CSAW: An audio **C**ontrol **S**urface built using the **A**rduino platform and **W**ireless capabilities

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***Abstract*—Audio control surfaces are practical tools for editing and mixing in a digital audio workstation. Despite recent technological advancements, however, there is a lack of robust physical commercial controllers with seamless wireless functionality. This paper describes the design and implementation of CSAW – an audio Control Surface built using the Arduino platform and Wireless capabilities. CSAW aims to remedy limitations of mobile control applications and certain hardware controllers through devising a proof of concept control surface and software platform using sophisticated open-source applications and wireless communication protocols.**

***Index Terms*—Arduino, control surface, OSC, Pd, ESP8266, wireless, DAW**

NOMENCLATURE

CSAW	Control Surface with Arduino Wireless capabilities
DAW	Digital Audio Workstation
ESP	ESP-01 ESP8266 WiFi Module
Pd	Pure Data
OSC	Open Sound Control

I. INTRODUCTION

THE advent of smart phone technology and software applications in the modern age has undoubtably seen an increased interest in wireless and remote audio control within the audio production spectrum. The consolidation of music with the Internet of Things (IoT) in recent years has surpassed the expectations of engineers and enthusiasts alike, who continue to discover and implement new means of audio manipulation at a rapid rate.

Despite these advancements, however, there is still quite a lack of robust wireless capabilities for physical controllers/control surfaces on the market. Big name brands such as Behringer influence the pack with products like the X-Touch, but even so, this type of control is not as widely implemented as expected, considering the universal adoption of WiFi in the late 90s. For audio professionals, the necessity of a physical controller is imperative, given the frequent need to make multiple changes simultaneously, in contrast to the visual limitations and un-natural feel of changing parameters on the small screen.

The CSAW project aims to remedy this through utilising and consolidating existing technologies and hardware to construct a functional wireless physical control surface for audio manipulation. Through the use of sophisticated applications and communication protocols, along with a fundamental electronics environment with elemental components, a proof of concept controller and software platform will be devised to enable the audio engineer to perform mixing and recording functions in an easier, more efficient manner than its software counterparts.

II. BACKGROUND & DESIGN

An audio control surface refers to a device or interface that "allows the user to control a digital audio workstation or other digital audio application" [1]. These range from the primitive, such as Behringer's X-Touch Mini [2] with its single fader and 8 rotary potentiometers for track volume control, to the more elaborate, like Avid's Pro Tools S3 [3], which allows for a wider range of functionality such as automation, routing management, etc. CSAW acts as such an interface, allowing for basic DAW and track control implemented through Arduino and WiFi capabilities.

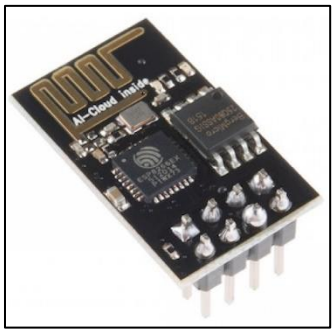

Fig. 1. ESP-01: ESP8266 WiFi module

At its core, CSAW design is closer to a combination of control surface and analog console than to a typical control surface. The controller includes analog sensors with pre-mapped controls for the more common DAW functions. It also makes use of DAW built-in OSC capabilities instead of sluggish WiFi setup and configuration over some of its counterparts.

CSAW houses a WiFi transceiver, the ESP-01 (Fig.1) [4], a model of the ESP8266 module to provide easier connectivity for the core Arduino component to a pre-existing network. Making use of simple, affordable electronic potentiometers and push buttons that connect to the Arduino Mega [5], the

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CSAW control surface keeps to a compact design. Layout is based on the Behringer Xenyx X1222USB analog mixer [6].

The Pure Data [7] visual programming language is utilised as middleware software, collecting sensor messages from the controller Arduino component and processing and broadcasting them to a DAW. These messages are communicated via Open Sound Control [8] – a message-based protocol for communication among computers, sound synthesizers and other multimedia devices and applications that is optimized for network distributed music systems. OSC was selected over the likes of MIDI based on its user-defined message structure and robust ability to define different data types among others.

