

Project Summary

Project Overview

The purpose of this Small Business Innovation Research Phase I project is to create an image processing software application for crime scene investigation. The intended user, a forensic scientist, would use the application to upload images of crime scene evidence (e.g. blood stains, debris) and automate the forensic process of bloodstain pattern analysis. Key modules of the project are defined as keywords in the following list:

- A **mobile application** for iOS and Android, where the user may upload images from a smartphone camera.
- An **algorithm** that outputs an analysis of the image from the input requests of the user, or automatically, when no input is provided.

Intellectual Merit

This Small Business Innovation Research Phase I project will gain most of its intellectual value from the image processing algorithm to be devised. Technical challenges will be faced at each defined project module. Developing an effective algorithm must overcome technical hurdles, because the algorithm must recognize the physical components (e.g. walls, surfaces) of a crime scene in addition to analyzing it. The primary goal of R&D, which is crucial to the innovation of the project, is the effectiveness, usefulness, and accuracy of the algorithm. The high-level plan for R&D is to research effective methods for computer image processing, and to research established forensic image analysis processes that can be automated. Development of the mobile application and infrastructure will require technical knowledge in iOS and Android development, and cross-platform development. As the topics of mobile interfaces and data analytics have received massive attention from businesses and researchers in the past few years, they have become the new standard in application development. Overcoming the aforementioned technical and algorithmic challenges in mobile development and forensic science processes, respectively, will yield a user-friendly application that is effective, lightweight, and useful in analyzing crime scene data.

Broader Impact

This project will yield a useful, automated solution for forensic scientists and other crime scene investigators. Therefore, the proposed application will have potential for commercialization. The proposed application will be used as a tool to compare against forensic results, or it can be used as an unbiased, unambiguous third party in a case analysis. An algorithmic image processing solution will allow crime scene investigators to pursue a deeper analysis of their cases, and it will consequently increase the probability that a case analysis of a crime scene verifies the unequivocal truth. Because it will automate existing forensic processes, the proposed application will allow forensic scientists to spend their time more efficiently by researching and analyzing other data. Furthermore, this project will encourage industry innovators to automate data analysis processes. This approach to data analytics will be helpful in the future because organizations currently have more data than they are able to effectively

analyze. To that end, the innovation and commercialization of this project will provide a net benefit to society.

Elevator Pitch

The expected customer of the application is a crime scene investigation professional (e.g. forensic science experts, detectives) who captures or analyzes photos of crime scene evidence. The primary customer need that will be addressed by the application is a demand for automation of existing analysis processes. In the current era, organizations obtain more data than they are able to effectively analyze. The proposed application will automate forensic science processes on a given photo. Therefore, a crime scene investigation organization that uses the application will have a better opportunity to allocate its resources to another project or analysis task. Automation of the forensic analysis process will also provide an unbiased, third-party solution to a criminal case, and thereby increase the probability that the results of a case reflect the truth.

The value of the proposed application will be generated from the innovation of its algorithmic component. Increasing the effectiveness, accuracy, or usefulness of the algorithm will directly increase the benefit of the application to the customer. The application will be as valuable as its ability to apply existing forensic processes. Another key differentiation of the application will be its ability to interface with the user. The application will allow the user to make his or her own decisions in analyzing an image, because the intended user is a professional in the field of crime scene investigation. The user will be able to focus on specific parts of an image, and apply automated processes of his or her choosing.

This application will advance the field of crime scene investigation by applying existing processes to an efficient and lightweight mobile software application. Applying concepts from mobile development, data analysis, and algorithmic problem-solving to the field will allow for deeper analysis of crime scene evidence. Furthermore, this project will encourage industry innovators to explore new approaches to the utility of mobile interfaces, and the automation of data analysis processes. This project will also apply emerging image processing concepts to a field that can benefit greatly from them. In its direct application of new concepts, and in its indirect encouragement of new approaches to solving problems, this project will benefit innovators in the field of crime scene investigation, as well as innovators that seek to apply the same concepts.

