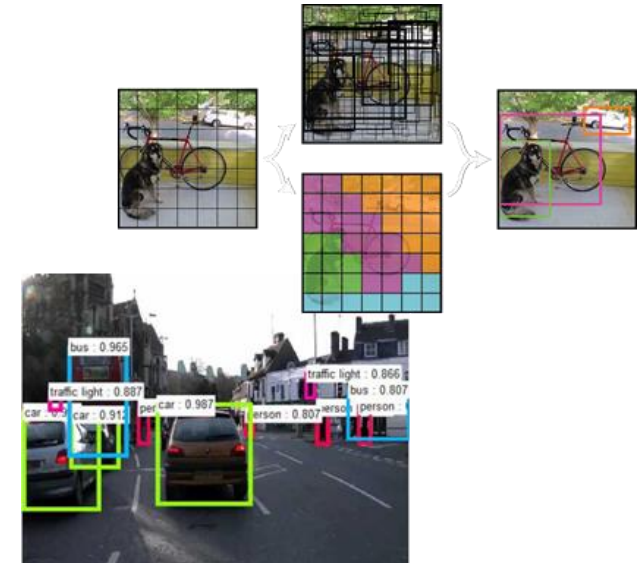
- CNNs are used in variety of areas, including image and pattern recognition, speech recognition, natural language processing, and video analysis.
- In pattern and image recognition applications, the best possible correct detection rates (CDRs) have been achieved using CNNs.

Objectives

- Create a dataset containing images from 5-10 objects ανδsubjects
- Implement a convolutional neural network for object and subject recognition in python
- Evaluation of different CNN implementation (layers, kernels, etc.)
- Validation of the CNN with random images

Outcome / Results

- CNN based online object and subject recognition module



Contact: N. Nikolakis nikolakis@lms.mech.upatras.gr
Dr. G. Michalos michalos@lms.mech.upatras.gr

Motion planning for a 13 degree of freedom robot arm.

Σχεδιασμός κίνησης ρομποτικού βραχιώνα 13 βαθμών ελευθερίας

Motivation of the Thesis

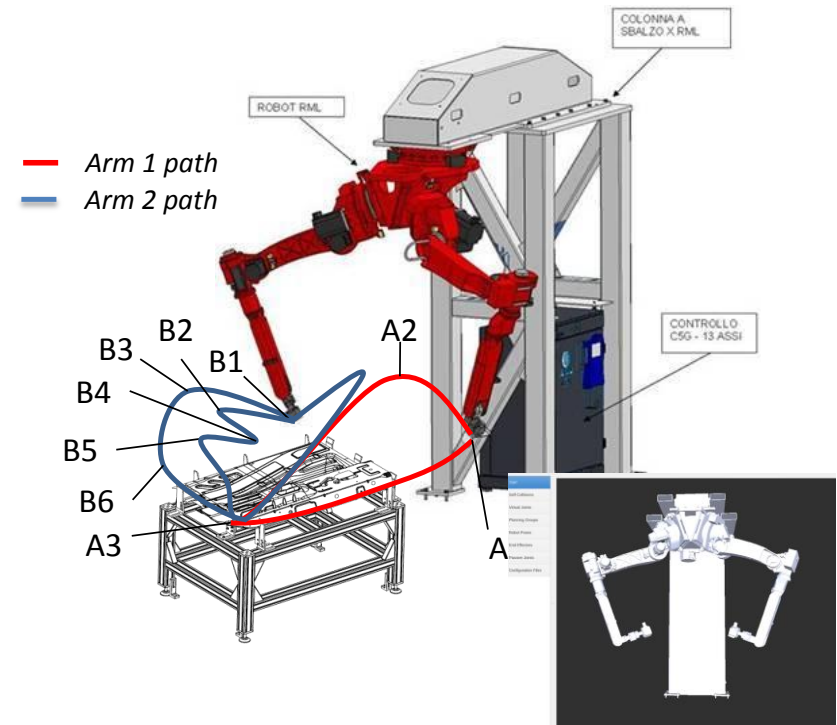
- Exchangeability of implementation of Cartesian motion with industrial manipulators.
- Lack of standardization of Cartesian interfaces for multiple robots.
- Absent documentation for existing package.
- Calibration of kinematic properties to is difficult.

Objectives

- Execution of the proposed algorithm in real time.
- Fast re-calculation of the new path if needed.
- High accuracy is needed.

