CARDINAL DIRECTIONS

BY RAFAEL LOZANO-HEMMER - RASPBERRY PI VERSION



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GENERAL IMPORTANT INFORMATION

This short section must be read for proper operation.

CARDINAL DIRECTIONS (2010)

BY RAFAEL LOZANO-HEMMER

Technique

Monitor, stepper motor, Raspberry Pi, motion sensors, custom electronics, stainless steel stand.

Description

Cardinal Directions, is a kinetic sculpture which consists of a surveillance monitor that displays an extract of Vicente Huidobro's poem "Altazor" (1919-1931). Referring to the geography of his native Chile, Huidobro wrote "The four cardinal directions are three: North and South". When a presence is detected by infrared sensors, the monitor starts to rotate. As the poem is "geolocated" it always aligns itself to the cardinal points, and the public must walk around the piece in order to read it, like a kind of periscope.

Operation

Please refer to <u>Appendix I - Installation</u> for detailed system information and wiring diagram. Ensure the artwork is well connected to a power source.

- 1. To turn the piece **ON**, flip the small switch on the side of the board underneath the circuit to the labeled "on" position. The Raspberry Pi will boot up and the display screen will begin to show information within 10 seconds.
- 2. To turn the piece **OFF**, flip the switch described above to the labeled "off" position. Wait about 20 seconds until everything has finished the shutdown routine.

General Artwork Behaviors

When a person is detected moving near the piece the motor will rotate the display screen to different cardinal directions. If no movement is detected for a certain amount of time the piece will go into "idle mode". In this mode the display will turn off and rotate into its "home" position.

Maintenance

Please do not clean the display's glass surface with Windex or soap. Use a lint-free cloth and LCD screen liquid cleaner, such as Kensington Screen Guardian found in most computer stores. Blowing compressed air on the motor and rotation components can prevent the accumulation of dust which may hinder movement.

Note the texture of the display case is aging in a particular manner: it will get stickier over time. While the case should be typically cleaned with a slightly humid soft cloth, it may start to reveal scratches and different coloured (or textured) patches. The artist considers that as a regular patine of the material, there are ways to remove the sticky texture, but we recommend waiting a maximum of time before doing so. Contact the studio if you are interested in exploring options for removal.

The metal support structure can be cleaned with regular all-purpose cleaner. Do not use harsh cleaners or rough sponges. Tough stains can be removed with a cotton rag and a small amount of acetone. Wear gloves when cleaning the stand or touching the display.

We recommend cleaning the piece at least every two months.

Placement Instructions

The piece should not be closer than 2 meters from any wall as this will hinder people from walking around the piece. Because the piece uses passive infrared sensors, any human size infrared light variation will trigger the system and, ultimately, the artwork rotation. If such behavior is noticed, check to see if a large sunny window, heater, fireplace etc. is in a 5 meter range of the piece. Try moving the piece further away from those elements.

The piece can be placed facing any direction: the software will later be used to set the north cardinal direction.

Make sure the metal base is leveled: adjust the length of all four feet by loosening the set-screws and sliding the inner cylinder in or out.

Use a cable channel or tape to secure the power cable running from the piece to the wall plug.

Once the sculpture is in position, confirm the position of true North and proceed to calibrate the motor's North position following the instructions in the <u>Motor Adjustments</u> section.

DETAILED TECHNICAL INFORMATION

Normal Software Operation

When the Raspberry Pi is turned on it should automatically launch the software and begin running. The initial startup screen of the Raspberry Pi should look like the image below labeled "Initial startup screen".

Once the Raspberry Pi has booted up the display should look like the image below labeled "Software running properly".

The piece should then run normally without any further actions necessary. When moving towards a specific direction the abbreviation associated with that direction should light up slightly. When movement is not happening near the piece it will eventually enter "idle" mode in which the display is turned off and rotated to its "home" position. Moving near the piece will re-engage the software.



Initial startup screen

Software running properly

Manual Software Calibration

The following operations require the keyboard's USB dongle to have been inserted into the Raspberry Pi prior before turning the artwork on in order to properly access the GUI.

If the artwork doesn't react properly to someone's presence, there are two presets to be tried: a more reactive mode, preferred in sunnier rooms - even if we must avoid direct sunlight near the artwork - and a quieter mode preferred in a more typical room. To trigger such presets, press either on the key **8** (more reactive) or key **9** (less reactive) on the keyboard. For details on adjusting the reactivity of the piece see the section titled <u>Adjusting Reactivity</u>.

