Narrative Section of a Successful Application

The attached document contains the grant narrative and selected portions of a previously funded grant application. It is not intended to serve as a model, but to give you a sense of how a successful application may be crafted. Every successful application is different, and each applicant is urged to prepare a proposal that reflects its unique project and aspirations. Prospective applicants should consult the Office of Digital Humanities program application guidelines at http://www.neh.gov/grants/odh/digital-humanities-start-grants for instructions. Applicants are also strongly encouraged to consult with the NEH Office of Digital Humanities staff well before a grant deadline.

Note: The attachment only contains the grant narrative and selected portions, not the entire funded application. In addition, certain portions may have been redacted to protect the privacy interests of an individual and/or to protect confidential commercial and financial information and/or to protect copyrighted materials.

Project Title: FACES: Faces, Art, and Computerized Evaluation Systems

Institution: University of California, Riverside

Project Director: Conrad Rudolph

Grant Program: Digital Humanities Start-Up Grants, Level 1

NEH Application Cover Sheet
Digital Humanities Start-Up Grants

PROJECT DIRECTOR

Dr. Conrad Rudolph
Professor, Art History
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UNITED STATES

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Field of Expertise: Arts: History and Criticism

INSTITUTION

The Regents of the University of California
Riverside, CA UNITED STATES

APPLICATION INFORMATION

Title: *FACES: Faces, Art, and Computerized Evaluation Systems*

Grant Period: From 6/2012 to 5/2013
Field of Project: Arts: History and Criticism
Description of Project: In recent years, a great deal of attention has been paid in art
history to the face both theoretically and historically, especially the portrait and above all the portrait bust. At the same time, an enormous amount of research has been conducted on face recognition technology (the use of computerized evaluation systems for the automatic identification of a human face from a digital image). But, to the best of our knowledge, no one has yet attempted to join these two developments in an interdisciplinary way, applying cutting-edge face recognition technology to works of art, specifically portraiture. Before the advent of photography, portraits were, almost by definition, depictions of people who were important in their own worlds. But as a walk through almost any major museum will show, a large number of these portraits from before the nineteenth century--many of them great works of art--have lost the identities of their subjects through the fortunes of time.

BUDGET

Outright Request	$25,000.00	**Cost Sharing**		
Matching Request		**Total Budget**	$25,000.00	
Total NEH	$25,000.00			

GRANT ADMINISTRATOR

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FACES: Faces, Art, and Computerized Evaluation Systems

A feasibility proposal for the use of face recognition systems in the identification of unidentified works of portrait art

Table of Contents

List of Participants

Rudolph, Conrad; Professor, Department of the History of Art, University of California, Riverside

Roy-Chowdhury, Amit; Associate Professor Department of Electrical Engineering, University of
     California, Riverside

Kohl, Jeanette; Associate Professor, Department of the History of Art, University of California, Riverside

Abstract

Abstract. In recent years, a great deal of attention has been paid in art history to the face both theoretically and historically, especially the portrait and above all the portrait bust. At the same time, an enormous amount of research has been conducted on face recognition technology (the use of computerized evaluation systems for the automatic identification of a human face from a digital image). But, to the best of our knowledge, no one has yet attempted to join these two developments in an interdisciplinary way, applying cutting-edge face recognition technology to works of art, specifically portraiture. Before the advent of photography, portraits were, almost by definition, depictions of people who were important in their own worlds. But as a walk through almost any major museum will show, a large number of these portraits from before the nineteenth century--many of them great works of art--have lost the identities of their subjects through the fortunes of time. FACES (Faces, Art, and Computerized Evaluation Systems) proposes to establish the initial potential of this technology to these figures, disseminating its findings through publications and a dedicated website.

Statement of innovation. It is not often that art history (as opposed to archaeology or art conservation) can partner in a truly interdisciplinary way with science. FACES represents a completely new idea: the application of state-of-the-art technology currently used to fight terrorism to venerable and sometimes ancient works of art in order to solve old and vexing art historical problems. While this will be done using or adapting existing technology to the degree possible, the newly introduced factor of artistic interpretation in the portrait will almost certainly demand developments in this technology.

Statement of humanities significance. The primary objective of this project is not to restore the identities of these works of art in the narrow sense but to strengthen humanistic inquiry by demonstrating the applicability of the latest scientific technology to problems in the humanities. This project will bring a new scientific objectivity to a traditionally highly subjective aspect of art history while at the same time retaining the human eye as the final arbiter. FACES has the potential to revitalize this particular aspect of the humanistic endeavor and may have important ramifications for other fields in the humanities.