Outcome / Results

- Path planning for a 13 degree of freedom
- Easily expanded to different kind of robot using URDF files



Contact: S. Matthaiakis (smatt@lms.mech.upatras.gr)
P. Tsarouchi (ptsarouchi@lms.mech.upatras.gr)

Adaptive force control for lightweight robots.

Σχεδιασμός συστήματος ελέγχου βασισμένο στον έλεγχο δύναμης για ρομποτικούς βραχιώνες

Motivation of the Thesis

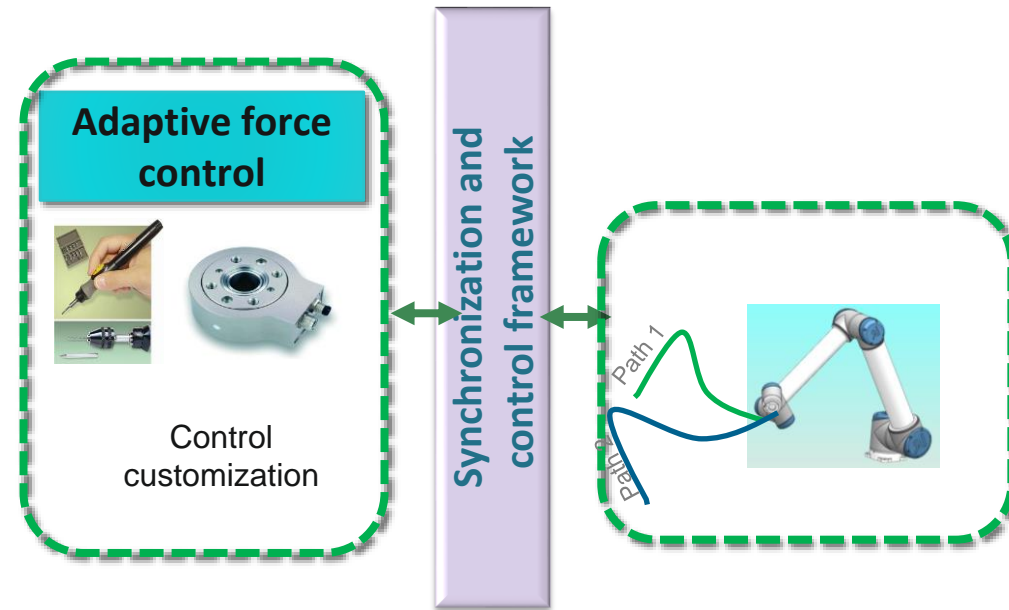
- Force control algorithms development for manipulate the tiny parts with lightweight robot.
- An additional challenge is the configuration of the force control schemes, as well as the force control integration.

Objectives

- Develop the appropriate control strategies for controlling the robot.
- Maximum applied forces of 5N during the assembly for parts.
- Adaptive force control in order to protect the part.
- Accuracy of 1.5mm during the insertion of tiny part.

Outcome / Results

- Experiments should be made to identify the force control strategies.
- Integrate the force sensor with UR10 robot.



Contact: S. Matthaiakis (smatt@lms.mech.upatras.gr)

Improve the efficiency of lightweight robot position during screwing tasks.

Σχεδιασμός συστήματος για βέλτιστη χρήση ρομποτικού βραχίονα σε διαδικασία βιδώματος

Motivation of the Thesis

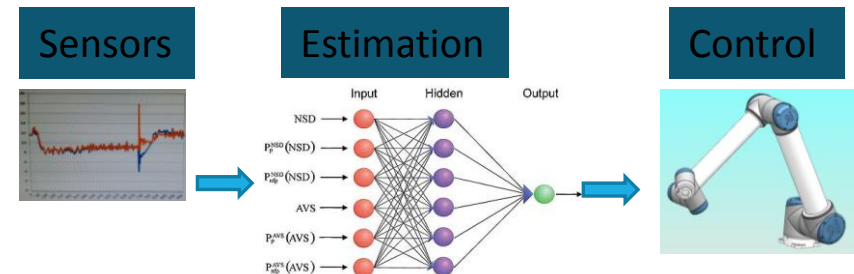
- Force control algorithms development for manipulate the tiny parts with lightweight robot.
- An additional challenge is the configuration of the force control schemes, as well as the force control integration.

Objectives

- Estimate the status of the robot operation based on the feedback of the sensors.
- Develop the appropriate control strategies for controlling the robot.
- Combine data from multiple sensor's.

Outcome / Results

- Experiments should be made to identify the force control strategies.
- Integrate the proposed method in real world.



