

From Hard Copy to Electronic

Recently, I pondered the following question: Is the future of books to be fully electronic, as many of us believe, or is the answer not so simple? This editorial will try to address this question and analyze its impact on the publications of the IEEE Control Systems Society (CSS). A book published last year and coauthored by Jean-Claude Carrière and Umberto Eco (the author of the best seller *The Name of the Rose*) makes an attempt to answer this question from a philosopher's perspective. The book is available in French and in Italian, and its title can be freely translated as *Don't Even Think to Get Rid of the Books*. The point made by the authors seems clear: "The book is like the spoon, the hammer, the wheel, and the scissors—once invented, they cannot be improved upon." However, what do we mean by a *book*? Are we referring to a book as a set of words or to its physical support, which may be in paper or in electronic form?

These questions lead immediately to discussing the volatility of the physical support. Floppy disks revolutionized data storage in the 1970s. These devices were produced in various sizes and became ubiquitous in the 1980s and 1990s for distributing software, transferring data, and creating backups. The advent of other portable storage devices of bigger capacity with faster access, such as thumb drives, recordable CDs, DVDs, and memory cards, made floppies completely obsolete by the early 21st century. Obvious subsequent questions include how long the currently used CDs and DVDs are going to last and how long

will compatible devices for reading them be available?

It is certainly true that a computer produced today cannot read a 15-year-old floppy disk, and data stored on these devices is largely inaccessible. On the other hand, paper is fragile and may easily deteriorate. It may also suddenly disappear—think about the fire described in *The Name of the Rose* that destroyed an entire library containing thousands of rare books. It is also true that paper evolved from papyrus, to parchment, to rag paper, and finally to paper as it is known today, but this process took several centuries, not one or two decades. Hard-copy books do not require any advanced reading technology, are more robust when they fall on the ground, and do not need batteries or software upgrades. Overall, weighing pros and cons, I am still happy to leaf through some ancient books like the

amazing treatise by the medical doctor Pietro Andrea Mattioli, which has been circulating within my extended family for several generations. Mattioli's book, which deals with curing illnesses using herbs and vegetables, was printed in Venice in 1573, or "M.D. LXXIII" in Roman numerals as shown in Figure 1.

Performing keyword searches, creating hyperlinks, continuously updating the text in a dynamic fashion, for example, are clearly major advantages of electronic papers and e-books. The presence of the Amazon Kindle, Sony's Pocket e-Reader, iLiad of Irex Technologies, the Apple iPad, and many others, indicates that these devices are becoming more user friendly and popular. These tools allow e-users to read books, journals, and magazines on the screen of a portable device. Some of the devices may be easily linked to the Web using wireless connections. In

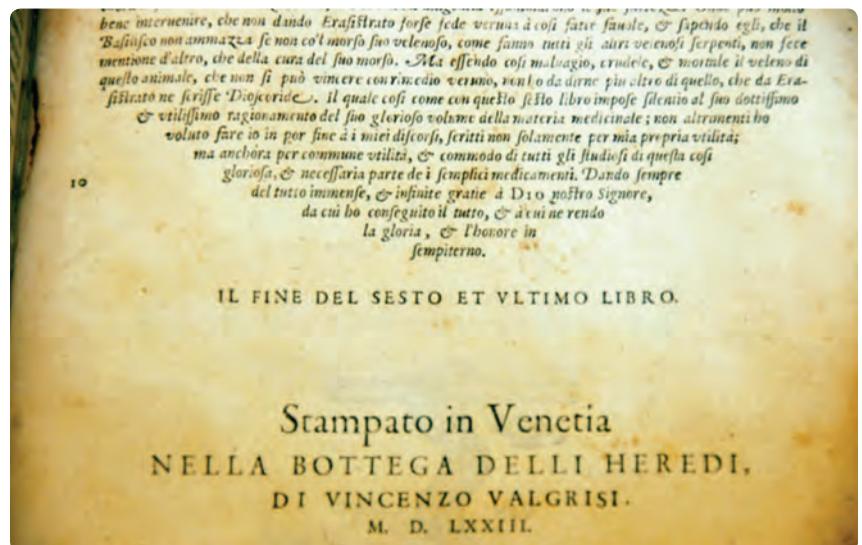


FIGURE 1 The end of the sixth and last book of Pietro Andrea Mattioli printed in Venice in 1573.