Narrative

Enhancing the humanities through innovation. In recent years, a great deal of attention has been paid in art history to the face both theoretically and historically, especially the portrait and above all the portrait bust. At the same time, an enormous amount of research has been conducted on face recognition technology (the use of computerized evaluation systems for the automatic identification of a human face from a digital image). But, to the best of our knowledge, no one has yet attempted to join these two developments in an interdisciplinary way, applying cutting-edge face recognition technology to works of art, specifically to portraiture. Before the advent of photography, portraits were, almost by definition, depictions of people who were important in their own worlds. But as a walk through almost any major museum will show, a large number of these unidentified portraits from before the nineteenth century-- many of them great works of art--have lost the identities of their subjects through the fortunes of time. Traditionally, identification of many of these portraits has been limited to often quite variable personal opinion. FACES (Faces, Art, and Computerized Evaluation Systems) proposes to establish the initial potential of face recognition technology to this highly subjective aspect of art history while at the same time retaining the human eye as the final arbiter.

In the first stages of FACES, the goal will be to establish the initial parameters of the application of this technology designed for actual human faces to works of portraiture. In the application of face recognition system technology to actual human faces, a number of difficulties are inherent in a real or perceived alteration of appearance of the face through variations in facial expressions, age, facial hair, angle of pose, lighting, and the very identity of the subject. The integration of 2D and 3D imagery with actual human faces introduces further issues still. With portraiture in sculpture, painting, and drawing, not only do all the problems that apply to human subjects apply but these works of art have their own additional challenges. Most notably, portrait art does not provide what might be called a photographic likeness but rather one that goes through a process of visual interpretation on the part of the artist.

To help address this challenge, initial subjects for FACES will be selected with as much control over variables as possible. For example, testing will begin by comparing the death or life mask of a known individual to a sculptural portrait of the same known individual (excellent fifteenth-century examples of both of these subjects exist in Lorenzo de'Medici and Battista Sforza). If this 3D to 3D test using the relatively certain controls of the death or life mask and the sculptural portrait of the same individual is encouraging, we will systematically broaden testing from highly controlled paradigms to less controlled: from one analogue (death or life mask) image and one artistic image to two artistic images, from the same artist for both subjects to different artists, from the same stage of life of the subject to different stages (standard aging models that have been used for recognition from photographs may not be applicable, something that will be a significant research consideration), from 3D to 2D, and, finally, an important goal of FACES is to test portraits of identified individuals to portraits of individuals that are unidentified. A full list of test paradigms in a more or less logical testing sequence is included in the appendix.

FACES will use a variety of open source software applications for scanning and evaluating the images. This phase of the project is directed toward establishing the general parameters of its applicability: what types of imagery are susceptible to this analysis, what is the success rate of different susceptible image types, what constitutes an acceptable percentage of probability, and so on. If a successful procedure can be established, it will be invaluable to researchers and those who use their findings, from scholars to museums to the general public.

Environmental scan. The time has come for this project. Although face recognition technology has made tremendous strides over the last twenty years and has reached a stage within the last decade where commercial applications are feasible, it is by no means a fully worked out area of research. Furthermore, through our positions in the fields of computer engineering and art history, through discussions with colleagues and museum professionals, and through bibliographic research, we are confident that no one has yet attempted to combine face recognition technology with the identification of works of portrait art [W. Zhao, R. Chellappa, A. Rosenfeld, P. J. Phillips, *Face Recognition: A Literature Survey*, ACM Computing Surveys, 2003, pp. 399-458; W. Zhao and R. Chellappa, *Face Processing: Advanced*

Modeling and Methods, Elsevier, 2006]. While basic software is available for much of this project, challenges raised by the artistic interpretation inherent in portrait art will create new research opportunities in the area of computer engineering.

History and duration of the project. FACES was conceived in the spring of 2011 and the project group formed. Amit Roy-Chowdhury undertook initial studies on the feasibility of the idea, comparing a carefully selected set of portraits against others in a test set. Seven different identified fifteenth-century portraits--death masks, busts, and painted images--of Lorenzo de'Medici and Battista Sforza were used. The method employed was the well-known elastic bunch graph approach, where each face is represented as labeled graphs and matching is performed by computing similarities between graphs [Laurenz Wiskott, Jean-Marc Fellous, Norbert Krüger, and Christoph von der Malsburg, "Face Recognition by Elastic Bunch Graph Matching," *IEEE Trans on Pattern Analysis and Machine Intelligence* 19 (1997), pp. 775-779]. This method was chosen because, at this point, we have very limited data and need to work with methods that are not reliant on the availability of a large training set. This is possibly the best known method that will work under these constraints. Since the number of examples is so few, recognition rates at this point have only limited meaning. However, it is significant that the system was able to get correct matches for pairs of images where multiple human subjects identified the pair as belonging to two different people without prior knowledge of the dataset. It was also seen that there was a systematic bias towards a face that was imaged in a good frontal pose. These initial tests demonstrate not only the potential for computerized recognition systems but also the necessity of further research in this area.

