

Biometrics

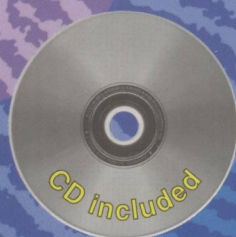
Advanced Identity Verification

The Complete Guide

Julian Ashbourn



Springer



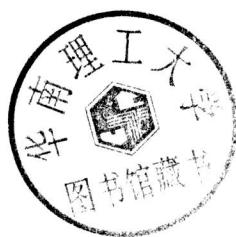
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Biometrics:

Advanced Identity Verification

The Complete Guide



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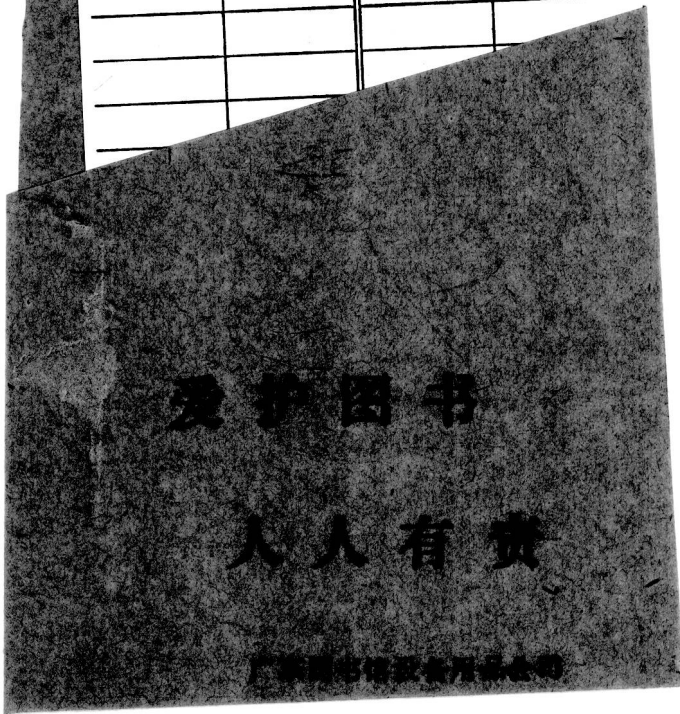
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*This book is dedicated to Joanna, a gifted author,
artist, naturalist and remarkable human being
whose like rarely walks on this earth.*

Very special thanks to David Sidlauskas for his background information and for being a true pioneer, to John Daugman for his foreword and for being a true innovator and to Rosie, Sally and Karen at Springer Verlag for their enduring support, which is as much a part of this book as anything I have written.

Thanks also to all the unsung heroes of the international biometrics industry who have provided the author with many bright moments over the last decade and have unwittingly been the inspiration for this work.

Julian Ashbourn

Foreword

Identifying a thing in terms of the properties that make it different from everything else is an old and venerable idea. Aristotle defined the "essence" (Gr. $\epsilon\iota\sigma\alpha\gamma\gamma\epsilon$) of something as that quality distinguishing it from all other objects; Linnaeus built our botanical and zoological classification system from this principle; and Shannon's Theory of Information measures the informativeness of a message, in bits, entirely in terms of its improbability or uniqueness.

The quest of biometrics is to find the particular within the universal. Nearly all people have faces, eyes, hands, and fingers; detecting these universal human traits helps to distinguish a person from a tree, but serves little to distinguish among individual persons. For that task, one needs to find unique aspects of (say) a facial feature configuration or a fingerprint which are more particular than universal. Not only must there be great variability in such features amongst different individuals (else the features wouldn't be unique), but also there must be little or no variability in those same features for a given person over time and conditions (else they wouldn't be reliable). Everything in the science behind biometric technologies hinges upon the relative sizes of these two variabilities: the between-person and the within-person variability.