These general hotkey may be useful

- Pressing key **g** will make the GUI appear and hide. Upon hiding the GUI, its settings will be saved.
- Pressing key **esc** will make the app shutdown.
- Pressing key f will toggle the app between fullscreen and window mode.

When the GUI is pulled up it should look like the image below. The following sections will break down the different sections of the GUI that will be most useful in making adjustments and how to use them. The table below gives the function of every variable in the GUI.

cardinal v49	0 B
fps	29
📉 showGui	
fullscreen	
🗌 admin keys	
debug	
language	1
text	+
motorSpe <mark>ed</mark>	510
RenableMotor	
north degree	0
idle degree	0
motor degree	0
mptionOnDur	3.5
motionOffDur	5
dleDur	10
offCCTVDur	300
sensorTriggerPercent	90
onSensorNumber	3
OffSensorNumber	3
powerSwitch	
Lbutton	
go to home	
go to idle	

0
0
265
110

Screenshot of GUI

Image of the Text menu expanded

Setting	Description
fps	Shows the frame rate per second being achieved by the piece. The ideal frame rate should hover between 29-30.
showGui	A check box to hide or show the GUI.
fullscreen	Sets the software to run full screen on the display. Should always be selected.
admin keys	Enables certain admin actions through pressing keys. These actions are explained in the <u>Admin HotKeys</u> section.
debug	Checking this box shows the Debug screen which contains more information about the rotation of the poem and sensor activity. Debug mode is explained further in the section <u>Debug Mode</u> .
language	Sliding this moves between the four available languages. Language can also be changed by pressing the button on the bottom of the board. See the <u>Printed Circuit Board</u> section for location.
Text - cylinderX	Seen when Text is expanded. Should not be pressed, see image above for ideal setting
Text - cylinderY	Seen when Text is expanded. Should not be pressed, see image above for ideal setting
Text - cylinderWidth	Seen when Text is expanded. Should not be pressed, see image above for ideal setting
Text - cylinderHeight	Seen when Text is expanded. Should not be pressed, see image above for ideal setting
motorSpeed	Sets the speed of the motor rotation.
enableMotor	Unchecking this box stops the motor from running normally. Checking it allows it to proceed it's rotation
North degree	Reflects what degree the software has set North at. See <u>Motor</u> <u>Adjustments</u> for more detail on how to set this.
Idle degree	Reflects what degree the motor will rotate to when in idle mode. See <u>Motor Adjustments</u> for more detail on how to set this.
Motor degree	Should remain at 0.

Setting	Description
motionOnDur	Sets the amount of seconds that motion needs to be detected by at least one sensor reporting a triggered state in order to prompt movement from the piece. Acts in conjunction with sensorTriggerPercent to determine how long a sensor must report an active state in order to change its state to triggered , see <u>Adjusting Reactivity</u> for more detail on how to set this.
motionOffDur	Sets the amount of seconds where if no motion is detected the motor will stop. See <u>Adjusting Reactivity</u> for more detail on how to set this.
idleDur	Sets the amount of seconds that has to elapse with the motor stopped before the piece will enter idle mode.
offCCTVDur	Sets the amount of seconds that has to elapse with the piece in idle mode before the display will turn off.
sensor Trigger Percent	Sets the percentage of the motionOnDur that a sensor must detect motion, in order to report a triggered state. See <u>Adjusting</u> <u>Reactivity</u> for more detail on how to set this.
onSensorNumber	Sets the number of sensors that must report a triggered state for motion to begin. When 2 or more are selected, at least 2 sensors need to be neighbors. See <u>Adjusting Reactivity</u> for more detail on how to set this.
offSensorNumber	Sets the number of sensors that must not motion for the timer period set by motionOffDur in order for motion to stop. See <u>Adjusting Reactivity</u> for more detail on how to set this.
powerSwitch	Clicking this button will turn off the Raspberry Pi.
button	Activates or deactivates the functionality of the physical button on the custom circuit.
Go to home	If the box is checked the piece will rotate to the home position. This can be used to make sure the homing sensor is functioning properly.
Go to idle	If checked will force the piece into idle mode and turn off the screen.

Admin HotKeys

The admin shortcuts can only be used if you have first pressed the **A** key or if you have checked the **admin keys** box in the GUI. Doing so unlocks the hotkeys explained in the table below. These actions are mostly used for debug purposes or main calibration: please use with precaution.

