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ABOUT ONE ISSUE OF DELAYED DIFFERENTIAL PLAY

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Abstract

The article explores the method of directional chasing to solve conflict state problems characterized by a neutral-type differential equation with a delay argument, as well as the method of decisive functions in solving the problem of chasing, the apparatus of differential and differential-differential equations, the mathematical theory of optimal processes, theories of differential games, the theory of multivariate reflections.

Us motion vector $z_1,.....,z_k$ s with that identify, $n-$dimensional E^n euclid in space

$$z_1^{'}=C_i z_i+u_i+\upsilon\ ,\ 1\le i\le k, \qquad (1.1)$$

linear differential equations given are. This land, $C_i-n\times n-$dimensional constant in matrix, $u_i\in U_i,\ \upsilon\in V, U_1,....,U_k,V-$the orientation of a convex compact package.

Also to us, $M_1,.....M_k-$closed, convex, the orientation of the E^n euclid space to the appropriate packages given are. Variables of a multiple that it is the condition representing (1.1) differential in the game chases group $P=\{P_1,.....P_k\}$ and prohibition realistically to the player (which escape) E are. In the game chases the group P, the management of vector $u=\{u_1,.....u_k\}$'s instructions according and any z_i vector in the corresponding basis on M_i $(1\le j\le k)$ the terminal in the package come down to the effort that will make. The player (which escape) E for his v guidance in M_i $(1\le j\le k)$ the collection to come down and not move does.

(1.1) of the game 's starting point $z^0=(z_1^0,......,z_k^0)$ is, to him suitable time $t(z^0)$ that is a sign let. You any of how the piece of continuous management $\upsilon(\cdot)$ to suited so that you manage to $u(\cdot)=(u_1(\cdot),.....,u_k(\cdot))$ choose , you can , fit without, $j(1\le j\le k)$ $z_j(t_1)\in M_j,\ t_1\le t(z^0)$ it is.

Us closed and convex, the orientation of which is M the package given is if its base function

$$W_M(\psi) = \sup_{x \in M} \langle \psi, x \rangle$$

is and a closed convex orientation conus

$$K_M = \{\psi : W_M(\psi) < +\infty\}$$

if, this $W_M(\psi)$ function K_M at continuous is. The last equality M_i is a compact package, the case is made in.

Us $N_i(q),\ (1 \le i \le k) -$ continuous convex value and compact package, as well as $q \in Q$ the orientation of a convex and compact package is given , which is ($N_i(q) \in E^n$).

Now

$$\lambda_i(q) = \min_{\|\psi_i\|=1} [W_{N_i(q)}(\psi_i) + W_{M_i}(-\psi_i)] \qquad (1.2)$$

the expression we do not look.

3.1-lemmaa.

$\bigcup_{i=1}^{k} (N_i(q) \cap M_i) = \varnothing$ is,

when $\min_{q \in Q} \max_{1 \le i \le k} \lambda_i(q) < 0$, if, thus, $q \in Q$.

Proof. Any $q_0 \in Q$ for $\bigcup_{i=1}^{k} (N_i(q_0) \cap M_i) = \varnothing$ that show needed to be.

Then volunteer $i = 1, 2, ..., k$ $N_i(q_0) \cap M_i = \varnothing.$ the last of our equal, just $\max_{1 \le i \le k} \lambda_i(q_0) < 0$ and fit basis $\min_{q \in Q} \max_{1 \le i \le k} \lambda_i(q) < 0$ when it is appropriate is.

Contrary $q_1 \in Q$ to while $\min_{q \in Q} \max_{1 \le i \le k} \lambda_i(q) = \max_{1 \le i \le k} \lambda_i(q_1).$ theorem from use each a $i -$ s for $N_i(q_1) \cap M_i = \varnothing$ also,

$$\bigcup_{i=1}^{k} (N_i(q) \cap M_i) = \varnothing$$

the fact that it came out.