This project is at the earliest stage and has received no financial support to date. The project enjoys the sufficient resources and research facilities of the University of California, Riverside. The goal of the first phase of FACES is to set the initial parameters of the application of face recognition technology to works of portrait art. When completed, we will analyze the findings of the first phase with the aim of taking this new process a step further in regard to both refinement and types of works of art. Toward this end, we expect to seek funding from a Level II Digital Humanities Start-Up Grant. We will also apply for support through a Kress Digital Resources Grant, an ACLS Collaborative Research Fellowship, the Henry Moore Foundation, and the National Science Foundation.At a later phase, we expect to apply for a grant through the DFG/NEH Bilateral Digital Humanities Program (Enriching Digital Collections), a program designed to facilitate collaboration between American and German partners. Although it is too early for anything firm, explicit interest has been expressed in FACES by the Staatliche Gemaeldegalerie in Berlin, which has itself approached the Bodemuseum in Berlin about FACES. These are two of the leading museums of Europe.

Work plan. Starting in June, 2012, Dr. Kohl will begin the involved process of acquiring high quality digital scans (along with publication rights) of all the subjects (death and life masks, sculptures, painting) from various museums in Europe and the United States. Following the procedure described above of moving from the simple to the more complex, Dr. Roy-Chowdhury will direct a Graduate Student Researcher in the application of face recognition technologies to approximately twelve of the paradigms constructed by Drs. Rudolph and Kohl. Prototype software modules are available for a number of these approaches. Roy-Chowdhury and his assistant will start by evaluating the strengths and weaknesses of existing methods. Based on our findings, they will propose modifications that will specifically address the distinctive characteristics of portraits. All the while, strong and weak points in the procedure will be determined and adjustments made accordingly. This phase of the work is expected to be completed by May, 2012. A thorough evaluation strategy will be developed by Roy-Chowdhury that will allow us to understand the variations in performance and the factors that are behind the variation. This will include a method of determining the degree of probability of identification with each paradigm. Finally, Rudolph and Roy-Chowdhury will evaluate our method and results in regard to the next phase of the project (Level II Digital Humanities Start-up Grant). Questions that will be asked include: what do our findings suggest for future test paradigms? What is the best and most user-friendly way of representing our method on a future website? What is the best way of representing the results of the paradigm tests on the website? How will applications of this method by others be included? Is a high level museum exhibition of project possible and what would be the best way to achieve this? We expect to be done with

this part of the project by the end of summer, 2012.

Staff: *Conrad Rudolph* is project director and Professor in the Department of the History of Art at UCR. He conceived and was the initial impetus to FACES. He is responsible for the general oversight and direction of the project, establishing a work plan, and assuring work progresses according to schedule. He is the primary grant writer and will be the primary author of any publications in the area of art history.

Amit Roy-Chowdhury is Associate Professor in the Department of Electrical Engineering at the University of California, Riverside. He is an expert in the area of face recognition technology and is responsible for the research aspects related to the computer analysis of the images and the hiring and oversight of all research assistants in this area. He is the primary writer of any technical reports and will be the primary author of any publications in the area of computer-based video analysis.

Jeanette Kohl is Associate Professor in the Department of the History of Art at the University of California, Riverside. A historian of Renaissance art and an authority on sculpture, portraiture, and the face in art, she is the primary museum contact and responsible for the acquisition of digital images from the original works of art.

Final product and dissemination. Our goal is to strengthen humanistic inquiry by calling greater attention to how the latest scientific technologies can be employed in age-old questions of identification without removing the human element from the equation. Project findings will be presented in a variety of ways. In the short term, our immediate plans call for presentations at national and international conferences in both art history and computer-based video analysis, as well as the publication of our findings in leading journals in both fields.