Contact: S. Matthaiakis (smatt@lms.mech.upatras.gr)

Automated robot grasp and path planning tool

(Ανάπτυξη εργαλείου για την αυτόματο προσδιορισμό της διαμόρφωσης και της κίνησης ρομποτικής αρπάγης)

Motivation of the Thesis

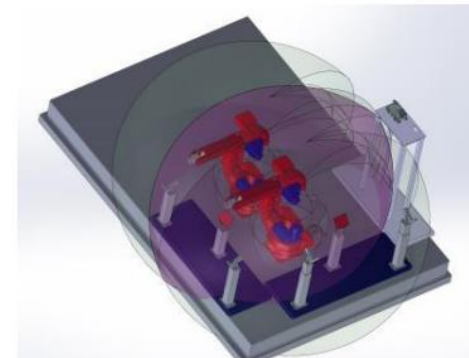
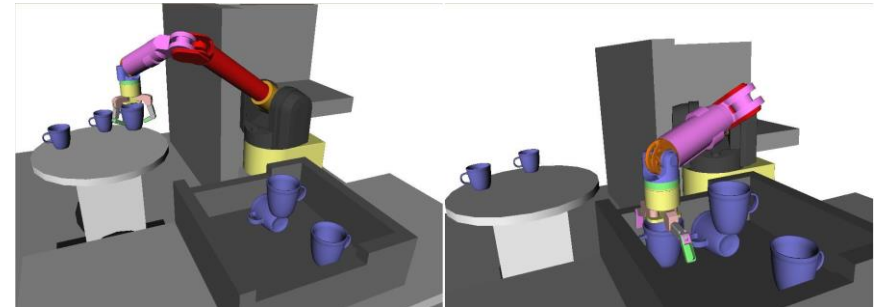
Grasp planning is a main issue of today's robotic systems because there is a **huge number** of possible **robot hand configurations** and the **grasping motion** as well as the **path of the griper** cannot easily be foreseen through simulation.

Objectives

- Provide the **user** the ability to **define pick & place position**
- Design an **algorithm** that will **determine** the **grasping posture** and the **arm motion**

Outcome / Results

- Literature review on **robot grasp** and **path planning**
- Design a tool for calculating **robot reachability in assembly tasks**
- Design and implement the method in an **assembly case study** using **programming tools**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Automated simulation of human operations using simulation tools

(Ανάπτυξη λογισμικού για την αυτόματη προσομοίωση διαδικασιών συναρμολόγησης από ανθρώπους)

Motivation of the Thesis

Simulation tools cannot automatically simulate **human motion** and **behavior**. In order to **resolve ergonomic issues** on **human operation**, an **automatic** as well as **realistic approach** for its simulation needs to be implemented.

Objectives

- Automatically **simulate human operation** and **extract human motion planning**
- Development of tool for **generating motion of human** by considering **part pick & place**

Outcome / Results

- Literature review on **human motion planning**
- **Integration** on **simulation tools** (DELMIA or Process Simulate)
- Implement this application in an **assembly line paradigm**



Before



After



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Performance assessment of assembly lines adapting the new production paradigm – mobility of resource and product

Μελέτη αποδοτικότητας γραμμών παραγωγής που χρησιμοποιούν αυτόνομα κινούμενες μηχανές και προϊόντα

Motivation of the Thesis

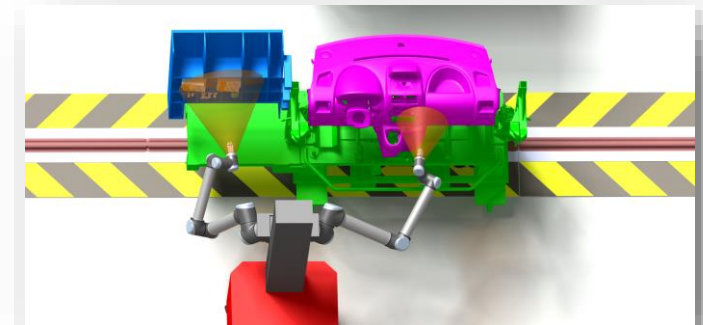
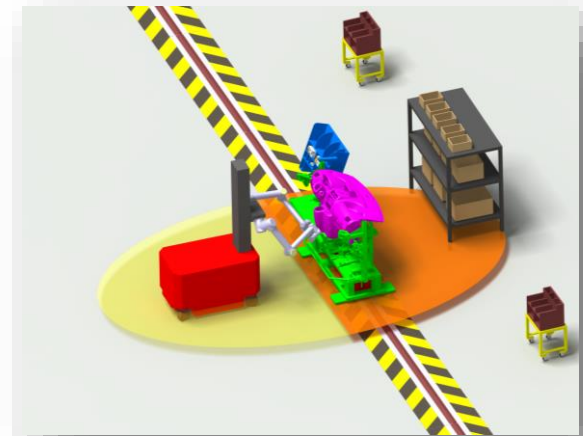
The transition from mass production to mass customization creates the need for designing **flexible assembly lines**. Such lines should enable the **easy and fast reconfiguration** of the production system according to demand profile. **Mobility** of both the **product** and the **resources** is considered as an enabler for increasing system's reconfigurability.