Given z_0 the initial cases of character, $u(\cdot)$ and $\upsilon(\cdot)$ controls (1.1) equation Cauchy to the formula according to the following appearance comes in.

$$z(t) = z(z^0, t, u(\cdot), \upsilon(\cdot)) = \Phi(t) z^0 + \int_0^t \Phi(t - \tau)[u(\tau) + \upsilon(\tau)]\, d\tau \qquad (1.3)$$

this earth $\Phi(t) -$ matrix in $\Phi'(t) = C\Phi(t),\ \Phi(0) = I$ terms you will build. This $I -$ unit in matrix.

The following yield will

$$A = \left\{ \alpha = (\alpha_1, ..., \alpha_k) : \alpha_i \ge 0, \sum_{i=1}^{k} \alpha_i = 1, \alpha_i \in E^1 \right\} \qquad (1.4)$$

$$\Psi=\left\{\psi=(\psi_1,.....,\psi_k):\|\psi_i\|=1,\psi_i\in E^n\right\} \quad (1.5)$$

$$W(z,t,\alpha,\psi)=\sum_{i=1}^{k}\alpha_i\left\langle \Phi_i^*(t)\psi_i,z_i\right\rangle+\sum_{i=1}^{k}\alpha_i\int_0^t\max_{u_i\in U_i}\left\langle \Phi_i^*(t)\psi_i,u_i\right\rangle d\tau+$$

$$\int_0^t\min_{\upsilon\in V}\left\langle \sum_{i=1}^{k}\alpha_i\Phi_i^*(\tau)\psi_i,\upsilon\right\rangle d\tau \quad (1.6)$$

$$\mu(z,t,\alpha,\psi)=W(z,t,\alpha,\psi)+\sum_{i=1}^{k}\alpha_i W_{M_i}(-\psi_i) \quad (1.7)$$

$$\lambda(z,t)=\max_{\alpha\in A}\min_{\psi\in\Psi}\mu(z,t,\alpha,\psi) \quad (1.8)$$

You in advance agreed, unless, in the game, the current controls $\upsilon(\cdot),\ u_1(\cdot),.....,u_k(\cdot)$ if, this time, $0\le\tau\le t$ is, $\upsilon(\tau),\ u_i(\tau)\in U_i,\ (1\le i\le k)$- dimensional functions, we understand.

Given $\upsilon(\cdot)$ the current administration, optional $i,1\le i\le k$ s for the following, don't look at

$$N_i(z_i,t,\upsilon(\cdot))=\{z_i(t):z_i(t)=\Phi_i(t)z_i+\int_0^t\Phi_i(t-\tau)u_i(\tau)d\tau+\int_0^t\Phi_i(t-\tau)\upsilon(\tau)d\tau,$$

$$u_i(\tau)\in U_i,\ 0\le\tau\le t\},$$

$$W_{N_i(z_i,t,\upsilon(\cdot))}(\psi_i)=\left\langle \Phi_i^*(t)\psi_i,z_i\right\rangle+\int_0^t\max_{u_i\in U_i}\left\langle \Phi_i^*(\tau)\psi_i,u_i\right\rangle d\tau+$$

$$+\int_0^t\left\langle \Phi_i^*(\tau)\psi_i,\upsilon\right\rangle d\tau,$$

$$\lambda_i(z_i,t)=\min_{\|\psi_i\|=1}\left[W_i(z_i,t,\psi_i)+W_{M_i}(-\psi_i)\right].$$

Now form those who make the above function with we are bound.

3.1-teorama. *The following relationship fitting*

$$\lambda(z_i,t)\le\min_{\upsilon(\cdot)}\max_{1\le i\le k}\lambda_i(z_i,t,\upsilon(\cdot)) \quad (1.9)$$

$$\lambda(z,t)\le\max_{1\le i\le k}\lambda_i(z_i,t) \quad (1.10)$$

Proof. Every how $\upsilon(\cdot)$ the current administration for

$$\max_{\alpha\in A}[\sum_{i=1}^{k}\alpha_i\lambda_i(z_i,t,\upsilon(\cdot))]\ge\max_{\alpha\in A}\min_{\psi\in\Psi}[\sum_{i=1}^{k}\alpha_i\left\langle \Phi_i^*(t)\psi_i,z_i)\right\rangle+$$

$$(1.11)$$

$$+\sum_{i=1}^{k}\alpha_i\int_0^t\max_{u_i\in U_i}\left\langle \Phi_i^*(t)\psi_i,u_i)\right\rangle d\tau+\min_{\upsilon(\cdot)}\int_0^t\left\langle \sum_{i=1}^{k}\alpha_i\Phi_i^*(t)\psi_i,\upsilon(\tau)\right\rangle d\tau]$$

