Student proftaak assignments HTES PII semester 7 Minor ES - 2020nj

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To: students in Minor ES/New Technologies
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Inhoudsopgave

The following concerns projects entered by the research group HTES projects (HTES) and projects based on questions proposed by Partners in Innovation (PII), where the HTES research group is involved as well.

1 Semester 7 Minor ES projects

project	Hardware/env	PO
2020nj PII HTES 1 – Monitoring robot with sound camera and positioning	Sorama camera, MWLC robot, simulator	Rink van Laar (HERE Technologies), Technical advice: Maarten Thomassen (Sorama)
2020nj PII HTES 2 - Mobile platform for egg picking	Jackal robot, simulator	Anatolii Savchuk (Hendrix Genetics)
2020nj PII HTES 3 – Cooperative Test robot II	Sawyer robot, simulator	Rink van Laar (HERE Technologies)
2020nj HTES 4 – Social Distancing Robot serving a drink	MWLC robot / Oxboard / Blue Segway	Teade Punter (HTES), Technical advice: VDL ETG
2020nj HTES 5 – Navigating a robot4care	Pepper robot, simulator	Erik van Alphen (HTES)
Fout! Verwijzingsbron niet gevonden.2020nj PII HTES 6 – Low Power Human Pose Recognition for Public Space	Jetson TX2, low power device	Lars van Raaij (inno sports lab sport en beweeg)
2020nj HTES 7 – Indoor positioning @ Low speed	UWB, sensorset Jackal-robot, Rifraf 0.2	John Vissers (TNO) Advice: Jan Dobbelsteen (HTES)
2020nj HTES 8 – Smart Tactical Robot IV2020nj HTES 8 – Smart Tactical Robot IV	Jackal RAS Oirschot	Kubilay Yildirim (RAS)
2020nj PII HTES 9 – Smart Office II	IoT system	Anthony van Ooijen (CTouch)

2 2020nj PII HTES 1 – Monitoring robot with sound camera and positioning

PII HTES project: HERE Technologies

Context

This project concerns the environment registration and positioning with an autonomous mobile robot at Strijp TQ.
The mobile robot will be the ground vehicle Clearpath of the HTES research group for indoor and outdoor use that will be programmed using the Robot Operating System (ROS) software framework[1]. Sorama's sound camera will be mounted on this mobile robot. This is an "acoustic camera" to perceive, locate and analyze sounds[2]. The camera is able to detect sound leaks ranging from 0 to 100kHz, which make this device suitable to detect leaking problems in industrial environments, like in warehouses, or assembly. The camera might detect and report abnormal situations. Depending on the source and the nature of the sound, the robot should take further action, such as e.g., logging and sending a report to a central server. The mobile robot should also know its own position, to decide which actions to be taken. Positioning is even more important for a monitoring robot: when problems are detected, then they should be reported to provide a repair team with appropriate information about position (x, y, angle for direction). Here Technologies[3] provides positioning systems and is interested in navigating vehicles and its positioning in- and outdoor. In addition to the sound camera the robot might have a vision camera as well.

Strijp TQ is a mix of office and factory buildings and open space consisting of gardens and paths. The mobile robot must therefore be able to find its way both indoor and outdoor, the robot should have in- and outdoor navigation, starting with indoor. The robot also drives around in environments where the amount of people differs. Sometimes they are sitting at their workplace and moves between offices and from the inside out and vice versa. The mobile robot should take these people into account. Furthermore, the platform should be able to move in corridors and along static objects, like walls, cupboards and tables.

The assignment is part of the theme (Ro)bots of the Research Groups of Fontys Hogeschool ICT. The (Ro)bots theme contributes to what industry defines as Smart Industry[4]. The results of this assignment will contribute to a test facility for driving with AGVs.

Assignment

Develop a monitoring mobile robot that patrols the Strijp TQ premises of Fontys ICT that might enter various other buildings. The robot applies the radio mapping technology of Here Technology to find its way in- and outdoor, first focus on indoor navigation. The robot has a soundcamera of Sorama on top that provides information about "dangerous" situations at Strijp T.
Your assignment continues with the results achieve by the 2019nj studentgroup Monitoring robot, https://git.fhict.nl/Lectoraat_HTES/monitoringbot.

User stories to be implemented:

- Robot drives on floor 2 Strijp T using Here's radio maps.

