1. Magnetic Maze

Input: 1 Webcam
Output: 1 xy table
Feedback: Walls seen on the camera influence the path that the xy table can follow. The motor moves the traveler, which is seen by the camera.
Feedback Rating: 8 out of 10.
Details: Users draw the maze with a pen on a whiteboard. The xy table moves beneath the whiteboard, pulling a magnet that's on top of it. The traveler avoids walls, and finds the shortest path from a "start" marker to an "end" marker.

2. Warehouse

Input: A variety of digital photosensors. For 6 rooms, you need 2*6+1 = 13 sensors. Of these, 6 tell whether a room is occupied, 6 tell whether the user is choosing a room, and 1 tells whether the launch pad is occupied.
Output: 1 Robot arm
Feedback: The robot moves objects depending on which photosensors are triggered. When the robot places an object somewhere, the state of 1 or 2 photodiodes changes.
Feedback Rating: 4 out of 10.
Details: The user never sees the computer. When the user shines a laser pointer at an unoccupied room in the warehouse, the robot will place whatever object occupies the launch pad into that room in the warehouse. If the room is instead occupied, the robot retrieves that object and places it on the launch pad.

3. Goalie

Input: 1 Webcam
Output: 1 Servo Motor
Feedback: The servo motors moves a goalie to prevent pucks from entering a goal. When the servo moves, the image showing where the goalie is changes.
Feedback Rating: 7 out of 10. Of course, if you cheat, and just assume that the motor always flawlessly positions the goalie, then this changes to 1 out of 10.
Details: Multiple "pucks" are launched toward the goal. They might enter the goal directly or after a rebound from a wall. The system continuously analyzes the video (determining position, speed, and projected position of each puck) to determine which puck will be able to reach the goal first, and then moves the goalie to block it.

4. CMYK Color Mixer

Input: 1 Webcam
Output: 1 Robot arm
Feedback: The robot iteratively opens the nozzle of one of 4 pipettes to add food color (Cyan, Magenta, Yellow, or Black) to water until the result reaches a color pre-selected by the user (using RGB controls)
Feedback Rating: 10 out of 10.

Details: The system must estimate the amount of each color needed based on current color and current volume of solution. Volume can be determined by using a pressure sensor, or by keeping track of the amounts already added.

5. RLC Circuit Analyzer

Input: 1 Multimeter
Output: 1 Variable AC power source
Feedback: The frequency range of the AC power source is iteratively varied based on the response to prior trials at coarser frequencies.
Feedback Rating: 8 out of 10.
Details: The circuit is a single series circuit containing the AC source, an unknown resistor, an unknown capacitor, an unknown inductor, and a small known resistor. As the input frequency is varied, the voltage across the known resistor is measured. From this, current is computed. For a given spectrum of frequencies, LabVIEW can estimate: the peak current, the frequency having the peak current, and the FWHM frequency range. From these 3 measurements, R, L, and C can be determined (assuming you account for the R, L, and C inherent to the AC source). Since scanning all frequencies would take forever, the system has to perform multiple trials with iteratively improved frequency ranges and refinement.

6. Color Sorting System

Input: 1 Webcam, or 3 color-sensitive photo resistors.
Output: 1 Robot arm
Feedback: The system continually monitors a variety of objects that pass by on a large conveyor belt. Based on the color of the object, the robot removes objects from the belt and stores them in appropriate bins (red, yellow, blue, black, etc.)
Feedback Rating: 3 out of 10.
Details: Care must be taken to make sure the conveyor belt moves objects adequately. Don't fall into the trap of thinking that the robot is limited to only using its claw to remove objects from the belt!

8. ATM

Input: 1 Card Reader. It can be made from 4 photodiodes, or purchased directly.
9 push buttons to enter a PIN.
Output: 1 Robot arm with vacuum pen to distribute cash (e.g., monopoly money)
1 Servo motor to finalize cash distribution.
Feedback: The system validates the ID card with the PIN, then checks the account balance before distributing cash. Distributed cash must be in multiple denominations (1's, 5's, 10's, and 20's).
Feedback Rating: 2 out of 10.
Details: If $13 is requested, then a 10 and three 1's are distributed, etc. It knows when it is out of cash. It must NEVER distribute a wrong amount.