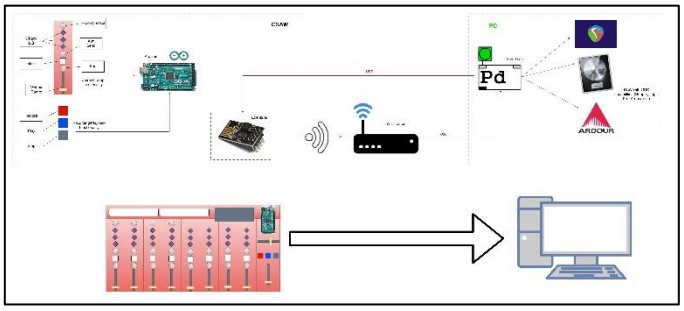

Fig. 2. CSAW architecture

III. IMPLEMENTATION

Two separate communication methods were used to send audio control to a DAW on a computer; a) transmitting control signals via USB (wired connection) or b) via WiFi using the ESP8266 chip (Fig.2). The Arduino Mega component scaled analog/digital data read from the controller's potentiometers and pushbuttons before sending them via serial to either USB or ESP. The numerical data was then received on a local instance of Pd running on the DAW PC through either method - the latter utilising OSC for ESP->Pd transmission. Both methods then utilised Pd to configure separate OSC messages to map data to built-in DAW actions, performing the appropriate task (e.g. volume control, equalization, etc.).

All potentiometers and resistors used were of 10kΩ resistance – the optimum value as anything smaller consumes current while anything larger takes longer to read or can be affected by values of other pots. Multiplexers were employed to extend analog inputs due to limitations of Arduino. The project applied 8xCD4051BE 8-channel muxes, developed by Texas Instruments Inc., to route sensor inputs for each channel strip to Arduino's analog pins.

CSAW makes use of contributions from the GitHub community for streamlining controller operations. The two primary repositories that were invoked during implementation were 'Arduino_Pd' – a library of Pd abstractions for facilitating reading of serial data [9] – and the main OSC library developed at CNMAT for Arduino integration [10].

Desk construction was outsourced to a local sign and display solutions company, given a measurements diagram (Fig.3). Basic black-box user testing comprised querying statements to testers based on John Brooke's System Usability Scale [11], for measuring the system's usability.

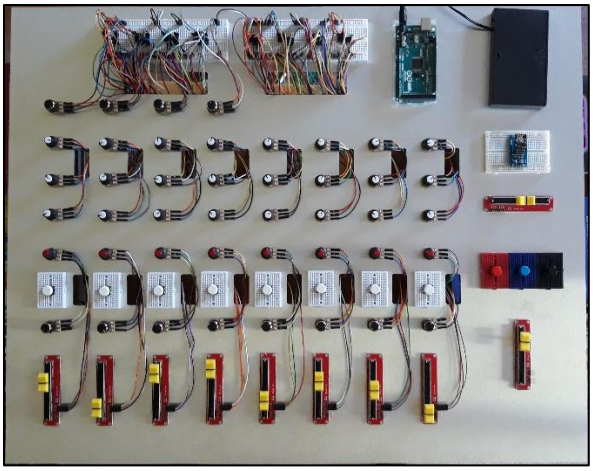

Fig. 3. CSAW final prototype

IV. CONCLUSION

The CSAW audio control surface successfully amounts to the principal capabilities of a DAW controller, proving itself among the many software-centric systems that currently dominate the market. With its recognisable design and built-in WiFi transceiver for consistent wireless facilities, CSAW exhibits an ergonomic digital workstation controller for the modern audio engineer, providing a key functionality that's ignored by many wholesale controllers.

Through its use of exclusively fundamental electronics and strictly open-source technologies and platforms, CSAW proves competent in matching many of the commercial physical products available in the public domain at present.

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