[1] https://clearpathrobotics.com/jackal-small-unmanned-ground-vehicle/
[2] https://www.sorama.eu/
[3] https://www.linkedin.com/company/here/
[4] https://smartindustry.nl/hubzuid/

- With the sound camera particular sounds are registered (e.g, signal @ 30kHz) at Strijp T and the coordinates and its direction can be mapped on a radiomap (indoor, outdoor).
- Robot navigates autonomously along floor 2 Strijp T using Here's radio mapping
- Robot navigates autonomously along floor 2 Strijp T using Here's radio mapping and acts when a specific sound (@ 30kHz) is detected. The position of the sound is depicted on a map.

<u>Product owner</u>
Rink van Laar (Here Technologies)
Advisory: Sorama (Maarten Thomassen, Rick Scholte)

<u>Applied research questions</u>
The following questions might be tackled:
- How to perform indoor and outdoor localization and navigation? Aspects are: transition from inside to outside, and avoiding stationary and moving people.
- How to realize the patrolling of the robot to have a good coverage of the terrain with the sound camera and the radio maps; random or planned course?
- What should be the robot do when registering sounds? Which categories of sound ich actions should the robot take when detecting an abnormal sound?
- How does the robot determine that the perceived sound is normal or requires special action? And how to detect sound for "dangerous situations"?
- How does the robot determine the exact position of the sound source on the radio maps?
- How to map the sound on the (robot) map? The robot is able to register its own position, and to position this in its map. But what about the origin of the sound, and more important: how to map the sound on the map? Research is needed to find the actual source and map it on the robot map. Which data / signal type is required to add to the HERE tracker to enable accurate mapping?
- How GDPR proof is the monitoring robot? Which sensors / camera's are GDPR proof?

3 2020nj PII HTES 2 - Mobile platform for egg picking

PII HTES project: Hendrix Genetics

<u>Context</u>
Hendrix Genetics is a world market company specialized in selective breeding of animal species. For its pure line breeding of turkeys, the company has several turkey farms for which they create lines of turkey breeds that have specific properties. To know which properties a new hatching has, the eggs of turkeys are marked to indicate its parents. This is important for tracing the phenotypes (genetic characteristics) of the hatching.
Hendrix Genetics is interested in an autonomous egg picking mobile robot that should enable automatic picking of egg, ensuring the trace between egg and parent. An autonomous egg-picking robot will encompass three functionalities:

- egg gripping – planned to be implemented by a robot arm,
- egg transportation – planned to be implemented by a mobile platform (Clearpath Jackal),
- egg finding – planned to be implemented by computer vision (e.g., OpenCV and/or with a CNN).

<u>Assignment</u>
In this assignment you will design and implement a prototype for the function egg transportation. Based on a nest replica[5] and a mobile platform (Clearpath Jackal) a prototype is developed for docking the mobile robot with the nest, without touching the nest solid surface, also being able to work with a gripper and robot arm (these are to be implemented). You are challenges to use your creativity and technical expertise to fulfill the assignment. The prototype should fulfill the following criteria:

1. Detect the nest
2. Navigation with Jackal to the nest.
3. Robust navigation.

Research questions:

- What is best sensor and software technology to navigate the Jackal to a Turkey's nest? Compare Orbec Astra camera vs lidar.

<u>Product Owner:</u>
Anatolii Savchuk (Hendrix Genetics)

<u>Technologies:</u>
ROS software (python or C++ code).

<u>User stories</u>

- Detecting a nest with an egg
- Navigating to the nest
- Docking with the nest

[5] specs will be provided by Hendrix Genetics

4 2020nj PII HTES 3 – Cooperative Test robot II

PII HTES project: Here Technologies

Context

Here Technologies has a robot arm to test navigation systems. This arm is for automated testing of the navigation systems. The robot arm should be that smart that it will act the same as a human. The end users of navigation are the humans that has to enter navigation instructions. In this assignment you focus on the movements that the test robot has to make to be a good tester, i.e. touching the screen of a navigation system, with a variety of screen sizes. This is done in the context of a future FHICT student project to provide test commands, enabled by machine learning via notebooks, to the arm.
The arm movement for touching is perceived as a workflow: a set of actions that results in positioning the top of the gripper on a Sawyer robot arm on a 2D surface. This requires accuracy in 3D. Furthermore, the workflow might be subject to disturbances. For example, a human comes in the working area of the robot interaction. Another scenario is that part of the testing of a navigation system is done by the test robot, while other actions are done by a human tester.