To take place in a later phase of the project, we are working toward an exhibition at one or more of the distinguished museums in the United States and Europe. Using some of the original works of art employed in FACES, this will present to the general public not only our findings but also our method in a user-friendly way, such a blending of art and science being something we feel will be extremely popular with the public. Also in a later phase, we plan to make our method and all of our findings available in a dedicated website, one that not only presents the outcome of this project but that also incorporates the findings of future applications of this procedure (both by us and by others) to the thousands of works to which it potentially applies. While primarily serving research in the humanities, it will also have a public-oriented component, clearly demonstrating to the general public how the method works, how it is applied, and how the findings are interpreted. Although it is too early to say, it may be that this website will be overseen by one of the major museums that may become involved with FACES in the future. Permanent dissemination on the California Digital Library (CDL), a University of California digital library, is another option. Eventually, the specific findings will be incorporated into mainstream art historical studies and surveys, and even permanently integrated into the museum displays of the portraits themselves. But we also hope that the method will be widely taken up by institutions such as museums and art conservation laboratories as a standard part of curatorial and preservation practice. We expect that the white paper, which will detail both the method and the parameters of this method, will be one of the major vehicles for this.

Although in this initial phase FACES will be strictly limited to the parameters described above, we are aware of and will remain alert to possible additional future applications. These may include the use of this general technology in an altered form in which, the basic method might be applied to bodies of other variables in works of art that are unique to individual artists such as brushstrokes in painting and carving techniques in sculpture, potentially opening up a whole new world in the identification of free standing sculpture, relief sculpture, small scale sculpture, painting, stained glass, illuminated manuscripts, etc. Once developed, such a technology almost certainly could be applied to widely recognized but visually minor variations in architectural details, revealing a wealth of information about building processes, building history, and architectural identities. This technology will also seem to have enormous potential with paleography (ancient writing), possibly allowing the determination of the origin and date of thousands of ancient manuscripts for which this information remains a very subjective matter.

YEAR 1
BUDGET PROPOSAL

Project Title: FACES
Sponsor: NEH Digital Humanities Start-up Grants, Phase I
Principal Investigator: Conrad Rudolph
Institution: University of California, Riverside
Period of Performance: 06/01/2012 - 05/31/2013

A. Senior Personnel	# People	# Months	% Time	Monthly Salary	Benefit Rate	Total Salary	Total Benefits	Personnel Total
Conrad Rudolph, PI								
06/01/2012 - 08/31/2012	1	1.0	25.49%	Ex. B6	12.70%	Ex. B6	Ex. B6	Ex. B6
09/01/2012 - 05/31/2013	0	0.0	0%	0	0.00%	0	0	**0**
Amit Roy-Chowdhury, Co PI								
06/01/2012 - 08/31/2012	1	1.0	35.07%	Ex. B6	12.70%	Ex. B6	Ex. B6	Ex. B6
09/01/2012 - 05/31/2013	0	0.0	0.0%	0	0.00%	0	0	**0**
B. Other Personnel - Academic								
Graduate Student Researcher, Step IV								
06/01/2012 - 08/31/2012	0	0.0	0%	Ex. B6	3.06%	0	0	**0**
09/01/2012 - 05/31/2013	1	9.0	20%	Ex. B6	3.06%	Ex. B6	Ex. B6	Ex. B6

Total Salary:	**13,855**
Total Benefits:	**1,199**
Total Personnel:	**15,055**

C. Graduate Student Benefits	Academic Yr.	Amount	Quarters	# Students	0
Resident Partial Fee Remission (PFR)		0	0	0	**0**
Grad. Student Health Insurance (GSHIP)		0	0	0	**0**
Non-Resident Tuition Remission (NTR)		0	0	0	**0**
D. Permanent Equipment					**0**
None				0	
E. Travel					**2,866**

Domestic Travel		2,866
Directors' Meeting, Washington, D.C.		
Roundtrip Airfare - Ont., CA to Washtington D.C.	350	
Lodging - $150/night x 1 nights	300	
Per Diem - $56/day x 3 days	168	
Conference Travel (2 persons, 1 conference ea.)		
Roundtrip Airfare - Ont., CA to East Coast	700	
Lodging - $150/night x 3 nights	900	
Per Diem - $56/day x 4 days	448	
Foreign Travel		0

F. Participant Support Costs			**0**
None		0	

G. Other Direct Costs			**4,400**
1 Materials and supplies		0	
2 Publication Costs/Documentation/Dissemination		4,400	
Licensing fees - 28 images x $50/ea	1,400		
Publishing rights - 10 images x $300/ea.	3,000		
3 Consultant Services		0	
4 Computer Services		0	
5 Subawards		0	
6 Other		0	

I. Total Direct Costs				**22,321**
J. F&A Costs				**2,679**
F&A	12.0%	x Base	$22,321	2,679
K. TOTAL AMOUNT REQUESTED				**24,999**

Budget Justification

This proposal requests $25,000 for Dr. Conrad Rudolph's proposal "FACES: Faces, Art, and Computerized Evaluation Systems" for the National Endowment for the Humanities Digital Humanities Start-Up Grants for a twelve month period beginning June 1, 2012.