Objectives

- Design of **flexible assembly lines**
- Eliminate rigidity of assembly line's structure caused by fixed fixturing and resources
- Apply different **planning rules** with respect to line's needs

Outcome / Results

- Literature review on the **current assembly line structure** practices
- Model the proposed paradigm with the use of discrete event simulation modelling (WITNESS)
- Evaluate **new paradigm** system's **performance**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Augmented Reality (AR) based feedback using virtual controls

(Ανάπτυξη εφαρμογής επαυξημένης πραγματικότητας με δυνατότητες αλληλεπίδρασης)

Motivation of the Thesis

AR application with **finger tracking** provides the user with more **natural, direct interaction** with the respective **objects**. Also, seamless **integration** of **real** and **virtual** world is performed.

Objectives

- Focus on resolving **ergonomics** issues
- Overcame the **lack of haptic feedback** (as in the use of touch screens)
- Design of **User Interface** with **virtual menus**

Outcome / Results

- Literature review on **AR applications** and **technologies**
- **Finger tracking** using **camera** and interaction with **virtual menus**
- Implement this application in an **assembly line paradigm**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Advanced interaction mechanisms for human robot collaborative workspaces

(Ανάπτυξη ανεπτυγμένων μεθόδων για την άμεση αλληλεπίδραση ανθρώπου και ρομπότ σε βιομηχανικό περιβάλλον)

Motivation of the Thesis

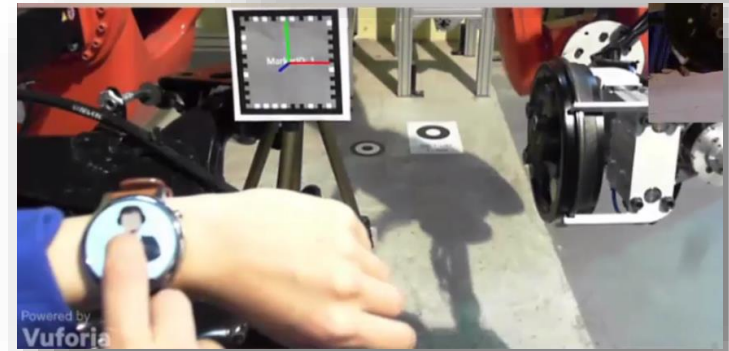
The latest trends in EU manufacturing foster the **combination** of the **human's** intelligence and flexibility with **robot's** strength and accuracy. In order to ensure an efficient collaboration among human and robot during execution, **multi modal mechanisms** that will enable their **direct interaction** need to be implemented.

Objectives

- Design application allow the human operator to **directly send commands to the robot** (gestures recognition, audio commands etc.)
- Control & regulate the **motion of the robot** according to the input by the human
- Implemented the developed application in an **assembly line paradigm**

Outcome / Results

- Literature review on **human robot interaction applications**
- Development of **Android application** to be deployed in wearable devices (smartwatch, etc.)
- Development for **robot's low level control**



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Method development for sensor based collision detection

(Ανάπτυξη λογισμικού για την ανίχνευση ενδεχόμενης πρόσκρουσης με χρήση αισθητήρων)