The Commercial Opportunity

This innovation addresses the market of crime scene investigation solutions, and it will enter the market through a low-cost software application. The major driver in this market is technological innovation. Advancements in technology have greatly influenced the market through innovations such as digital fingerprinting, security video surveillance, and DNA analysis. This project will contribute to the existing technology solutions in the market through its application of both mobile computing and image processing. Due to the compatibility of the software with ubiquitous mobile operating systems (e.g. iOS, Android), the business model for the innovation will be a low-price, high market share model. The targeted customers are law enforcement agencies, particularly those at the state, county, and municipal level. Most federal agencies have sufficient funding for high-cost, advanced solutions for crime scene investigation. Therefore, this proposed innovation will fill the niche of widespread, low-cost mobile solutions for lower-budget agencies.

Because of the low cost of entry into a market for software solutions, the primary competition to this innovation will be other attempts by research groups and firms to apply mobile computing and image processing algorithms to the field of crime scene investigation. After the product has been released as a pioneer to the market, firms will most likely attempt to gain market share by either purchasing the rights to the innovation, or by producing a similar product at a lower cost. The competition can change over time as new innovations develop in the fields of mobile technology and image processing, which can cause the current version and algorithmic component of this innovation to become outdated.

The key risk in bringing this innovation to market is the risk of whether it will adequately fill its market niche to low-budget law enforcement agencies. While this innovation provides a new technological approach, it mainly serves as a low-cost alternative to existing procedures and processes used at the most advanced level of crime scene investigation. The major challenge of bringing this innovation to market is to provide useful solutions to customers that are targeted for their limited budget.

In order to respond to the risks and challenges of the market, the commercialization approach of this innovation will be to build relationships with law enforcement agencies that have a high demand for the innovation. Agencies with a low budget, and agencies with a low return on investment (crime rate vs. department spending per capita) would benefit from the operational efficiency offered by this proposed innovation. For example, New York City, Orlando, Fort Lauderdale, and Washington, DC, rank poorly among police departments for return on investment (Bernardo, 2015). At a price of \$1,000 per year, and the 100 lowest-ROI metropolitan police departments are successfully targeted, this innovation could yield a yearly revenue of \$100,000.

<https://wallethub.com/edu/cities-with-the-best-and-worst-roi-on-police-spending/9565/>

Societal Impact

The broader societal impact of this innovation is to better determine the truth of criminal investigations, in order to identify suspects, improve clearance rates for homicides, and hold criminals accountable with greater accuracy. This innovation will help law enforcement organizations to act more efficiently, because it is a simple, user-friendly approach to crime scene investigation. Agencies will benefit operationally from this solution, and its widespread use will encourage faster communication and investigation processes. Ultimately, this project aims to benefit society by protecting the public from criminal activity, and the proposed commercialization approach targets law enforcement agencies to have this responsibility.

Regulations should be strongly considered for the widespread use of this innovation. Because law enforcement agencies are accountable to the public, the transparency of this innovation is a key issue. Legislators should decide how much of the documented use, software infrastructure, and algorithmic component should be open to the public. The algorithm is particularly impactful because it may be used to determine the outcome of a criminal case. If the algorithm is hidden from the public, there may be some opportunity for legal corruption. Cases could be falsely determined, while their outcome is publicly attributed to a non-transparent algorithm. However, a full public release of the algorithm could also have problems, because criminals could abuse workarounds in the software, and leave crime scenes unable to be correctly analyzed by the algorithm. In addition to the regulatory considerations of the innovation, cybersecurity standards are also an important issue. If a hacker gains access to the intellectual components of the innovation, they would be able to abuse vulnerabilities in the algorithm. To address this risk, it is important to set a high standard for the security of the system. Because of the massive ethical value of the algorithm in its societal context, legislators should come to an agreement to determine the best use of this innovation.

This innovation can be applied to global issues due to its compatibility with mobile platforms, and its low cost. Law enforcement agencies could benefit from the effectiveness of this innovation, which would help to stabilize governments across the world that would otherwise be too weak to earn credibility. This innovation is relevant to global issues because of its implications to criminal justice, ethics, and society as a whole.