Personnel. We have requested summer salary compensation for Conrad Rudolph, PI and Amit Roy-Chowhurdy, Co-PI. Compensation for Dr. Rudolph is calculated at 25.49% for one month and for Dr. Roy-Chohurdy at 35.07% for one month. During the summer, Dr. Rudolph will work on identifying and securing rights to images of life or death masks, sculpture and paintings of the subjects selected for the study. Dr. Roy-Chowhurdy will begin preliminary work selecting face recognition software and testing paradigms for the experiments.

We have requested funds to support a Graduate Student Researcher, Step IV who will commit 20%-time during the academic year working along side Dr. Roy-Chowhurdy running face recognition experiments on the subject and images selected for the study.

Travel. We have requested funds to support the travel of Dr. Rudolph to the NEH Digital Humanities Start-Up Grant Director's meeting in Washington, D.C. We have also requested funds for both Drs. Rudolph and Chowhurdy to attend professional conferences in their disciplines for the purpose of presenting and disseminating preliminary findings from this project. Travel costs include roundtrip airfare, lodging and per diem.

Other Direct Costs. We have requested funds for licensing fees and publication rights for the images required to conduct the face recognition experiments. Licensing fees are anticipated to cost approximately $50 per image for 28 images. Publishing rights for 10 images are estimated at $300 each.

Indirect Costs. Indirect costs have been calculated at 12% of the total modified direct costs.

Biographies

Conrad Rudolph is Professor of Medieval Art History at the University of California, Riverside. He has received fellowships and grants from the Guggenheim, J. Paul Getty, Mellon, and Kress foundations, as well the College Art Association. He is a member of the board of editors of *Speculum* (the leading journal of medieval studies in the United States) and of *caa.reviews* (the online journal of reviews for the College Art Association, the professional organization of art historians in the U.S.), for which he also served as Medieval Field Editor. He has acted as a reviewer for the John Simon Guggenheim and Getty Grant Foundations. He has served as a member of the International Advisory Board of the journal *Art History*, of the Advisory Board of the series Companions to Art History (Blackwell, Oxford), and of the Board of Directors of the International Center of Medieval Art. He is the author of *The "Things of Greater Importance": Bernard of Clairvaux's Apologia and the Medieval Attitude Toward Art* (University of Pennsylvania 1990), *Artistic Change at St-Denis: Abbot Suger's Program and the Early Twelfth-Century Controversy over Art* (Princeton University 1990), *Violence and Daily Life: Reading, Art, and Polemics in the Cîteaux Moralia in Job* (Princeton University 1997), *Pilgrimage to the End of the World: The Road to Santiago de Compostela* (University of Chicago 2004), and *"First, I Find the Center Point": Reading the Text of Hugh of Saint Victor's The Mystic Ark* (American Philosophical Society 2004) ; and he is editor of *A Companion to Medieval Art: Romanesque and Gothic in Northern Europe* (Blackwell, Oxford 2006) (a collection of thirty original essays from leading scholars in the field, each historiographically analyzing one of a wide range of subjects in the development of Romanesque and Gothic art history).

Amit Roy-Chowdhury is an Associate Professor of Electrical Engineering and a Cooperating Faculty in Computer Science at the University of California, Riverside (UCR). He received his PhD from the University of Maryland, College Park. Previous to that, he was at the Indian Institute of Science in Bangalore where he received a Masters in Systems Science and Automation. Dr. Roy-Chowdhury leads the Video Computing Group at UCR. His group is studying problems in video analysis with applications in national and homeland security, commercial multimedia, and computational biology. The underlying approach of his research is to harness various methods in systems theory, signal processing, machine learning, mathematics, and statistics to the analysis of images and videos in order to obtain an understanding of their content. This scientific understanding can lead to machine vision technologies that can provide an automated/semi-automated analysis of the 3D environment from images/videos, analogous to the capabilities of biological visual systems. Currently, the group is focused on multi-agent autonomous camera networks, modeling and recognition of complex behaviors in video, face tracking and recognition, and image-based modeling of biological processes. Prof. Roy-Chowdhury is a PI on several grants from the National Science Foundation, Office of Naval Research, Army Research Office, DARPA, and private industries like CISCO and Lockheed-Martin. He has served as a program committee member and reviewer in various capacities, organized workshops and special sessions, is an Associate Editor of the journal *Machine Vision Applications*, and a Section Editor of *Elsevier's Electronic Reference on Signal Processing*. He has recently co-edited a book on the topic of "Distributed Video Sensor Networks".