FIGURE 2 Picture of a wild poppy printed from the treatise of Pietro Andrea Mattioli.

2009, it has been reported that 5 million e-readers were sold, 60% of which are Kindle. In 2010, the estimated revenue in the United States for e-books is as much as US\$1 billion, but some analysts say that it will take at least another five years before they become an everyday tool.

Even though I feel satisfied when I look at a picture illustrated in Mattioli's treatise showing a wild poppy (Figure 2), and although I still study technical papers in hard-copy form, I believe

that the future is leaning toward electronic publications. When the e-readers combine color display, touch screens, note-taking functions, and many other useful features, then perhaps electronic paper will replace real paper. The amount of time required to complete the transition may depend on several unpredictable factors in much the same way it was difficult to predict the success of the Internet 15 years ago.

SOCIETY NEWS

Significant changes affected our two transactions in recent months. Panos Antsaklis succeeded Christos Cassandras as editor-in-chief of *IEEE Transactions on Automatic Control* (Christos served in this capacity for 11.5 years, the second longest term after George Axelby), and Thomas Parisini took over for Frank Doyle as editor-in-chief of *IEEE Transactions on Control Systems Technology*. Warm thanks are extended to Christos and Frank for their remarkable performance, and my personal best wishes to Panos and Thomas at the beginning of their new adventures.

During my president-elect year, I had the great pleasure to chair a task force "Future of *IEEE Transactions on Automatic Control*." Members of the task force were Panos Antsaklis, John Baillieul, Christos Cassandras, Eduardo

Misawa, Pradeep Misra, M. Vidyasagar, and Steve Yurkovich. The task force concentrated on two main tasks, balancing electronic versus hard-copy distribution and dealing with an increasing number of submissions. For the latter, I refer to the editorial written by Panos Antsaklis, and published in the January issue of the journal, which describes some policy changes. Regarding the former, it is indeed true that many of us have access to *IEEE Xplore* using the subscription provided by our institutions, but this is definitely not the case for all members of the Society. Those members who wish to access electronic papers may use their personal subscription, but this is valid only for the current year and is therefore *temporary*. Hence, the task force concluded that there is an urgent need to provide *permanent* electronic *IEEE Transactions on Automatic Control* papers, exactly as it is done for participants of the Conference on Decision and Control (CDC) who receive a CD containing all papers published in the proceedings. There is indeed another factor that should be considered; producing and shipping hard copies of the journal is partially subsidized by the Society, and it is expensive.

The CSS Board of Governors at the December 2009 meeting unanimously approved the task force proposal to offer six complimentary CDs in 2010 (each containing papers of two issues) to all hard-copy subscribers of *IEEE Transactions on Automatic Control*. The sixth CD will contain the material of all 12 issues, and it will have more sophisticated functionalities such as links from the table of content of various volumes to pdf files of papers. I would like to emphasize that no changes regarding access to *IEEE Xplore* and hard-copy distribution of the journal will be made in the current year. In 2011 we will provide the option to receive the CD or the hard copy, and the feature "print-on-demand" will be always available at the production cost for subscribers who desire to receive hard copy of the journal.

(continued on page 18)



FIGURE 3 The combined 48th IEEE Conference on Decision and Control and 28th Chinese Control Conference. From left: Daizhan Cheng, Faryar Jabbari, Roberto Tempo, John Baillieul, and Lei Guo.

which, by using (14)–(15), is equal to (13). \square

Next, using (6) and (8) in (5) yields

$$J_k(L_k) = \text{tr}(P_{k+1}^{xx}W_k), \quad (17)$$

where P_{k+1}^{xx} is given by (13).