Assignment and Research questions

In this project you develop the prototype software product on a Sawyer robot arm to touch screens, that is able to test navigation systems. The software development start with deploying and testing software developed by the previous student group[6]. Probably reverse engineering of the software is required, this is done in a model based way, using FlexBE or Behavior Tree. The test system is able to execute testing scripts that are developed by students in the ADS minor. The adequate working of the arm is shown by implementing ~5 testcases of HERE Technologies.

Product owner

Rink van Laar (HERE Technologies)

Technologies

Sawyer robot arm[7] is used as the robot platform.
The arm can be programmed via ROS[8].
Modelling approach: ROS/FlexBE[9].

User stories

- Vision –letter recognition on a screen, using Sawyer and/or additional camera's.
- Touching movement for touching the screen – using ROS FlexBE.
- Examine accuracy of the arm; defining measures to improve the accuracy of the arm; e.g., adding sensors, camera.

[6] https://git.fhict.nl/pii_htes/enabling-a-cooperative-test-robot-1920vj
[7] https://www.rethinkrobotics.com/sawyer/
[8] http://www.ros.org/
[9] http://wiki.ros.org/flexbe

5 2020nj HTES 4 – Social Distancing Robot serving a drink

HTES project: A robot is no super contaminant[10]

Context

People who come into contact with many others are potential superinfectants. Examples that we think of are people who deliver orders in a restaurant or on a terrace, or who distribute meals in a hospital or nursing home. These are tasks that a robot could easily take over. Robot might help us in social distancing. But what are the appropriate interfaces between human and robots?

Robot solutions for social distancing are already on the market, but that they are either expensive to purchase or limited in functionality. The professionally deployable solutions also require a high level of technological infrastructure and specialist personnel.
In this project you look for a low-cost solution, based on standard low-cost available technology, that are good enough for many daily situations. We are thinking, for example, of colored or QR markings on the ground with simple "stations". In a restaurant you could then send the robot to "blue 3", where simple visual color or pattern recognition is enough. The robot will also have to be able to deal with obstacles and interact with people in a basic way, for example “asking” if he can pass and make excuses if he bumps into them.

Assignment and Research questions

The development of a low-budget robot for use within organizations for contact-rich distribution tasks, such as serving in a restaurant. Your assignment is to develop the software, based on ROS, for this platform. The platform is: a 2-wheel (Segway/Oxboard) or 3-omniwheel robot.
The control of the robot should be simple enough for use by non-technically trained personnel. The robot will have to be able to work both indoors and outdoors, and to be able to bring orders to the customer's table. This also requires a form of stabilization mechanism, so that loose or liquid items also arrive properly. Questions:

- How to detect a person and navigate to this person?
- What is a minimal technical configuration (sensors) needed, to enable a low cost robot?
- How to have a good overview on the terrace to be able to pay attention to all attendees?
- How to map the sound on the (robot) map? The robot is able to register its own position, and to position this in its map. But what about the origin of the sound, and more important: how to map the sound on the map? Research is needed to find the actual source and map it on the robot map. Which data / signal type is required to add to the HERE tracker to enable accurate mapping?

Product owner

Teade Punter (HTES)
Experts from VDL Technologies

Technologies:

- Vision - OpenCV
- ROS

[10] https://fontys.nl/Innovatie-en-onderzoek/High-Tech-Systems-and-Materials/HTSM-onderzoeksprojecten-2020/Een-robot-is-geen-superverspreiderBartender.htm

- 2 wheel: Oxboard / blue Segway, or 3 wheel: soccer robot platform

6 2020nj HTES 5 – Navigating a robot4care

HTES project: ROAZ II - with Catharina ziekenhuis Eindhoven

Context:

This assignment is about the programming and modeling of a robot for a care department, which is the recovery section of the heart surgery department in Catharina Ziekenhuis, Eindhoven.

Pepper is the robot platform. Although the Pepper is a well known and a nice humanoid, which attracs all ages of people, programming the Pepper is a challenging task. For example, Pepper does not navigate naturally. Applicable sensors for Pepper are a head camera and a laser in its pedestal. Which is most appropriate, delivers the best results for navigation? Navigation is done along static objects such as carts and beds, but also along dynamic obstacles such as people in the hospital corridor. Attention is paid to the relationship between robot and human, so-called social force, and (reaction) speed. The care robot must also be able to handle various situations. One moment it is quiet and everyone has time and an eye for each other. The other moment can be an emergency situation in which all actions speed up. It is precisely then that it is important that the robot does not get stuck and aggravates the already hectic situations by blocking the walking space.