Jeanette Kohl is an Associate Professor of Art History at the University of California, Riverside (since 2008). Her research focuses on image concepts and strategies of representation in the Italian Renaissance with a particular interest in the art and theory of portraiture, in sculpture and materiality, and issues of methodology and perception. In 2001, she earned her PhD from the University of Trier/Germany; from 2001-2004 she held a postdoctoral fellowship at the Kunsthistorisches Institut in Florence, followed by positions as Assistant Professor at the University of Leipzig (2004-2008) and as Visiting Professor at the Friedrich-Schiller University Jena (2007). From 2006-2009, she chaired the international academic network "The Power of Faces: The Bust, the Head, and the Body in the Middle Ages and the Renaissance," with six international conferences in Paris, Berlin, Karlsruhe, Basel, Leipzig, and Florence. She is the author of a book on Bartolomeo Colleoni's burial chapel, *Fama und Virtus* (Ph. Diss.,

Akademie Verlag, Berlin 2004), and co-edited several other volumes, inter alia *Kopf/Bild: Die Büste in Mittelalter und Früher Neuzeit* (Deutscher Kunstverlag, Munich 2007). Currently in preparation are three other edited volumes: *Renaissance Love: Eros, Passion, and Fellowship in Italian Art Around 1500*, Jeanette Kohl/Marianna Koos/Adrian Randolph (eds.), Ashgate; and *Similitudo: Concepts of Likeness in the Middle Ages and the Renaissance*; Jeanette Kohl/Martin Gaier/Alberto Saviello (eds.), Wilhelm Fink Verlag and EN FACE; and *Seven Essays on the Human Face* (thematic volume of *Kritische Berichte*, winter 2011). Her new book on *Sculpted Portraiture in the Renaissance* is in production for 2012. She is also active as a journalist and art critic.

Data Management Plan

1. Expected Data

1.1 Types of Data

This project is expected to produce three types of data:

a. Still photographic images (.jpg or similar machine-readable format).
b. Video images (.mpg or similar machine-viewable format).
c. Algorithms for comparison of images.

Some or all of the algorithms will be based on prior work by one of the investigators (Roy Chowdhury) on recognition of human faces. Some or all of the algorithms may have already been published or otherwise disseminated.

1.2 Management of Unprocessed or Work-in-Progress Data

All principal investigators in the Bourns College of Engineering (BCOE) are provided with sufficient computer storage to store and process the data generated in their research. The College of Humanities, Arts and Social Sciences (CHASS) also has central computing and data storage for all departments in the college. Every principal investigator has the ability to create his or her personal web site, and to make data sets available through that web site. Additionally, BCOE has established an archive based on the open-source EPrints system (www.eprints.org) to be a permanent, accessible repository `for articles and processed data sets to facilitate data sharing.

Complementing this infrastructure, the UCR Libraries and the California Digital Library/UC Curation Center are available to principal investigators to consult on the formatting of data from project inception through dissemination of finished products. Further, the California Digital Library has established Merritt as a repository for published articles and data sets that can be searched along with other resources of the University of California system, including the highly popular Melvyl catalog. As Merritt develops, the BCOE intends to make data sets available through both the locally housed EPrints archive and Merritt, which will provide two channels for access to the results of our research.

1.3 Limitations and Restrictions

This Data Management Plan addresses the policy that primary data "commonly accepted in the scientific community as necessary to validate research findings" should be made available to the research community. In accordance with this policy and guidance from the Office of Management and Budget, this plan does not include preliminary analyses (including raw data), drafts of scientific papers, plans for future research, peer reviews, or communications with colleagues. Data that must be withheld long enough to enable peer review and publication/dissemination or protection of intellectual property is subject to this plan only after those steps have taken place.

The release of data about students or any other human subjects is subject to policies and restrictions in protocols adopted by the relevant Institutional Research Board (IRB) and the Family Educational Rights and Privacy Act (FERPA) regulations.

It is common for museums to restrict the publication of images of works in their collections. The investigators intend to secure permission (free or paid) to reproduce images for use in published articles, lectures, presentations at professional societies, and classroom instruction. However, depending on the

image, the owner, and the agreement governing each work of art, the rights to use these images might not extend to other researchers or to follow-on or derivative research by others. In light of this, materials will be disseminated only to the extent that the owners of images allow, and reproduction or reuse may be restricted.