9. Artillery

Input: 1 web cam

Output: 1 toy dart launcher with at least 2 degrees of freedom (left/right, up/down).
Feedback: The video is analyzed to determine the position AND RANGE of a target. A dart is launched to hit the target.
Feedback Rating: 2 out of 10. If you instead take multiple shots at the same target in the same position, and use the video to see how far the previous dart missed by, this changes to 10 out of 10.
Details: The target must identify Friend/Foe correctly. Note that toys behave inconsistently. A big part of this project is modifying the toy dart launcher to be consistent. Or, instead of a toy launcher, you can launch using a height-based rollercoaster system with an off-ramp.

10. See-Saw/Balance

Input: 1 potentiometer to measure angle (inferred from resistance)
Output: 1 large stepping motor.
Feedback: The position of a "large" counterweight is varied to ensure that the see-saw remains level as the user adds weights of varying amounts to different places on (one side only) of the see-saw.
Feedback Rating: 10 out of 10.
Details: The see-saw must be at least one meter long. The counterweight is attached on 2 sides by a small string. The string's path is: weight, to pulley, to motor shaft (wrapping neatly around the shaft 3 or 4 times), to pulley, to other side of the counterweight. Don't use tape!

11. Analog Lamp Follower

Input: 1 web cam
Output: 2 servo motors
Feedback: The user walks around the (darkish) room with flashlight or other analog light source. The servos rotate the web cam so that the light is always centered in the image.
Feedback Rating: 10 out of 10.
Details: This project can also be done with an array of 9 photodiodes for input (instead of just 1). That will more easily give the "brightest direction".

12. Analog Line Follower

Input: 2 photodiodes
Output: a "car" or "tank" with forward/reverse and left/right.
Feedback: The photodiodes are mounted near some bright LED's aimed at the ground. The diodes are about 1.5 inches apart on the front bumper. When the ground is white, the photodiodes see light. If the ground is black, they don't. The car is turned and moved forwards based on the relative inputs of the two diodes until it reaches a target.
Feedback Rating: 10 out of 10.
Details: The black line is created using electrical tape, following a single path that can be bent or curved, but has no branches.

13. Star Wars Laser Satellite

Input: Web Cam
Output: 2 Servo motors
Feedback: A laser is aimed by the servos to hit a target viewed from above by the "spy satellite" web cam.
Feedback Rating: 2 out of 10, unless you use prior misses to re-aim the laser over multiple shots, which changes it to 9/10.
Details: The camera will see multiple targets, changing over time as the user moves them around between shots. The system must determine "friend or foe".

14. Battleship

Input: Webcam
Output: 1 Servo motor
Feedback: The laser is re-aimed based on the degree of failure of prior shots.
Feedback Rating: 9 out of 10.
Details: The used builds a small battery powered target. It has one photodiode, one LED, and a reset button. Whenever light hits the photodiode, the LED comes on and stays on until a person pushes the reset button. The camera views the target and then aims the laser at it. The laser is turned on for 1 second. If it hits the diode, the LED comes on, and the camera sees that. If not, the camera instead observes the position of the laser spot for the 1 second interval, and makes the appropriate small change to the servo motor to hit it the next time.

15. Double Balance

Input: Resistance from rotary potentiometer. Weight measured on a scale.
Output: 1 stepping motor.
Feedback: The potentiometer is the pivot of the lever arm. The motor pulls the string, rotating the potentiometer until it is restored to it's original value (level).
Feedback Rating: 10 out of 10.
Details: A level pivot arm assembly rests on a scale. The user adds an unknown weight m at an unknown point x on the pivot arm, which causes the pivot arm to tilt. Using a pulley, string, and spring of known k, the motor pulls on the other end of the pivot arm until the arm is once again level, as sensed by the pot. You'll need to keep track of the total distance pulled by the stepping motor. Between the known value on the scale, and the known distance pulled by the motor, you'll have 2 equations in two unknown to solve for m and x.

15. BlackJack?

Input:
Output:
Feedback:
Details:

16. Ultrasonic Interference & Diffraction?

Input:
Output:
Feedback:
Details: Requires a good bit of data analysis.