iCOP: IoT-Enabled Policing Processes

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Abstract. Analyzing data-driven and knowledge intensive business processes is a key endeavor for today's enterprises. Recently, the Internet of Things (IoT) has been widely adopted for the implementation and integration of data-driven business processes within and across enterprises. For example, in law enforcement agencies, various IoT devices such as CCTVs, police cars and drones are augmented with Internet-enabled computing devices to sense the real world. This in turn, has the potential to change the nature of data-driven and knowledge intensive processes, such as criminal investigation, in policing. In this paper, we present a framework and a set of techniques to assist knowledge workers (e.g., a criminal investigator) in knowledge intensive processes (e.g., criminal investigation) to benefit from IoT-enabled processes, collect large amounts of evidences and dig for the facts in an easy way. We focus on a motivating scenario in policing, where a criminal investigator will be augmented by smart devices to collect data and to identify devices around the investigation location and communicate with them to understand and analyze evidences. We present iCOP, IoT-enabled COP assistant system, to enable IoT in policing and to accelerate the investigation process.

Keywords: Process data science · Data Analytics · Internet of things · Knowledge Lake · Law enforcement · Policing

1 Introduction

The introduction of Information and Communications Technology (ICT) has been a success factor for conducting police investigations. Advances in technology have improved the ways police collects, uses, and disseminates data and information. This include the advent of always-connected mobile devices, backed by

X. Liu et al. (Eds.): ICSOC 2018 Workshops, LNCS 11434, pp. 447–452, 2019.
https://doi.org/10.1007/978-3-030-17642-6_42

access to large amounts of open, social and police-specific private data. Among all these advances and technologies, the Internet of things (IoT) [2,11], i.e., the network of physical objects augmented with Internet-enabled computing devices to enable those objects sense the real world, can be a valuable asset for law enforcement agencies and has the potential to change the processes in this domain such as detection, prevention and investigation of crimes [6]. For example, considering cases such as Boston Bombing, one challenging task for the police officers and investigators would be to properly identify and interact with other officers on duty as well as Internet-enabled devices such as CCTV and drones, to enable fast and accurate information collection and analysis.

In this paper, we present a framework and a set of techniques to assist knowledge workers (e.g., a criminal investigator) in knowledge intensive processes (e.g., criminal investigation) to benefit from IoT-enabled processes, collect large amounts of evidences and dig for the facts in an easy way. We focus on a motivating scenario in policing, where a criminal investigator is augmented by smart devices (e.g., cell phone and watch) to collect data (e.g., recording voice, taking photos/videos and using location-based services), to identify the Things (e.g., CCTVs, police cars, officers on duty and drones) around the investigation location and communicate with them to understand and analyze evidences. This will accelerate the investigation process for cases such as Boston bombing (USA) where fast and accurate information collection and analysis would be vital. We implement a research prototype and present an IoT-enabled COP assistant system (iCOP), to: (i) facilitate the evidence collection: through an evidence-based GUI framework for policing. The goal is to provide a coherent and rigorous approach to improve the effectiveness and efficiency of a police officer in the field when responding to, detecting and preventing crime, and (ii) develop and explore how an evidence-based interface on a smart mobile device can be deployed in policing to provide an IoT-enabled approach, to interrogate a 'policing knowledge hub': an IoT infrastructure that can collaborate with internet-enabled devices to collect the data, extract events and facts, and link different part of the story using a real-time dashboard.

The iCOP framework will take a structured provision of knowledge approach, delivering a range of functions. This will include a workflow technology that controls how the frontline police officer gets information and job tasks. We leverage our previous work, i.e. Knowledge Lake [5], to transform the raw IoT data into a contextualized data and knowledge represented as a set of data summaries. The summaries, include a set of facts, information, and insights extracted from the raw data (ingested from open, social and IoT data sources) using data curation techniques [4] such as extraction, linking, annotation, and classification. The rest of the paper is organized as follows. In Sect. 2, we present an overview of the iCOP, while in Sect. 3 we describe our demonstration scenario.

2 System Overview

We present iCOP, IoT-enabled COP assistant system, to enable IoT in policing and to enable fast and accurate evidence collection and analysis. Figure 1 illustrates the iCOP Architecture. The main components include: IoT-Enabled Data Collection, Data Transformation and Data Analytics.