1.4 Data Sharing/Dissemination

All applicable electronic materials produced in BCOE will be made available through the BCOE EPrints server and, subsequently, through Merritt. Data will be made available only after appropriate steps have been taken to protect intellectual property. Confidential material will be handled according to policies and protocols for human subjects, FERPA, and any other applicable regulations and restrictions.

The EPrints server will be read-only; therefore, data will be secure from tampering. Files will stored on a Net App RAID file server and will be backed up twice per week using an unencrypted LTO5 tape drive system.

2. Period of Data Retention

The BCOE EPrints archive is intended to be a permanent, read-only repository. There will be no schedule for deleting the data from the archive.

If any PI leaves UCR, the products in the BCOE EPrints database will remain stored there. PI is free to reproduce and repost these materials at his/her new institution.

3. Data Formats

It is anticipated that data will be in the form of images (.jpg or other common machine-readable formats) and video images (.mpg or other common machine-viewable formats). Any algorithms will be developed using commercial off-the-shelf software and thus will be usable by the broad research community.

September 7, 2011

To
Whoever IT May Concern

I am writing this letter in support of the proposal FACES: Faces, Art, and Computerized Evaluation Systems and the capabilities of Prof. Amit Roy-Chowdhury to be able to conduct the computation related research in this effort. I am a Minta Minta Professor of Engineering at University of Maryland, College Park. I received the M.S.E.E. and Ph.D. Degrees in Electrical Engineering from Purdue University, West Lafayette, IN, in 1978 and 1981 respectively. Prior to joining the University of Maryland in 1991, I was an Assistant (1981-1986) and Associate Professor (1986-1991) and Director of the Signal and Image Processing Institute (1988-1990) at University of Southern California, Los Angeles. Over the last 30 years, I have published numerous book chapters, peer-reviewed journal and conference papers. I have co-authored and edited books on MRFs, face and gait recognition and collected works on image processing and analysis. My current research interests are face and gait analysis, marker-less motion capture, 3D modeling from video, image and video-based recognition and exploitation, compressive sensing, and hyper spectral processing. I have served as the associate editor of four IEEE Transactions and as the Editor-in-Chief of IEEE Transactions on Pattern Analysis and Machine Intelligence. I served as a member of the IEEE Signal Processing Society Board of Governors and as its Vice President of Awards and Membership. Recently, I completed a two-year term as the President of IEEE Biometrics Council. I am a Fellow of the IEEE, the International Association for Pattern Recognition and the Optical Society of America. I have served as a General the Technical Program Chair for several IEEE international and national conferences and workshops. I am a Golden Core Member of the IEEE Computer Society and served a two-year term as a Distinguished Lecturer of the IEEE Signal Processing Society.

In this project, the principal investigators propose to use advances in facial recognition technology to works of portrait art with the goal of connecting the faces of different portraits with each other. It is interesting to note that Picassa and Facebook are implementing similar features in their systems for linking together pictures of the same person. However, doing this is portrait art introduces issues that need detailed study because photography and portrait art are very different media. The investigators have proposed a number of paradigms by which this can be achieved. Having worked in face recognition for decades, I believe that this application domain is indeed novel. The current state-of-the-art in face recognition provides confidence that the proposed research plan is feasible, but there is no existing solution that can be directly applied.

Face recognition systems, in their existing form, work quite well is controlled environments like matching passport pictures, but leave a lot to be desired in uncontrolled environments where people are free to move around. In the analysis of unidentified works of

portrait art, the environment is not completely uncontrolled nor is it as well-defined as when taking a passport picture. Moreover, it has unique challenges that necessitate a separate study rather than just using an existing piece of software that is commercially available. Probably the most important distinction is that a portrait created by an artist is fundamentally different from the picture taken by a photographic camera. This aspect has not been studied in face recognition, and its effects on the existing software are unknown. This study can provide insights into this effect.

I have known Dr. Roy-Chowdhury for about 13 years now and am confident that he has the capabilities to perform the computation related research tasks with success and distinction. Since starting his independent research program at UC Riverside in 2004, Amit has worked on a number of projects funded by the National Science Foundation, the Office of Naval Research, the Army Research Office, DARPA and private industries like Lockheed-Martin and CISCO. His research interests span a number of problems within the broad domain of video analysis including tracking in video, face recognition, activity analysis, camera networks and biological image analysis. His work has been published in the very top conferences and journals in the area (please note that in the computing sciences, there are many conferences which have very low acceptance rates and carry a prestige similar to or higher than the top journals). In the area of facial image analysis, Dr. Roy-Chowdhury has recently obtained some results that provide a theoretical model of the facial image space showing that the facial pose, the lighting on the face and shape of the face have a multilinear relationship. This result and its application to tracking and recognition has been very well received in the community and well cited. In fact, we have used the result in our group. This work will be useful for the proposed research effort.

