Submission date: September 17, 2010
Subject: "Kevin's Arcade – A MAME Controller Project" Design Plan
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Attachments: 1. Gantt chart

Objectives

The goal of this senior capstone project is the design, construction, and time-based documentation of a portable two-player arcade-style control panel. It is designed to operate the Multiple Arcade Machine Emulator (henceforth referred to as "MAME") computer software system plus a variety of other vintage and modern-era video games. The measure of success, also known as the performance criteria, will be composed of both qualitative and quantitative findings determined by both my extensive experience with video games as well as acquaintances experienced in their area of gaming expertise. This, alongside evaluation of the control panel's construction, will form the evaluation system of the overall project.

Problem Statement

Staples of the 1970s all the way into the 21st century, video arcades are a ubiquitous image of contemporary entertainment and stress relief, attracting new and experienced players both young and old. However, the enormous weight, size, and (sometimes) cost of owning most machines can be prohibitive for the average dorm-dwelling student. Fortunately, the development of MAME by the online open-source software community has eased these concerns, allowing us to relive thousands of classic arcade titles with a general-purpose computer. With the proper custom human interfaces, one can accurately simulate the look and feel of most stand-up cabinets, and with some additional considerations, permit playing of modern titles as well.

The solution is to design a visually-appealing human interface control panel, both portable enough to be transported around campus and, when properly set up with a personal computer and its auxiliary peripherals, permit two players to simultaneously utilize it. Components will be chosen so that most MAME titles and modern arcade-style games can be played on a single interface seamlessly without alteration of hardware. Additional parts will be selected so that the keyboard shortcuts and basic mouse functions on the PC can be controlled directly by the panel itself.

Engineering Requirements

Success of this project will be determined by the following criteria below. There is no fixed priority for each requirement; however, the loss of one function will reduce or impede play of certain games dependent on the feature.

1. Control requirements:
    a. A single USB output to the configured computer for ease of connection.
    b. Non-conflicting keyboard emulation for ease of mapping buttons to each game.
    c. Two joysticks capable of 4-direction, 8-direction, and full-analog control, one for each player.
    d. Two right-handed *Street Fighter*-style button arrays ("player buttons"), one array for each player.
    e. Two single-axis rotary encoder controllers ("spinners").
    f. One optical trackball with basic left/middle/right mouse button functions.
    g. One array of buttons for basic MAME functions: Player 1-2 Start, Player 1-2 Coin, and emulator navigation and administration ("auxiliary controls").
    h. One standard keyboard below control panel top for computer administration.

2. Cross-game compatibility:
    a. Unplug and reattach controller on the configured PC without loss of functions.
    b. Play titles requiring a 4-direction or 8-direction joystick without swapping internal hardware (for example, *Pac-Man* requires a 4-direction joystick while *Street Fighter II* requires an 8-direction joystick).
    c. Play titles requiring analog joysticks without swapping internal hardware (for example, the *Beat Hazard* music rhythm game).
    d. Automatic re-mapping of player button functions between properly-configured games.
    e. Automatic spinner detection for games that require it (such as *Tron* and *Araknoid*)
    f. Automatic trackball detection for games that require it (such as *Golden Tee Golf*)
    g. Auxiliary controls function as expected in the MAME application and its games.

3. Player comfort
    a. Player buttons and button layout should not cause hand or wrist fatigue after extended use.
    b. Player buttons and button layout should permit quick, accurate, tactile response.
    c. Joysticks should have adequate return spring tension while permitting fast, accurate play.
    d. Spinner and trackball should operate as expected when installed according to the manufacturer.
    e. Joysticks, spinners, and trackball should have adequate height without physically binding or limiting control actions.

4. Enclosure and overall appearance
    a. Enclosure painting and sealing are chip and dent-resistant.
    b. Edges and (future) artwork are properly protected.

Proposed Solution

As I am the sole person to design, construct, and document this project, I am responsible for designing the enclosure and selecting each component to suit the stated Engineering Requirements.

Preliminary enclosure and control layout design will be via traditional sketches; exact dimensions will be imported into SolidWorks for adjustments and sample renders. The final plan will be exported as one or more mechanical drawings for transfer onto the raw material and subsequent cutting.

The enclosure will use high-grade solid wood panel or plywood, sanded, painted, and sealed for good appearance and durability during its lifetime. The top play surface, rounded of sharp edges, will use T-molding to withstand any physical shock incurred on the edges. Detachable window-grade polycarbonate panels surrounding the sides and top add further visual appeal, as well as protection for inlaid custom artwork in the future. The overall size of the controller will be dimensioned to allow two players to comfortably stand or sit side-by-side during its use. A keyboard drawer will be added to the enclosure body for a standard computer keyboard, used for MAME configuration and PC administration when required.

At the heart of the controller is a dedicated USB keyboard emulator known as the I-PAC, capable of up to 56 fully-configurable, non-conflicting digital inputs from the player and auxiliary pushbuttons. Onboard EEPROM store all button settings after power is removed. The analog joysticks do not require a separate controller and will be connected directly to the USB hub inside the controller, and contain their own EEPROM ICs to store mapping settings. However, they also have separate digital emulation outputs that simulate traditional switch-based 4-direction and 8-direction joysticks; these outputs will be directed to the I-PAC for games that require digital joystick inputs. In addition, the trackball and arcade spinners contain built-in quadrature encoders, ADCs, and USB host interfaces for direct connection to the hub.

Each player switch array will contain eight Sanwa-brand authentic Japanese convex-shaped arcade pushbuttons; they are known worldwide for their quick action, durability, and lack of an inconsistent two-step "click" common to American-made pushbuttons. The eight buttons will be arranged in a hybrid linear-curve *Street Fighter*-style 3x2 array for the index/middle/ring fingers, with a 1x2 straight section for the pinky finger; this will ease hand and wrist strain commonly attributed to linear-only button layouts, but still permit playing by those who desire such arrangements. Two additional Sanwa pushbuttons on each side of the controller will be used for pinball-style games. Auxiliary switches, excluding the trackball's Sanwa mouse buttons, will be Happ-brand arcade pushbuttons; these are chosen for appearance's sake over performance and feel.

Each of the two joysticks will be an Ultimarc-brand UltraStik 360 analog/digital programmable USB arcade joystick with low-tension springs, optional digital emulation output wiring harnesses, and optional circular movement limiters ("restrictors") installed. The restrictors are present to enhance performance in games requiring fast, short stick movements, but they can be removed in the future if longer throws are needed. Unlike traditional switch-based units, the UltraStik 360's durability is vastly improved over the former, as there are no moving contacts to wear and replace. Everything onboard other than the handle unit and return spring is solid-state, utilizing Hall Effect sensors to determine the handle's absolute position.

For ease of mounting and connection, the two spinners will be SlikStik-brand USB Tornado Spinners, containing built-in steel flywheels for good performance when long-term spinning is required. Knobs will be chosen as appropriate to match the appearance of the completed controller.

Timeline of Progress

Please view the included Gantt chart for the intended course of design, construction, and documentation tasks associated with the project, as detailed under the Engineering Requirements and Proposed Solution of this Design Plan. Projected spans for on-time and late (lagging) time usage are included for each task.

Documentation of Progress

An informal photo documentary with text descriptions will be updated as needed on a static web page, located on my personal site at http://www.plasmafire.org/ Additional information on the page's URL will be announced once it is fully set up.