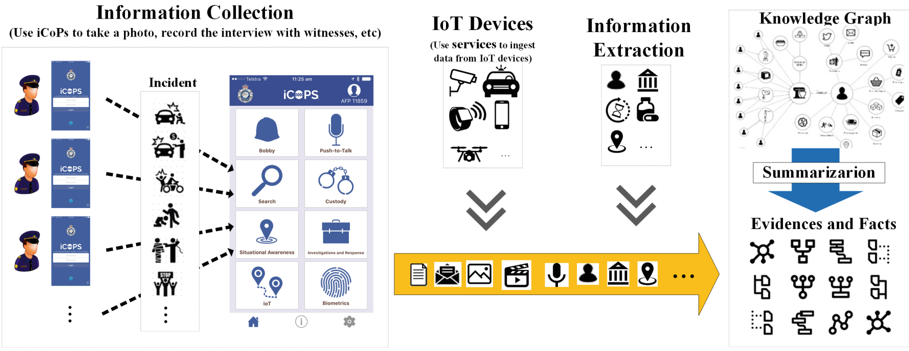

Fig. 1. The iCOP architecture.

IoT-Enabled Data Collection. The research questions at this level is how IoT can assist with responding, detecting crime as well as preventing crime [6]. The goal here is to contribute to research and thinking towards making the police officers more effective and efficient at the frontline, while augmenting their knowledge and decision management processes through information and communication technology. The proposed framework enables: (i) Manual Data Collection: at this level, the frontline police can take a photo of the scene, record video and audio, as well as writing notes and statements in an easy way; and (ii) IoT-Enabled Data collection: at this level, we develop ingestion services to extract the raw data from IoT devices such as CCTVs, location sensors in police cars and smart watches and police drones. We have used our previous work, Data Lake services [4], to organize this information in the data lake, i.e., centralized repository containing raw data stored in various data islands.

Data Transformation. At this level and inspired by Google Knowledge Graph [14] - a system that Google launched in 2012 that understands facts about people, places and things and how these entities are all connected - we focus on constructing a 'policing knowledge hub': an IoT infrastructure that can collaborate with Internet-enabled devices to collect data, understand the events and facts and assist law enforcement agencies in analyzing and understanding the situation and choose the best next step in their processes. We leverage our previous work, Knowledge Lake services [3,5,10], to automatically extract features (from keyword to named entities), enrich the extracted features and link them to external knowledge bases, such as Wikidata (wikidata.org/) and more. In particular, we use the Knowledge Lake [5] to automatically transform the raw data in the Data Lake into contextualized data and knowledge, i.e., facts, information, and insights extracted from the raw data using data curation techniques such as extraction, linking, summarization, annotation, enrichment, and classification.

Fig. 2. iCOP screenshots.

Data Summaries and Analytics. At this level, we provide a set of services to summarize the constructed knowledge graph, and to extract complex data structures such as timeseries, hierarchies, patterns and subgraphs and link them to entities such as business artifacts, actors, and activities. We will use the concept of Folder and Path (presented in our previous work [7–9]) to summarize the knowledge graph and to model, organize, index and query such complex data structures and to consider them as first-class entities in the Knowledge Graph. We present a real-time dashboard that enables the knowledge workers interact with the data in an easy way. The dashboard will enable monitoring the entities (e.g., IoT devices, people, and locations) and dig for the facts (e.g., suspects and evidences) in an easy way.

3 Demonstration Scenario

The demonstration scenario consists of three parts: *(Step 1) Information Collection:* first, we would like that the attendee appreciates the difficulties that an investigator can encounter when dealing with data collection phase. The iCOP mobile application, will enable the investigators to identify the relevant datasets (e.g. private, open and social data sources) and link them to the current investigation case. *(Step 2) IoT-Enabled Data Collection:* by activating the location-based services in the iCOP system, it is possible to automatically identify the Internet-enabled devices around the location area. For example, the investigator can identify and interact with IoT devices such as CCTVs, police cars and drowns. *(Step 3) Data Transformation and Evidence Discovery:* we present data summaries and analytics services as well as the real-time dashboard to enable the attendees interact with the data in an easy way. In this step, we leverage our previous work, i.e. Knowledge Lake [5], to transform the raw IoT data into a contextualized data and knowledge represented as a set of (tagged [12]) data summaries. Figure 2 illustrates some screenshots of the iCOP system.

4 Conclusion and Related Work

The existing body of policing research shows significant strides in the adoption of technology in some areas in the police department [1]. A significant number of investigators have focused on the role of mobile devices in helping the police respond to current policing challenges and improve their effectiveness [13]. Today, law enforcement agencies use data analysis, crime prevention, surveillance, communication, and data sharing technologies to improve their operations and performance. In this context, IoT services has the potential to improve knowledge exchange, communication practices, and analysis of information within the police force. To achieve this goal, in this paper, we presented iCOP, IoT-enabled COP assistant system, to enabling IoT in policing. The iCOP provides techniques to assist investigators benefit from IoT to identify the best next steps. The current version of iCOP has been implemented as a research prototype. As future work, we are turning iCOP into a fully functional system.

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