DINAMIČKO POZICIONIRANJE PLOVNIH OBJEKATA

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Zagreb

(disertacija)

Dynamic positioning of marine vessels (PhD thesis)

Sažetak: Dinamičko pozicioniranje sagledano je iz perspektive teorije upravljanja kao i drugih znanstvenih disciplina. Opisan je razvitak izvršnih organa (propulzora) koji se najčešće koriste kod dinamičkog pozicioniranja, te je raščlanjen problem na njegove sastavne dijelove, kao što su na pr. okruženje (valovi, morske struje i sl.), alokacija izvršnih organa, problem njihove kontribucije, i td. Problem optimalnog izbora propulzora, njihovog smještaja, proračuna njihovog doprinosa, te osobito problem singularnih konfiguracija propulzora, koji se u novije vrijeme vrlo intenzivno proučava, kao i problem energetskih resursa na plovilu za svrhu dinamičkog pozicioniranja su obrađeni. Pojašnjeni su i opisani matematički modeli komponenata za dinamičko pozicioniranje. Tako je dan matematički model plovila sa 6 stupnjeva slobode, te pojednostavljeni model sa 3 stupnja slobode. Za matematički opis poremećaja korišten je suvremeni pristup preko energetskih spektara, te je ukazano na problem racionalizacije spektara te njihove linearne aproksimacije. Predložen je učinkoviti numerički algoritma za projektiranje obojenih filtera. Propulzori su opisani preko svojih dinamičkih modela, te su opisane pojave međudjelovanja propulzora i trupa plovnog objekta. Mjerenje je opisano stacionarnim stohastičkim modelom. Objašnjena je višekriterijalnost zadaće dinamičkog pozicioniranja te su navedeni neki od postojećih pristupa u rješavanju toga problema. Postupak kovarijansnog pridruženja i postupak ograničenog kovarijansnog upravljanja izdvojeni su kao postupci prikladni za ovu primjenu. Međutim, kandidat ukazuje na određene nedostatke ovih postupaka kada se radi o dinamičkom pozicioniranju i predlaže novi postupak – postupak optimalnog ograničenog kovarijansnog upravljanja, čije prednosti pokazuje na konkretnom ilustrativnom primjeru. Za potrebe simultane stabilizacije sustava u više radnih točaka primijenjen je postupak optimizacije zasnovan na linearnim matričnim nejednadžbama. Za potrebe postoptimalne analize učinkovitosti rada predloženog sustava dinamičkog pozicioniranja, a u svrhu kritičke ocjene polaznih zahtjeva (točnosti držanja pozicije), predložena je metoda koja se inače koristi u ekonomiji pod nazivom teorije prikrivene cijene. Primjenom te metode može se pokazati da neznatna promjena u zahtjevu na točnost držanja pozicije može rezultirati u znatnim uštedama energije, što je za svako plovilo s ograničenim resursima energije vrlo značajno. Primjena predloženog postupka optimalnog ograničenog kovarijansnog upravljanja zajedno sa predloženim postupkom postoptimalne analize daju projektantu sustava upravljanja moćan alat za projektiranje ne samo sustava dinamičkog pozicioniranja. Znanstveni doprinosi disertacije su u novom originalnom postupku numeričke optimizacije pri racionalizaciji spektralnih karakteristika Pierson-Moskowitz spektra valova. Predloženi postupak prikladan je za sustave upravljanja plovilom koji rade u stvarnom vremenu. Predložen je novi postupak numeričkog projektiranja regulatora za dinamičko pozicioniranje koji se zasniva na optimalnom ograničenom kovarijansnom upravljanju. Ovaj postupak ima univerzalni karakter, jer ga je moguće primijeniti za stabilizaciju stohastičkih sustava, kod kojih se regulator projektira s praktičnim i pragmatičnim opisom željenog ponašanja sustava. Konstruiran je i

primijenjen postupak " prikrivene cijene" za postoptimalnu analizu projektiranog sustava upravljanja. Time je pokazano da je uobičajeni postupak iz ekonomske analize moguće korisno primijeniti i na tehničke sustave.

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