Proposition 2

Assume that, for all $k \geq 1$, P_k^{yy} given by (14) is positive definite. If L_k minimizes (17), then L_k is given by

$$L_k = P_k^{xy}(P_k^{yy})^{-1}, \quad (18)$$

where the error covariance P_k^{xx} in (13) is updated by the Riccati equation

$$P_{k+1}^{xx} = A_k P_k^{xx} A_k^T + Q_k - L_k P_k^{yy} L_k^T. \quad (19)$$

Proof

The necessary condition for a minimizer L_k is given by

$$\begin{aligned} \frac{\partial J_k}{\partial L_k} &= \frac{\partial \text{tr}(L_k P_k^{yy} L_k^T W_k)}{\partial L_k} - \frac{\partial \text{tr}(P_k^{xx} L_k^T W_k)}{\partial L_k} \\ &\quad - \frac{\partial \text{tr}(L_k P_k^{xy} W_k)}{\partial L_k} \\ &= 2P_k^{yy} L_k^T W_k - 2P_k^{xy} W_k \\ &= 0_{p_k \times n_{k+1}}. \end{aligned} \quad (20)$$

Using (20) and the fact that W_k and P_k^{yy} are positive definite yields (18). Finally, substituting (18) into (13) yields

$$\begin{aligned} P_{k+1}^{xx} &= A_k P_k^{xx} A_k^T + Q_k \\ &\quad + (P_k^{xy}(P_k^{yy})^{-1})P_k^{yy}L_k^T \\ &\quad - P_k^{xy}L_k^T - L_k(P_k^{yy}(P_k^{xy})^{-1})P_k^{xyT} \\ &= A_k P_k^{xx} A_k^T + Q_k + P_k^{xy}L_k^T \\ &\quad - P_k^{xy}L_k^T - L_k P_k^{yy} L_k^T, \end{aligned}$$

which proves (19). \square

Note that the optimal gain L_k given by (18) does not depend on W_k . Also, as shown in the next result, L_k is the unique global minimizer of $J_k(L_k)$.

Proposition 3

L_k given by (18) is the unique global minimizer of $J_k(L_k)$ given by (17).

Proof

For all $\alpha \in (0, 1)$, $A_1, A_2 \in \mathbb{R}^{n \times m}$ such that $A_1 \neq A_2$, and positive-definite $B \in \mathbb{R}^{m \times m}$, it follows that $\text{tr}[\alpha(1-\alpha)(A_1 - A_2)B(A_1 - A_2)^T] > 0$ [3, p. 483]. Hence, for $A \in \mathbb{R}^{n \times m}$, the mapping $A \rightarrow \text{tr}(ABA^T)$ is strictly convex. It thus follows that $J_k(L_k)$ is strictly convex, and thus L_k is the unique global minimizer of $J_k(L_k)$. \square

Finally, the Kalman predictor is given by (4), (14), (15), (18), (3), and (19).

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» PRESIDENT'S MESSAGE *(continued from page 14)*

In December 2009 I enjoyed attending the combined 48th IEEE CDC and 28th Chinese Control Conference (CCC), which was hosted in Shanghai by the CSS in collaboration with the Technical Committee on Control Theory (TCCT) of the Chinese Automation Association (CAA). This was the third time that the CDC was held outside the United States in the Asia-Pacific region, and it is the first time that the CSS has chosen to organize its flagship conference in China. The CDC/CCC was held in the Shanghai International Convention Center, one of the new buildings of the growing area of Pudong District. The conference was truly a remark-

able event attended by 1465 delegates. Its exceptional success is certainly due to the vision and leadership of a few individuals, in particular the General Cochairs John Baillieul and Lei Guo and the Program Cochairs Daizhan Cheng and Faryar Jabbari, as well as a remarkable team that made this event possible. Figure 3 shows some of the key organizers of CDC/CCC. Technical highlights of the conference were the Bode Lecture by Peter Caines and the plenaries by Roger Brockett, P.R. Kumar, and T.-J. Tarn. Regarding social events, the show that took place during the banquet, which was attended by 1460 participants and held in one of the

largest conference halls in the world, was certainly amazing. The show featured gymnastics, music, acrobats, and more. I am sure that the successful cooperation between the CSS and the CAA will continue, and I am looking forward to attending the 29th CCC, which will take place at the end of July in Beijing at the China National Convention Center.

Your comments, suggestions, and ideas regarding how activities for the Society can be improved are welcome. I can be reached by e-mail at roberto.tempo@polito.it.

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