Motivation of the Thesis

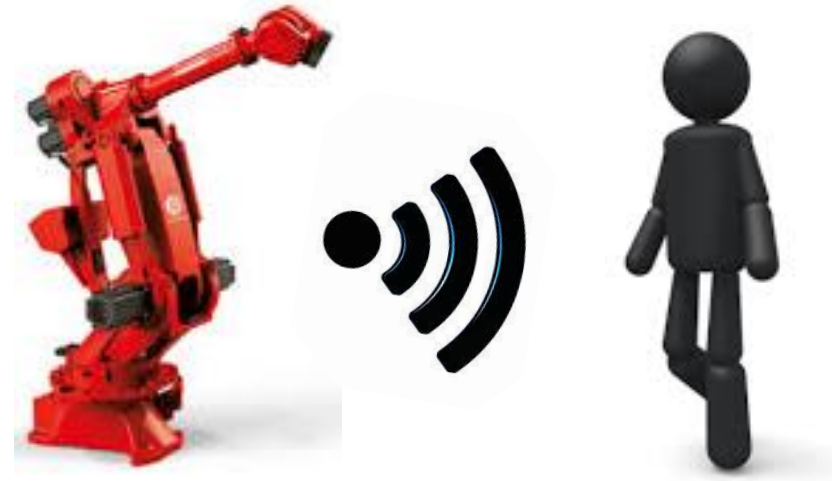
Human Robot Interaction requires the ability to **detect the operator** in order to **ensure its safety** when working in proximity with the robot.

Objectives

- Implement a **sensing set up** for detecting human and objects in the **workspace** of the robot
- Regulate the **motion of the robot** according to the **sensor's input**
- Apply the sensor in a **real scenario** with an industrial robot

Outcome / Results

- Literature review on **proximity sensing, collision avoidance / detection** and **non contact sensors**
- **Experimental sensors** (capacitive, ultrasonic and visual)
- **Evaluation** of the **system's performance** such as response time etc.



Contact: Dr. S. Makris (makris@lms.mech.upatras.gr)
Dr. G. Michalos (michalos@lms.mech.upatras.gr)

Full body motion capture in virtual environments using inverse kinematics for ergonomic considerations

Ανίχνευση κίνησης του ανθρωπίνου σώματος σε εικονικά περιβάλλοντα με χρήση αντίστροφης κινηματικής για ανάλυση εργονομίας

Motivation of the Thesis

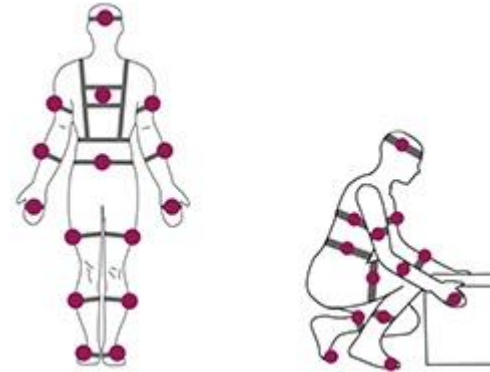
- Precise body tracking is needed to transfer body movement into the virtual environment for several types of analyses
- Need to realistic visualization of human movement during industrial case scenarios

Objectives

- Selection, setup and configuration of a full body movement tracking system
- Real time visualization of moving parts as an avatar

Outcome / Results

- Avatar performing real time the same movements as human in the virtual environment
- low latency and precision



Contact: Dr. G. Michalos (michalos@lms.mech.upatras.gr)
A. Karvouniari (karvouniari@lms.mech.upatras.gr)

Implementation of methods for real time ergonomic evaluation of a task in a virtual environment

Υλοποίηση μεθόδων για εργονομική αξιολόγηση μιας εργασίας σε πραγματικό χρόνο

Motivation of the Thesis

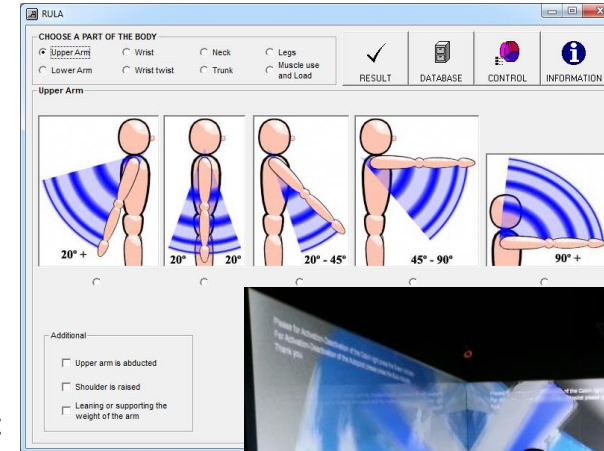
- Important role of ergonomics in workplace design
- Need of effective virtual prototyping

Objectives

- Selection and implementation of method for real time ergonomic evaluation in a virtual environment
- Implementation of engineer interface

Outcome / Results

- Engineer can check in real time whether the user in the virtual environment is performing ergonomically correct tasks



