# Economical Design Process for Integrated Single Input Environmental Control Systems as a Commercial Alternative for In-Home Assistive Technologies

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*Abstract*— **While existing environmental control systems have existed for a number of years, this paper proposes a design targeting a more universal design. The process is demonstrated through an implementation controlling a television and cable box. The controller is modified such that it will be controlled through a single switch to simplify the use of the remote that may be complicated due to impairments in range of motion in the wrist, hand and fingers. In addition to the standard television and cable remote, an X10 PowerHouse remote is incorporated and linked with the cable remote, this X10 remote allows power control functions for various appliances around the house. The two remotes are connected to a PIC18F452 microcontroller, which allows both remotes to be controlled individually through a single input switch in the form of a push button.**

## I. Introduction

The purpose of assistive technology is to enable an individual with disabilities to perform tasks that may be difficult or impossible to accomplish without assistance. This process will take a device common to many homes and modify it in such a way that will allow an individual with physical impairments to control their home environment with ease. Enabling an individual to control their home environment with ease will greatly help to reduce their reliance on a caretaker as well as provide some independence. Reducing the need to rely on a caretaker to accomplish simple everyday tasks such as adjusting the lighting or changing the TV channel will allow the caretaker to continue performing other tasks. While there are ECS (Environmental Control System) devices that solve this problem, many are expensive, some costing up to thousands of dollars. Our goal is to create a device that is lower cost and has a universal design that will be able to be used with any commercially available remote control, as well as the preferred method of triggering the device's switch. In previous years students at the University of Rhode Island have developed a similar alternative to expensive in-home environmental control, known as the Powerscan remote. We adopted and modified the methods used to obtain external control over this older universal remote, improving the design such that original functionality is not impaired and all buttons on the remote may remain functional.

Research has indicated that commercially available systems for in-home environmental control remotes can cost the consumer and device users at least $200 for systems that only control the lighting appliances in the home. [1] More complex devices that allow the user to control in-home appliances from any computer with internet connection have a consumer cost of about $600, but a device like this is not applicable for assistive technology and provides an interface that may provide even more difficulties for an individual with physical impairments [2]. It may also be useful to note that it is difficult finding an ECS device that functions as an all-in-one control system that also has a user input interface that is easy to use for an individual with limited muscle control, and some companies simply pick and choose devices that are already available on the open consumer market to satisfy each individual's level of environmental control desired without modifying the input systems to simplify device control [3]. The proposed system attempts to solve all of the above issues while drastically reducing the cost of the system to the individual. By utilizing the pre-existing cable and TV remote as the core of the system we eliminate the need to purchase a more expensive universal remote and tapping into the cable remote for exterior control is simplified. Thus far our methods for external control of the remote controllers have been successful using cable remotes from Cox Communications, DirecTV, and two different X-10 Powerhouse remotes. Normal input functionality remains for each of the remotes post-modification.

## II. Methods & Results

### A. The Main Circuit

The proposed device's circuit can be split into two categories, the main control circuitry and the external control circuitry. The main control circuit (see Fig. 1) utilizes a PIC18F452 microcontroller which is a small inexpensive DIP processor chip that has the capability to be programmed to control the modified remotes all from a single input switch [4]. This is accomplished by creating a software program that utilizes a system of customized timers that will cycle through the different control options available to the user. As the chip cycles through each process an LED is illuminated that acts as a mode designator, indicating the current function to the user. The processor will continuously cycle through the modes waiting for user input. When the single switch is depressed the program will then execute the selected function, and will remain in this function mode for a few seconds incase the user would like to input multiple sequential button presses for example raising the volume or changing the channel on the TV multiple times in a row.

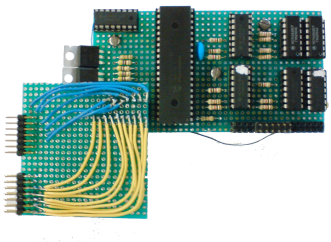

*Figure 1. The main processing module*

*Figure 2. A modified remote control*

### *B. The External Circuit*

The external circuit contains the two remotes utilized to provide the device control functionality that is desired, this would be either the Cox Communications or the DirecTV cable remotes (see Fig. 2) as well as the new X-10 Powerhouse remote for appliance control via RF (radio-frequency) communications. The external system is currently being set up through two different methods, our primary design has both remotes installed into a black box such that the remotes can only be controlled via the single switch input. This design process was adopted and modified from the original Powerscan designs, instead of drilling into the copper leads found throughout the printed circuit board of the original remote the two conductors connected by the button press were utilized [5]. Altering the methods used to control the remote externally increases the durability of the system, reducing the chances of connections being interrupted and broken. Often, the buttons were found to be unresponsive on the prior Powerscan design requiring single switch use. This was the result of newly added internal connections interfering with the original keypad depression or broken connections in the circuitry of the remote due to drilling. Our new method of external control ensures that the rubberized buttons may be reinstalled into the remote and still retain full functionality, enabling the device to be controlled via traditional methods or through our simplified single switch input.

The secondary design leaves original functionality of the cable remote intact, where the user can control everything like they would if they just purchased the remote from their cable provider. The difference here is that a piggyback module is created and installed inside of a smaller project housing that will contain the internal circuitry responsible for the single input control as well as the X-10 compatible device control. This system is more suitable for an individual who is able to use a remote without difficulty but may have some difficulties in mobility, making it easier for them to control their TV entertainment system as well as the lighting appliances throughout their house all from a singular location. This secondary system may also be more suitable for use in a house where only one remote is available for use, such that the assistive device will not impair individuals from normal use on a daily basis alongside individuals who may need assistance in utilizing the functions of their remote.

## III. Discussion

The proposed design has been broken up into two sets of circuitry, which can be easily connected together. The reason this approach was taken was to allow for a more universal design. The user would be able to select a variety of remote controls to suit their individual needs. The design approach also allows for a variety of trigger mechanisms. The user may not have enough muscle strength in their hands to trigger the device, but they may be able to use an air controlled “sip and puff” switch instead. The design allows for almost any simple control method to be attached to the unit, this will ensure that the environmental control device can be designed for any individual based around their needs and abilities to control the system. This modular approach will be able to provide a multitude of users with a customizable, yet affordable device that will restore their personal independence in their home and ensure a comfortable living environment.


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