To us $\varepsilon_1,....,\varepsilon_k$ −is given is

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$$\max_{\alpha\in A}\left[\sum_{i=1}^{k}\alpha_i\varepsilon_1\right]=\max_{1\le i\le k}\varepsilon_i \qquad (1.12)$$

the formula according to the following results possible you will be

$$\max_{\alpha\in A}\left[\sum_{i=1}^{k}\alpha_i\lambda_i(z_i,t,\upsilon(\cdot))\right]=\max_{1\le i\le k}\lambda_i(z_i,t,\upsilon(\cdot)) \qquad (1.13)$$

That's in addition to the following relation on from on bring a can

$$\min_{\upsilon(\cdot)}\int_0^t\left\langle\sum_{i=1}^{k}\alpha_i\Phi_i^*(t-\tau)\psi_i,\upsilon(\tau)\right\rangle d\tau=\int_0^t\min_{\upsilon\in V}\left\langle\sum_{i=1}^{k}\alpha_i\Phi_i^*(\tau)\psi_i,\upsilon\right\rangle d\tau \qquad (1.14)$$

Therefore, (1.1) in the expression, is (1.13) and (1.14) relationship considering beneficially (1. 9) the relationship is reasonable that show easy.

(1.10) the relationship we will prove

$$\min_{\upsilon\in V}\left[\left\langle\sum_{i=1}^{k}\alpha_i\Phi_i^*(\tau)\psi_i,\upsilon\right\rangle\right]\ge\sum_{i=1}^{k}\alpha_i\min_{\upsilon\in V}\left\langle\Phi_i^*(\tau)\psi_i,\upsilon\right\rangle$$

also

$$\mu(z,t,\alpha,\psi)\ge\sum_{i=1}^{k}\alpha_1[W_i(z_i,t,\psi_i)+W_{M_i}(-\psi_i)].$$

So make

$$\lambda(z,t)\ge\max_{\alpha\in A}\min_{\psi\in\Psi}\sum_{i=1}^{k}\alpha_i\left[W_i(z_i,t,\psi_i)+W_{M_i}(-\psi_i)\right],$$

the relationship is made. (1.12) and the relations (1.10) of the relationship private is free.

The game finish time and his analyst will feature.

To us, the initial state is a $z^0=(z_1^0,...,z_k^0)$ form fixed

$$I(z^0)=\{i:z_i^0M_i,1\le i\le k\}$$

the package given is.

3.1-lemma to according say that $I(z^0)=\varnothing$ is, when $\lambda(z^0,0)<0$ it is. You $I(z^0)\ne\varnothing$ if, so $T(z)$ the function we determine it z^0 at $T(z^0)=0$ are. You $I(z^0)=\varnothing$ have $T(z^0)$ as the equation of the first positive root $\lambda(z^0,t)=0$ as we can. The remaining case $T(z^0)=+\infty$.

$T(z)$ the function of the meaning more accurate understanding for following lemma in the mix come.

3.2 - lemma. *$T(z^0)<+\infty$ is any how $\upsilon(\cdot)$ current management $j\,(1\le i\le k)$ procedure on being found, for him to fit , which comes to the current administration $u_i(\cdot)$ by a determined, all $z_j(z_j^0,T(z^0),u_j(\cdot),\upsilon(\cdot))\in M_j$ that is.*

Proof. You prove not only of the game z_0 the initial state to see out enough is, $I(z^0)=\varnothing$ that to show difficult it is.

