SAM: The School Attachment Monitor

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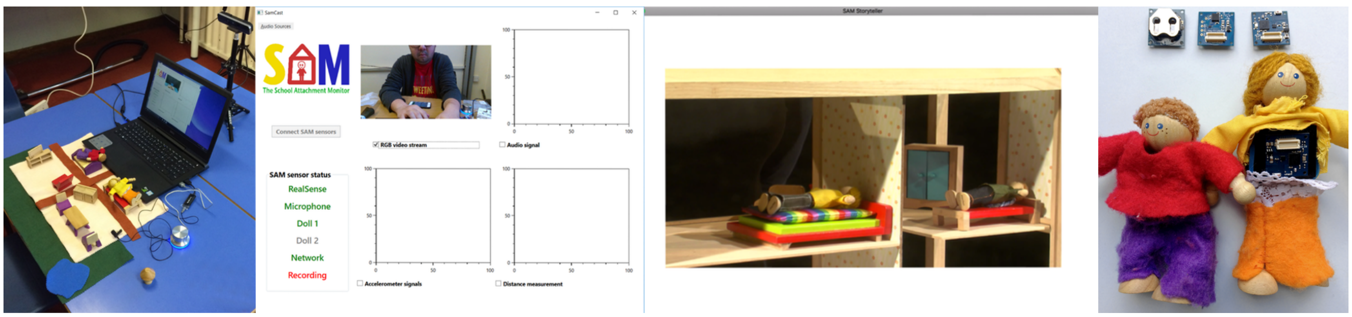

Figure 1: From left to right: SAM setup (a), SAM data collection app (b), SAM story telling app (c) and smart dolls (d).

ABSTRACT

Secure Attachment relationships have been shown to minimise social and behavioural problems in children and boosts resilience to risks such as antisocial behaviour, heart pathologies, and suicide later in life. Attachment assessment is an expensive and time-consuming process that is not often performed. The School Attachment Monitor (SAM) automates Attachment assessment to support expert assessors. It uses doll-play activities with the dolls augmented with sensors and the child's play recorded with cameras to provide data for assessment. Social signal processing tools are then used to analyse the data and to automatically categorize Attachment patterns. This paper presents the current SAM interactive prototype.

CCS CONCEPTS

• **Human-centered computing → Interactive systems and tools**;

KEYWORDS

Child Attachment; Attachment Assessment; Child Psychiatry; Automation; Social Signal Processing; Tangible Interaction; Child Computer Interaction

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1 INTRODUCTION

Attachment is the natural tendency of children to seek and to maintain physical proximity with their caregivers which provides protection and nurtures physical and psychological wellbeing. While it is a primitively motivated process to ensure survival of the species across humans and the animal kingdom, insecure attachment may reflect inconsistency, absence or hostility in the quality of care their young receives [1].

Secure Attachment can nurture confidence and a sense of self-worth in children. Research suggests that it also provides the child with resilience against risk of suicide, social and emotional problems or even heart pathologies [2]. Early identification of Attachment misalignments would therefore minimise these risks and ameliorate the societal costs. Unfortunately, administrating and coding Attachment evaluations is costly, time consuming and requires highly-trained assessors [5]. This limits the number of children that can be assessed and referred for treatment. Automating Attachment evaluations would facilitate population screening and allow health care professionals to prioritise their expertise for those in need of intervention. Our vision is that our School Attachment Monitor (SAM) will address this unmet need and provide a tool to make automatic Attachment classification possible.

SAM is designed to reflect methodology and principles of MCAST [3], the gold standard for measuring Attachment in children aged 4-8 years. MCAST assigns a child of school age to one of the four possible Attachment conditions: interpersonal (secure) strategy, non-interpersonal (avoidant) strategy, ambivalent interpersonal strategy and disorganized strategy. During MCAST, assessors show story vignettes to a child which portray mildly stressful situations (e.g., falling over and hurting a knee). The child is then asked to act out and tell the rest of the story using dolls that represent the child and a caregiver. The way the child completes the story and their behaviour during the test provides the cues to assess their Attachment status. For example, the trained assessors rate on Attachment-related behaviour, narrative coherence, disorganized phenomena (if any), state of mind and the psychological motivation of the characters and any other elements relevant to the story.

SAM is the first attempt at automating Attachment assessments. It has the potential to screen Attachment across the population and quickly and cheaply identify the children with attachment problem who need further attention. Our research will significantly improve population health and wellbeing.

2 THE SCHOOL ATTACHMENT MONITOR

In this paper, we outline the design of SAM. One of the objectives of SAM is to provide a tool to allow a non-expert to administer an Attachment assessment (based on MCAST) and automatically categorize the Attachment status of the child. SAM is made up of three components: one to collect data, one to administer the test, and another to process the data to make an Attachment classification. SAM is based around a laptop so it is easily portable and can be taken into schools for assessments (Figure 1a).

The first application collects data when the child is telling a story (Fig. 1b). Tracking the movements of the dolls is difficult given the wide range of ways in which children may play with them. We overcome this by using a novel combination of tangible dolls with embedded sensors and depth camera tracking so that the child being assessed can handle and play with dolls as they would in MCAST, without the technology interfering their play behaviour. A small Intel Realsense SR300 camera[1] is used to record RGB and depth data depicting the face and the hands when the child tells the story using the dolls. A lapel microphone worn by the child records speech. Finally, a Bluetooth inertial measurement unit is embedded in a 3D printed case inside each doll (Fig. 1d) to provide orientation and acceleration data from the dolls for classification.

Recording and synchronising the data flow coming from high definition RGB, depth, audio and inertial measurements requires a significant amount of storage, bandwidth and computing power. Our final approach, which operates in real time, relies on simultaneously running FFMPEG[2] on the laptop GPU to compress and encode the RGB video stream, and an LZ4 based algorithm on the CPU to compress depth data. An SSD drive copes with the high demand for data bandwidth and storage. A Bluetooth Low Energy stack and a mechanism to synchronize the inertial measurements with the other data streams was developed and deployed on a Tinyduino[3] fitted inside each doll (Fig. 1d).

[1]http://j.mp/RealSenseTech
[2]https://ffmpeg.org
[3]https://tinycircuits.com

The second software component delivers the story vignettes to the child and engages them in acting out the stories with the dolls (Fig. 1c). Implemented using Unity, it has been designed as a game. The application starts by playing a video sequence where a professional actor introduces the task and what is expected from the child. She/he is then prompted to set up the play area according to the story that is about to be told.

The third component of the software is the machine learning techniques that automatically identify children attachment status. Facial features such as eye movement, head pose, facial expressions, eyebrow movements, are first extracted from the video data. Along the same line, audio data is processed for feature extraction which includes mathematical properties of the signal such as zero-crossing rate, Fourier transform, mel-frequency cepstrum and cosine transform. Lastly, doll movement signals are also processed to extract more features. The first step in developing the machine learning algorithms is to find among all the features the ones that are representative of children attachment. In a second step, we look for the best features set for each signal's classification algorithm. We finally combine the output of each individual classification algorithm with ensemble methods to achieve better predictive performance [4].

SAM development has already reached an important milestone. The current prototype has been evaluated and used to collect data from 62 children in primary schools and we are now analysing the data to build the classification models.

3 SAM DEMONSTRATION

In this demonstration, we will exhibit two components of SAM: the data collection and the story delivery. The attendees of ICMI will be able to experience SAM as an administrator by monitoring all the sensors the system is using to collect data from the children's stories and by examining the different types of data that are being collected. They will also be able to experience SAM as a child who is receiving the attachment assessment by watching the vignettes and completing the stories with the dolls.

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