Contact: Dr. G. Michalos (michalos@lms.mech.upatras.gr)
A. Karvouniari (karvouniari@lms.mech.upatras.gr)

Implementation of human factors methods for workplace design validation

Υλοποίηση ανθρωποκεντρικών μεθόδων αξιολόγησης του σχεδιασμού ενός περιβάλλοντος εργασίας

Motivation of the Thesis

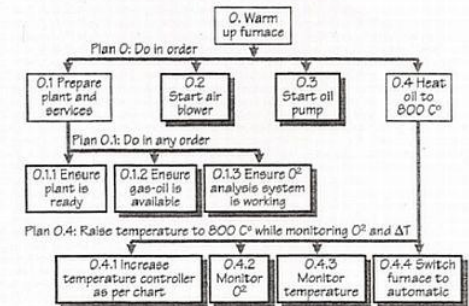
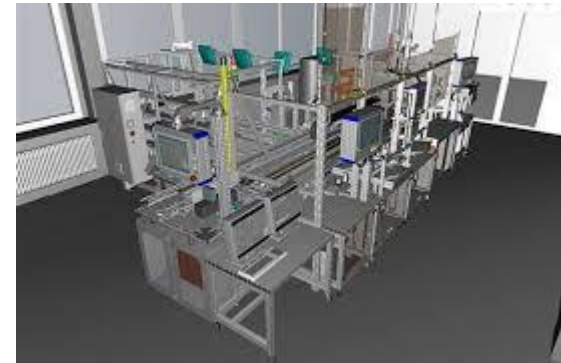
- Workplace adaptation

Objectives

- Research of human factors methods for workplace design
- Implementation of human factors methods in the virtual environment

Outcome / Results

- Engineer can perform complex human factors analyses to assess the workplace



Contact: Dr. G. Michalos (michalos@lms.mech.upatras.gr)
A. Karvouniari (karvouniari@lms.mech.upatras.gr)

Holographic technologies in early product design

Ολογραφικές μέθοδοι στην πρώιμη σχεδίαση προϊόντος

Motivation of the Thesis

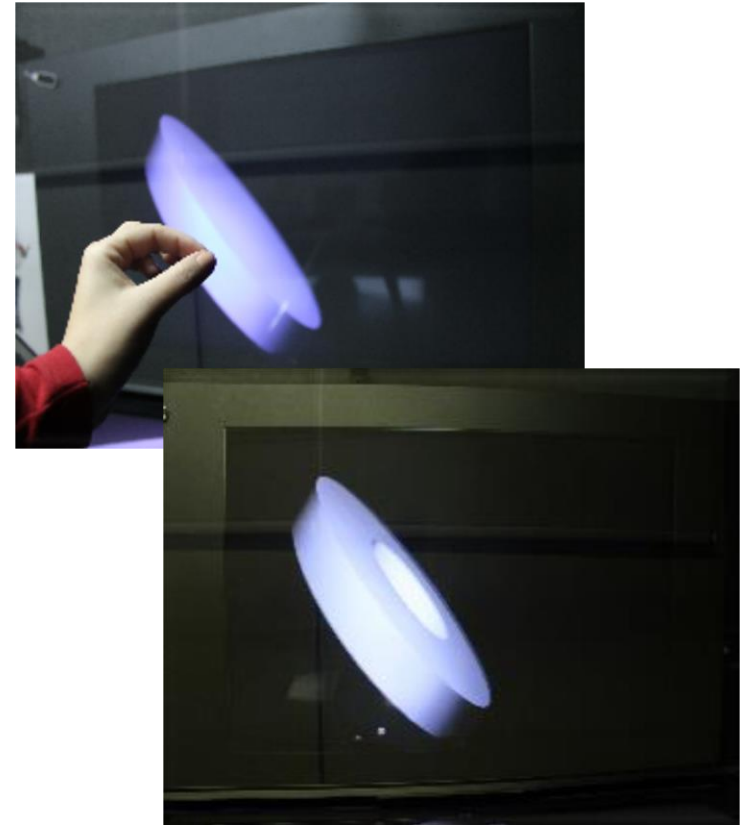
- Users pay more attention to learning CAD systems than visualizing the product they design
- Early design is important in the product life-cycle

Objectives

- Creation of methods to perform real-time modifications to the geometry of the designed product
- Implementation of intuitive gestures to interact and modify the designed product

Outcome / Results

- The user can view the virtual prototype of the product as a hologram and use gestures to make modifications in its geometry



Contact: A. Karvouniari (karvouniari@lms.mech.upatras.gr)