Traditional methods of establishing or confirming the identity of an unknown person have relied either upon some secret knowledge that he uniquely should have (such as a password or a PIN number), or upon an object that he uniquely should possess (such as a key, a token, or a card). Passwords date back at least to the Roman centurions, and special tokens at least to the Bronze Age. But testing for secret knowledge or special possessions can only confirm that the knowledge or possession is present, not that a rightful owner is present. It is in order to establish a more fundamental link between an identity and a particular body, through its unique appearance or behavior, that automated biometric pattern recognition techniques are being developed and tested.

The growing need for effective biometric identification is widely acknowledged. Famous cases of "identity theft" have emerged recently, and current estimates of credit card fraud based on falsely claimed identity reach several billions of dollars annually. Even more urgently, the rapid adoption of and increasing economic dependence upon electronic commerce and transactions create systemic vulnerabilities to impersonation on a scale that remains poorly appreciated, just as vulnerability to Internet viruses, and their cost, was misunderstood. Commenting on such emerging "information warfare" risks,

Whitfield Diffie (co-author of the Diffie-Hellman security protocol) has written that: "Society's dependence on electronic commerce will make this the target of first resort in future conflicts, continuing the 20th century trend toward involvement of civilian populations." But we should not imagine that high-stakes roles for biometrics are entirely new. The Old Testament reports the slaughter of 42,000 persons who failed a biometric test that remains under development today: voice identification. The Gileadites sought to track down escaped Ephraimites and to identify them as such by testing whether they pronounced "shibboleth" with a "s-" instead of a "sh-" sound. (All Gileadite readers of this foreword will know that "sh-" is the correct pronunciation.) We read in Judges 12:5-6, "Then said the men of Gilead unto him, Say now Shibboleth: and he said Sibboleth: for he could not frame to pronounce it right. Then they took him, and slew him at the passages of the Jordan: and there fell at that time of the Ephraimites forty and two thousand." This Biblical example illustrates a "phenotypic" biometric: one based upon features or behaviors that are acquired through experience and development, as opposed to a "genotypic" biometric which measures genetically determined traits. Examples of the latter include gender, blood group, and DNA sequence; examples of the former include fingerprints, iris patterns, and signature. Some biometrics are both: facial appearance changes dramatically with age and with expressions, and is thus phenotypic, but it is also very strongly genotypic as illustrated by monozygotic (identical) twins and even by family members sharing only half their genes. Many people consider DNA sequence to be the ultimate biometric, but the fact that one person in about 120 has a monozygotic twin means that the false match rate of a DNA biometric in the population at large cannot be much lower than one percent. The intrusiveness of acquiring a DNA sample is obviously a further limitation (although it must cheerfully be admitted that nearly half of the human race constantly seeks to provide a sample of its DNA to the other half). Elusive, non-scientific factors such as perceived intrusiveness and public acceptability are crucially important in the practical success of biometric systems, as Julian Ashbourn's work so ably shows.

Although the mathematical decisiveness of biometric decision-making depends ultimately just on the combinatorial complexity of the biometric, i.e. the number of degrees-of-freedom spanned by the variability of the chosen feature across the population, its actual success in deployment will depend equally on implementation and application issues that require careful consideration. The biometric literature to date has focused largely on scientific and mathematical issues underlying the pattern recognition and decision-making, leaving a vacuum in these other areas. In contrast, Julian Ashbourn's work both prior to and including this book has made much-needed contributions to understanding, gauging, managing, and improving how humans interact with devices, perceive their experiences, learn from them, and influence design. As such, this book has much to offer to all in the biometrics field, whether they be vendor, user, integrator, assessor, or researcher.

John Daugman

Cambridge

About the author

After studying both art and electronics in his native England, Julian Ashbourn has enjoyed a varied career across several industries including professional audio, security electronics and information technology. He has travelled to many countries including America, Africa, Saudi Arabia, Australia, Germany, France, Luxembourg, Netherlands, Belgium and Ireland in the context of systems design, troubleshooting and general project management.

He was one of the first people to successfully integrate biometric technology and has had an input to a diverse range of biometric systems including border control, prison visitor systems, physical access control and many others. He has developed several software utilities including the innovative BioTrack series - the first applications to present biometric functionality in a familiar and easy to use 32 bit Windows format.