Assignment and Research questions:

Design and implement robust navigation and path finding for a servicing robot in a hospital. How to design and implement robust robot behavior for navigation and path finding for a Pepper platform at the care section of a hospital?

Product owner:

Erik van Alphen (HTES Research Group, Fontys ICT). e.vanalphen@fontys.nl.

Technologies:

- Gazebo model - Starting point for the assignment is a simulated world of the care department (Gazebo) in which a Pepper drives.
- Pepper robot, with ROS Navigation stack (to enable AMCL, 2Dnav)
- C++, Python, ROS.

Use cases:

1. Basic navigation with Pepper – the Pepper is able to drive from a starting point (SP) to a spot where a human is sitting or standing (EP). Start as simple as possible and apply odometry of the robot. It will be likely that you will need more support. The following two options should be examined and compared to each other:
   a. Use of laser – apply SLAM[11].
   b. Use of depth camera – apply RTMap[12].

   Criteria for this use case: The accuracy of the driven trajectory should be measured.
   Technologies for this use case: You will use the ROS Navigation stack (TEB planner), and probably configure the parameters of this software stack. Apply TF for camera and laser.

[11] http://wiki.ros.org/gmapping

[12] http://wiki.ros.org/rtabmap_ros

2. Navigation with Pepper is conducted repeatedly – the Pepper is able to drive several times repeatedly from a starting point (SP) to a spot where a human is sitting or standing (EP). A comparison of laser vs use of depth camera should be made.
   Criteria for this use case: The accuracy of as well as time delays in the driven trajectories should be measured.
   Technologies for this use case: ROS Navigation stack, RTMap (camera), SLAM (laser). Apply TF for coordinates of camera and laser.

3. Encountering people – the Pepper is able to drive to a (random) person waiting in the care section and addresses this person. Pepper addresses this person intelligent: it is able to address family of patients, and e.g., not a doctor or nurse. The Pepper is also able to remember who is addressed by himself, to avoid repeteadly addressing the same person.
   The following technologies should be applied:
   a. Face detection, face recognition and recognizing people on behalf of particular characteristics
   b. Tracking people
   Criteria for this use case: The identification of single person, and then be able to trace the person when addressing him/her.

For all use cases: develop in Gazebo world and do final test on the real Pepper.

7 2020nj PII HTES 6 – Low Power Human Pose Recognition for Public Space

Project: Smart Vitality Living lab
Link with: 2020nj HTES – Interaction Module on platform

Context
Municipalities need (structural) data collection and insights into the movement and social effects of specific areas, places and equipment. Such detailed information is often not yet available at the moment. With this information, municipalities can:

1. Use objective data to define policies, e.g., invest in a sporting area.
2. Gaining insight into who does what, where and when in the neighborhood
3. Use targeted communication based on insight into social meeting places
4. Balancing an investment against the social return

InnoSportLab Sport & Beweeg (ISL S&B) want to develop an efficient and accurate measurement system for human movements in public spaces. A protocol is defined for measuring in public spaces. With this protocol, ISL S&B is able to measure the social performance (social and physical activity) of areas or equipment and to provide municipalities with substantiated advice for possible improvement.

The protocol describes a labor-intensive process. In order to offer an affordable process to municipalities, it is necessary to use technology. A few examples: GIS data banks combine in one system and use AI technology to register data effectively and efficiently. ISL S&B is currently experimenting with the OpenPose software program. OpenPose is an AI system that automatically analyzes the movement of citizens by means of a camera image.

Assignment and Research questions
Developing a low powered system with a camera measure the parameters for the protocol to measure human movements; using a Learned NN for human pose recognition (OpenPose). This is for getting smart effect in public space using smart technology. The focus is on following use cases:

• Meeting behavior
• (Active) transport
• Activities (sports, games, walking, running, etc.)
• Returning “movers

Product Owner
Lars van Raaij, inno sports lab sport en beweeg. lars@innosportlabsportenbeweeg.nl

Technologies

- Pose Net
- Open CV, Python
- Vision, Connectivity

8 2020nj HTES 7 – Indoor positioning @ Low speed

Automation project
Link TNO Automotive, Here Technologies

Context
With the increasing application of autonomous robots, like AGVs and with the interest in automotive industry for low speed automated driving in automotive there is an interest for indoor positioning. Indoor positioning is the localization of a vehicle in a building or half open space, like a bus depot or parking garage. Indoor positioning offers precision where e.g., GPS cannot offer. Indoor positioning uses a network of devices that is used to localize vehicles.

