Kratek opis usposabljanja mladega raziskovalca (*Short description of the Young Researcher's training)*

1. Raziskovalna organizacija (*Research organisation)*:

Univerza v Ljubljani, Fakulteta za strojništvo
University of Ljubljana, Faculty of Mechanical Engineering

2. Ime, priimek in elektronski naslov mentorja (*Mentor's name, surname and email*):

Marko Šimic, marko.simic@fs.uni-lj.si

3. Šifra in naziv raziskovalnega področja (*Research field*):

2.10 Proizvodne tehnologije in sistemi
2.10 Production technologies and systems

4. Kratek opis usposabljanja mladega raziskovalca (*Short description of the Young Researcher's training)*:

Navedite tudi morebitne druge zahteve, vezane na usposabljanje mladega raziskovalca (npr. znanje angleškega jezika, izkušnje z laboratorijskim delom, potrebne licence za usposabljanje…).

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Usposabljanje mladega raziskovalca bo potekalo v okviru raziskovalne tematike programske skupine P2-0248, ki zajema tudi raziskave konceptov Pametnih tovarn in pametnih sistemov znotraj tovarne. Razvoj pametnega kibernetsko-fizičnega sistema, kot so to lahko energijsko učinkovite hidravlične naprave uporabljene v procesih proizvodnih tehnologij in njihova implementacija v realno okolje Pametne tovarne, zahteva poglobljeno znanstveno-raziskovalno obravnavo. Na podlagi pregleda obstoječega stanja na področju industrije 4.0 in pametnih sistemov (pametne hidravlične naprave) je še vedno zaslediti slabo definirana področja. Eno od pomembnejših je razvoj novih metodologij za integracijo različnih distribuiranih podsistemov z lastno inteligenco in možnostjo odločanja, ter načini povezljivosti in komunikacije med posameznimi podsistemi. Drugo pomembno področje je razvoj digitalnih dvojčkov posameznih podsistemov (preslikava realnega procesa, sistema v virtualno okolje) in digitalnih agentov z odločitvenimi algoritmi.

Mladi raziskovalec bo v okviru svoje doktorske naloge obravnaval področje hidravličnih naprav, ki se uporabljajo v proizvodnih tehnologijah. Izbrano napravo bo nadgradil v pametni sistem in jo integriral v koncept demonstracijskega centra Pametno tovarne. Izhodišče raziskovalnega dela predstavlja konvencionalna hidravlična naprava za katero je izdelano osnovno krmiljenje in vizualizacija. V sklopu raziskovalnega dela bo kandidat za izbrano hidravlično napravo določil ustrezne senzorje in krmiljenje, ter komunikacijske protokole. Izdelal bo grafični vmesnik za spremljanje in nadzor merjenih veličin ter krmiljenje. Osrednji del naloge predstavlja razvoj digitalnega dvojčka procesa naprave, ki vsebuje digitalnega agenta katerega funkcija je sprejemanje odločitev na podlagi realnih vhodnih podatkov in kreiranje nove strategije procesa. V sklopu eksperimentalnega dela se bo nova pametna hidravlična naprava integrirala v demonstracijski center Pametne tovarne, kjer se bodo testirali predvsem ustreznost komunikacijskih protokolov (informacijski tok) ter delovanje digitalnih agentov. Enega od končnih rezultatov doktorske naloge predstavlja metodologija razvoja pametne hidravlične naprave in integracija le te v Pametno tovarno.

Zaželeno je, da imajo kandidati poleg znanja angleškega jezika ozadje iz naslednjih področij:

- strojništvo (proizvodne tehnologije, hidravlika, proporcionalni in servo hidravlični sistemi),
- elektrotehnika (mehatronika, avtomatika in informatika, analiza signalov, strojno učenje),
- informatika (komunikacijski protokoli – OPC UA, razvoj grafičnih vmesnikov, vizualizacija).

Za usposabljanje je zaželeno poznavanje naslednjih programskih okolij in strojne opreme: Matlab, SolidWorks (3D modeliranje objektov), DSHplus (simulacijski program za simulacijo hidravličnih komponent in sistemov), Phython (programiranje), Bechoff (krmilnik), TwinCAT 3 (programski vmesnik krmilnikov Beckoff).

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The training of a young researcher will be carried out within the framework of the research topic of the P2-0248 program group, which also includes the research of Smart Factory concepts and smart systems. The development of a smart, cyber-physical system, such as energy-efficient hydraulic drives used in manufacturing processes and their implementation in the real environment of the Smart Factory, requires in-depth scientific research. Based on an overview of the current state-of-the-art in the field of the industry 4.0 and intelligent systems (smart hydraulic devices), poorly defined areas still remain. One of the most important is the development of new methodologies for the integration of various distributed subsystems with their own intelligence and decision-making options, as well as ways of connectivity and communication between individual subsystems. Another important area is the development of digital twins of individual subsystems (mapping the real process, the system into a virtual environment) and digital agents with decision algorithms.

Within his doctoral thesis, the young researcher will deal with the field of hydraulic devices used in production technologies. The selected device will be upgraded into a smart system and integrated into the concept of the demonstration centre of Smart Factory. The starting point of the research work is the conventional hydraulic device for which basic control and visualization is made. As part of the research work, the candidate for the selected hydraulic device will determine the appropriate sensors and control technology, as well as communication protocols. He will create a graphical interface for monitoring and controlling the measured parameters and control. The main part of the task is the development of the digital twin of the process that contains a digital agent whose function is to make decisions based on real input data and to create a new process strategy. As part of the experimental work, the new smart hydraulic device will be integrated into the demonstration centre of Smart Factory, where the adequacy of communication protocols (information flow) and the operation of digital agents will be tested. One of the final results of the doctoral thesis is the methodology of developing a smart hydraulic device and integrating it into the Smart Factory.

It is desirable that candidates have the background from the following areas in addition to the knowledge of English language:

- mechanical engineering (manufacturing technologies, hydraulics, proportional and servo hydraulic systems),
- electrical engineering (mechatronics, automation and informatics, signal analysis, machine learning),
- Informatics (communication protocols - OPC UA, development of graphic interfaces, visualization).

Knowledge of the following software environments and hardware is desirable for training: Matlab, SolidWorks (3D modeller), DSHplus (simulation program for simulation of hydraulic components and systems), Phython (programming), Bechoff (controller), TwinCAT 3 (Beckoff controller software interface).