The author of many technical papers and popular biometric articles, he has presented at conferences around the world and was for many years a key contributor to the Association for Biometrics, providing a voice for biometrics in Europe and further afield. He has contributed to both TV and radio broadcasts on the subject and was responsible for the highly regarded Avanti international biometric journal.

With a broad range of interests including art, music, ancient history and emerging technology, his unique and down to earth approach coupled with considerable personal experience acts as a beacon to both light the way forward and dispel myths and misconceptions surrounding this fascinating technology.

Preface

Biometrics bring a new dimension to individual identity verification. They allow the process to be automated and unsupervised where applicable whilst providing levels of accuracy and consistency that simply cannot be guaranteed by traditional methods relying solely on human interpretation. However, biometric verification is not infallible and its implementation requires an understanding of both the technology and the human interface with the technology, if success is to be achieved. Careful consideration must be given to all aspects of biometric systems design including the user interface, the technical architecture, the environment in which it is to be deployed and all the background processes necessary for a particular situation. Only then can we be sure of a successful implementation of the technology.

Whilst biometrics may be seen by some as a new or emerging technology, there have in fact been a large number of biometric systems installed around the world during the last decade. Continuing technological developments in other areas such as communications and microprocessors coupled with an increasingly global society will provide more opportunities to integrate biometric verification into other processes for the benefit of both administrations and users.

This book provides an in depth grounding in the subject of biometrics for all those interested in identity verification, whether they be a potential end user of the technology such as a large corporation or government department, or a professional practitioner such as a consultant or systems integrator. It will also provide a valuable source of reference for the academic researcher or student of biometrics who will find a great deal of practical information to start them off on their particular voyage of discovery. Indeed, there is something in this book for everyone, even if they are of a non technical persuasion and are simply interested in biometrics as an exciting branch of 21st century science and technology.

The book is arranged as a series of logical self contained sections which are perhaps best read sequentially, although this is not essential. An experienced reader may choose to go directly to a chapter of interest.

Julian Ashbourn

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1. Where it all began

Khasekem could feel the heat of the sandy path even through his sandals as he walked under the burning morning sun down the gentle sloping hill towards the dock at Aswan. His thoughts turned to his student days at Heliopolis in lower Egypt, where he had stayed at the house of his uncle Sebekkhu. Sebekkhu was a man of learning and Khasekem was much indebted to his uncle for both his kindness and continual guidance throughout his training as a scribe at Heliopolis.

His first official post had been to copy some of the records appertaining to the construction of the great pyramid of Khufu which had been completed in the year of Khasekem's birth. From this he knew that the pyramid was designed to be 288 cubits tall with a base of 452 cubits square and required in excess of 2.5 million blocks of stone, each one precisely cut and identified as to its exact position within the construction. He also knew that over 1600 talents of silver had been spent on food for the workforce which at times approached 100,000 men, many of whom were from farming communities and were glad to have the opportunity to work on the project during the inundation periods in which their land was often flooded for 10 weeks or more. The food and shelter provided as a result of the pyramid construction was particularly welcome at this time. Khasekem had noted that there were many issues around accurate identification of these individuals.

Other men, particularly the skilled stonemasons would work on the project full time, many of them at remote quarry sites such as Aswan. This presented a logistical challenge of some note, as provisions were gathered and stored in a number of areas and then transported across land to various docking points on the Nile from which they would be transported by ship to Aswan. All provisions had to be accounted for and registered in the central records. It was Khasekem's good work in understanding and accurately copying these records that had won him his current post as assistant to the chief administrator at Aswan whose name was Tafnekht.

Khasekem's role was in the administration and provision of food to the workforce, a key element in the overall smooth running and success of the project. His dream was that through hard work and diligence in this position, he might one day be presented to the great Pharaoh Khaefre who was known to take a direct interest in the project and often commended outstanding workmanship and administration when brought to his attention.

The ships which docked at Aswan were typically of 100 cubits length and looked magnificent as they approached around the curve of the mighty river just north of the settlement. Khasekem never got tired of watching these graceful giants