Identified $T(z)$ function for $\lambda(z^0,T(z^0))=0$. That (1.9) the relationship is as follows: write you can

$$\min_{\upsilon(\cdot)}\max_{1\le i\le k}\lambda_i(z_i^0,T(z^0),\upsilon(\cdot))\ge 0$$

now the 1.1 - to lemma according optional $\upsilon(\cdot)$ current management for

$$\bigcup_{i=1}^{k}\left[N_i(z_i^0,T(z^0),\upsilon(\cdot))\cap M_i\right]\ne\varnothing$$

expression of the form we make. This last expression from the lemma confirmation come out.

Us $\nu(z,t,\alpha)=\min_{\psi\in\Psi}\mu(z,t,\alpha,\psi)$ function and

$$A(z,t)=\{\alpha\in A:\nu(z,t,\alpha)=\lambda(z,t)\},\quad \Psi(z,t,\alpha,\psi)=\nu(z,t,\alpha)$$

to package given.

$A(z,t)$ to package to relevant $\{z,t\}$'s α to citizens of the continuous image of $\Psi(z,t,\alpha)$. $\Psi(z,t,\alpha)$ the image $\alpha\in A(z,t)$ is A a package of each a point to be made. Again $e^{'}=(e,\square)$ given is, thus, $e=(e_1,....,e_k)$, e_i-n-- dimensional vector, $\square-$ of any number.

The following write you can

$$\frac{\partial\lambda}{\partial e^{'}}=\sup_{\alpha\in A(z,t)}\min_{\psi\in\Psi(z,t,\alpha)}[<\partial_z\mu(z,t,\alpha,\psi),e>+\square\partial_t\mu(z,t,\alpha,\psi)] \qquad (1.15)$$

this here $\partial_z\mu-$ $\mu-$'s z on gradient function, $\partial_t\mu-t$ on to get derivative. Also $A(z,t)$ from taken and $\Psi(z,t,\alpha)$ the collection $\{z,t\}$ point fixed $\alpha\in A(z,t)$ at the point $\Psi(z,t,\alpha)$ the function from above semi - continuous is.

(1.6) and (1.7) formula use

$$\partial_z\mu(z,t,\alpha,\psi)=(\alpha_1\Phi_1^*(t)\psi_1,....,\alpha_k\Phi_k^*(t)\psi_k) \qquad (1.16)$$

$$\partial_z\mu(z,t,\alpha,\psi)=\sum_{i=1}^{k}\alpha_1<\Phi_i^*(t)\psi_i,C_iz_i>+$$
$$+\sum_{i=1}^{k}\alpha_i\max_{u_i\in U_i}<\Phi_i^*(t)\psi_i,u_i>+\min_{\upsilon\in V}<\sum_{i=1}^{k}\alpha_i\Phi_i(t)\psi_i,\upsilon> \qquad (1.17)$$

If (1.12) to the expression of $e^{'}=\{0,1\}$ and $e^{'}=\{0,-1\}$ to have put

$$\left(\frac{\partial\lambda}{\partial t}\right)^{+} = \sup_{\alpha\in A(z,t)}\min_{\psi\in\Psi(z,t,\alpha)}\partial_t\mu(z,t,\alpha,\psi),$$

$$\left(\frac{\partial\lambda}{\partial t}\right)^{-} = -\inf_{\alpha\in A(z,t)}\max_{\psi\in\Psi(z,t,\alpha)}\partial_t\mu(z,t,\alpha,\psi),$$

that is, it $\left(\frac{\partial\lambda}{\partial t}\right)^{+}$ and $\left(\frac{\partial\lambda}{\partial t}\right)^{-}$ the expression $\lambda(z,t)$ from t by taken the left and right surge whom finds doing so means.

Comments. Following

a) $0 < T(z) < \infty$;

b) $\inf_{\alpha\in A(z,T(t))}\max_{\psi\in\Psi(z,T(z),\alpha)}\partial_t\mu(z,T(z),\alpha,\psi) > 0$;

conditions is carried out, $z=(z_1,...,z_k)$ to the point regular point is called.

You $\Omega-$ regular - point package that beneficially, his close $\overline{\Omega}$ with and its border $\omega=\overline{\Omega}/\Omega$ with we will write.

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