Lower speed environments are often more structured, while lower speeds and less or no "other road users" are helpful. The other way around, very specific situations are needed when it comes to route planning and indoor localization. Due to this specific nature, the question is: what are appropriate techniques required for my indoor positioning?

Assignment and research questions
Develop a prototype indoor positioning system for low speed robot/automotive application, using UWB/Pozyx focusing on improving its accuracy by taking into account other data sources, like odometry and knowledge of the vehicle itself. The assignment requires an experimental attitude of measuring e.g., accuracy of Pozyx, as well as finding the correct combination of data sources.

Research questions:

- What are additional information sources needed to improve indoor positioning with UWB?
- How to apply Kalman or particle filters in context of UWB and positioning? This requires Kalman filter (E/U KF) or particle filter mathematics and (vehicle) modelling.

Product owner:
John Vissers (TNO Automotive)

Technologies

- Pozyx UWB
- Kalman filter, ROS EKF

9 2020nj HTES 8 – Smart Tactical Robot IV

Context

A shooting area is an area where soldiers are practicing their training in shooting abilities. To enable more realistic battle contexts for soldiers a robot is developed.

The goal of the assignment is to develop a robot that serves as a target in a shooting area. The target is a dummy body mounted on top of the robot. The robot itself is a mobile platform that is able to move in a shooting area, which is situated outdoor at the base of the 13e Brigade at Oirschot. The robot is a Smart Tactical Robot (STR) that is part of opposing forces to help with shooting exercises.

Several student groups have already worked on the Smart Tactical Robot, e.g., on autonomous driving, random pathfinding, remote control with an emergency button and reverse engineering of the software. So you continue on top of their achievements.

Assignment and Research questions

The project starts with testing existing software on a Clearpath Jackal. The STR solution of the previous student group is installed and can be demonstrated. I.e. the robot software is implemented on Clearpath Jackal.

The robot should show unpredictable/random behavior within given assignments at the shooting area, in which randomness (game design) is applied. For this it is needed to define and implement unpredictable behavior of the STR in a shooting area, e.g., that the robot accelerates, decelerates, makes sudden changes in directions and oscillates around its main axis, see picture above.

The STR is able to predict its future positions (x,y, angle phi) to prepare itself for unexpected situations it might face, e.g., an object or ‘dangerous’ situation and to enable the robot to navigate autonomously and localizes its own position and coordinates movements within its team through the area of operation.

Product Owner

K. Yildirim, Ministerie van Defensie, RAS eenheid, basis Oirschot PII ism lectoraat HTES.

Technologies

C++, Python, ROS, Gazebo.

10 2020nj PII HTES 9 – Smart Office II

Context
A smart office is a workplace where technology enables people to work better, faster and, hopefully, smarter. Beacons, sensors and mobile apps help employees to perform their tasks better and faster, so they have enough time to focus on innovating their business and work processes.

Fontys ICT's innovation hub at Strijp TQ is the blueprint for the smart office, but other open office environments might benefit from the applied research. The project goal is to examine which factors do influence the decrease of concentration in open working environments with students and teachers. Therefore the measurement of environment variables, such as CO2 and temperature, is required, to see if advises can be generated on how the end-user can improve their concentration by following simple steps.

A Fontys ICT student group has defined an architecture to collect data from IoT devices in 2020vj semester. Your project proceeds on the results of this group's results.
Assignment and Research questions
Your assignment is to develop and extend the available software platform for a smart office to enable smart working by integrating existing IoT technology. This includes the setup of the sensoring part, e.g., sensors to measure CO2 content, noise level and location data. The sensors has to be placed at actuals building location to get real measurement data. Furthermore the ability to extend with new sensors and take away available sensors has to be implemented.
Secondly, the data about the room air quality and noise level should be presented in the (Outlook) booking/scheduling system. The question is: how to use or present this data to support or direct the user? This can possibly be enriched with other smart office data such as booking/calendar data. The second question is: what can be done with the system to control the behavior of the people working in the smart office? For example, opening a window when CO2 is at too high level might be done. People also might go to a quieter place. Game elements might help to enable this type of behavior. And are the users ultimately happy with the help offered?
Thirdly, a predictor is developed to predict air quality in the Smart Office on behalf of collected sensor data and (machine learning) algorithm.

Product Owner
Anthony van Ooijen, CTouch

Technologies
Node-Red, InfluxDB, MQTT, CTouch screen, C#