In summary, I can unequivocally attest to the uniqueness of the proposed effort, the feasibility of the research plan and the qualifications of Dr. Roy-Chowdhury in leading the computational efforts. Please feel free to contact me if you have any questions.

Sincerely,

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Appendix

The following is a list of test paradigms given in a more or less logical testing sequence (from relatively simple to increasingly complex).

- Death or life mask of a known individual compared to a sculptural portrait of the same individual
        - works:
                - Lorenzo de'Medici; death mask; 1492 (Societá Colombaria, Florence)
                - Lorenzo de'Medici; bust; 1480; Verrocchio (National Gallery of Art, Washington)
- Sculptural portrait of a known individual compared to a sculptural portrait of the same individual
        - around the same stage of the individual's life
        - both by the same artist
        - works:
                - Urban VIII; bust; c. 1632; Bernini (Palazzo Barberini)
                - Urban VIII; bust; c. 1632; Bernini (Ottawa)
- Sculptural portrait of a known individual compared to a sculptural portrait of the same individual
        - at different stages of the individual's life
        - both by the same artist
        - works:
                - Urban VIII; bust; c. 1632; Bernini (Palazzo Barberini)
                - Urban VIII; bust; c. 1656; Bernini (Louvre)
- Sculptural portrait of a known individual compared to a sculptural portrait of the same individual
        - around the same stage of the individual's life
        - by different artists
        - works:
                - Cardinal Scipione Borghese; bust; 1632; Bernini (Galleria Borghese CCLXVI)
                - Cardinal Scipione Borghese; bust; 1631-1632; Finelli (Met)
- Sculptural portrait of a known individual compared to a sculptural portrait of the same individual
        - at different stages of the individual's life
        - by different artists
        - works:
                - Alexander VII (age 58); bust; 1657; Bernini (Private collection)
                - Alexander VII (age 68); bust; 1667; Cafá (Ariccia, Palazzo Chigi)
- Death or life mask of a known individual compared to a painted portrait of the same individual
        - works:
                - Battista Sforza; death mask; c. 1472; Francesco Laurana (Louvre, Paris)
                - Battista Sforza; painting; c. 1472; Piero della Francesca (Galleria degli Uffizi)
- Sculptural portrait of a known individual compared to a painted portrait of the same individual
        - both by the same artist
        - works:
                - Urban VIII; bust; c. 1632; Bernini (Ottawa)
                - Urban VIII; painting (oil): Bernini (Palazzo Barberini)
- Sculptural portrait of a known individual compared to a painted portrait of the same individual
        - by different artists
        - works:
                - Richelieu; bust; Bernini (Louvre)
                - Richelieu; painting, triple portrait (oil); Philippe de Champaigne (London)
- Sculptural portrait of a known individual compared to a painted copy of the same sculptural portrait
        - by different artists
        - works:
                - Francesco I d'Este; bust; Bernini (Modena)

           - Francesco I d'Este; painting of bust; attributed to Stringa (Minneapolis)

- Two-dimensional self-portrait of a known individual compared to a two-dimensional self-portrait of the same individual
  - around the same stage of the individual's life
  - works:
    - Bernini (age c. 25); self-portrait (oil); c. 1623; (Galleria Borghese)
    - Bernini (age c. 27); self-portrait (chalk); c. 1625(Ashmolean)
- Two-dimensional self-portrait of a known individual compared to a two-dimensional self-portrait of the same individual
  - at different stages of the individual's life
  - works:
    - Bernini (age c. 25); self-portrait (oil); c. 1623; (Galleria Borghese)
    - Bernini (age c. 67-72); self-portrait (chalk); c. 1665-1670; (Windsor)
- Two-dimensional portrait of a known individual compared to a two-dimensional portrait of the same individual
  - both by the same artist
  - around the same stage of the individual's life
  - works:
    - Richelieu; painting (oil); Philippe de Champaigne; 1640 or 1642 (Strasbourg)
    - Richelieu; painting, triple portrait (oil); Philippe de Champaigne; 1640 or 42 (London)
- Portraits of known individuals compared to portraits of individuals that are unidentified but that are either thought to be of the known individual or that show a general resemblance