Setting	Description
Н	Forces the display to go to the "home" position.
x	Toggles the display motion On or Off.
Y	Toggles the display power On or Off.
D	Toggles the "debug" mode. This mode should be useful to understand the sensor's behaviors. Debug mode is explained further in the section <u>Debug Mode</u> .
м	Toggles the detection via the motion sensors.
Space Bar	Switches between languages in sequence.

In debug mode more detailed information about the piece is displayed visually.

- When the homing sensor is triggered: The background color will change. This is less visible on the original CRT display then it will be on an LCD display.
- **The motor's angle of rotation:** This is represented by the line that rotates within the circle in the piece seen in the screenshot below.
- **Sensor placement:** The sensors are numbered and situated on the rectangle relative to their actual positions on the board. By checking where the circle is cut out of the board you can see which sensor is which.
- Sensor State: The sensors are capable of reporting three states. Inactive, Active and Triggered, see section <u>Adjusting Reactivity</u> for a full explanation of sensor states. When the sensor is circled by a white outline it is **Inactive.** When it is circled by a filled in white circle it is Active. When surrounded by a square the sensor is **Triggered**.



Debug Mode Running Normally

Motor Adjustments

You will need to set the **North degree** manually in the software at the beginning of an exhibition or if the piece has been moved to face a different direction. In order to safely do that please follow the instructions below. These instructions also apply to changing the **Idle degree** of the software.

Gather the materials listed below.

- Cotton gloves to protect the piece from your skin oils.
- A compass/phone app or other way to identify where North is.
- 1. Open the GUI, follow the directions specified in <u>"Manual Software Calibration"</u>.
- 2. Disable the Motor and Enable Admin Keys, with the GUI open check the "admin keys" box and uncheck the enableMotor" box as seen in the image below. Or use the admin hotkeys to do this by first pressing A and then pressing X.
- 3. Find North, using a compass or phone app, find which way North is.
- **4.** Move the display to face North, make sure you are wearing gloves for this step. With the motor disengaged you should be able to gently move the display to face a different direction. Move the display so that its screen is pointing towards North.
- **5.** Set the North direction in the software, once the display's face is pointing towards North press **A** to ensure admin hotkeys apply and then press the **N** key on the keyboard. You should see the word "North" snap to the front of the display. The piece is now calibrated to display directions appropriately.

Adjusting Reactivity

Sensor States

As mentioned in the <u>Debug Mode</u> section of the GUI the sensors are capable of reporting three states. **Inactive, Active** and **Triggered**. These definitions are important in understanding how to adjust the reactivity of the piece.

State	Description
Inactive	A sensor is not detecting any movement.
Active	A sensor has detected movement.
Triggered	A sensor has been detecting movement for the sensorTriggerPercent of the motionOnDur variable

Setting Movement Conditions

In order for the piece to react to movement three conditions must be met.

- 1. The number of sensors set in the variable **onSensorNumber** must report a **triggered** state.
- 2. At least two of those sensors must be neighbors.
- 3. At least one of those sensors must have detected motion for the full length of the **motionOnDur** variable.

For example given the following values:

motionOnDur: 1 sensorTriggerPercent: 40 onSensorNumber: 3

In order for the piece to begin moving 3 sensors must have all detected motion for at least 0.4 seconds. Two of those sensors must be next to each other and one of them must have detected motion for 1 second.

A lower **motionOnDur, sensorTriggerPercent and onSensorNumber** value will result in a piece more sensitive to motion and surrounding infrared light fluctuations and vice versa.

Setting Stop Conditions

In order for the piece to stop moving the following conditions must be met.

- 1. The number of **triggered** sensors must be less than the **offSensorNumber** variable.
- 2. The above condition has been true for as long as the time set in **motionOffDur**.

For example if the variables mentioned above have the following values:

motionOffDur: 2 motionOnDur: 1 sensorTriggerPercent: 80 offSensorNumber: 3

Then in order for the piece to stop moving less than 3 sensors must have detected motion for at least 0.8 seconds. When two or less sensors have detected motion for 0.8 seconds a timer begins. When that timer reaches 2 seconds the piece will stop moving if it is in motion.

Preliminary Troubleshooting Steps

If the monitor is not showing an image

Make sure the piece has power. There should be an LED visible on the PCB showing it is receiving power. Make sure the power button on the monitor is pressed, the biggest button on the bottom left part of the display front face. A very dim LED should be illuminated right under the button.

Make sure the other 3 push buttons on the monitor are **NOT** pressed. Try adjusting the 1st and 2nd rotary knobs next to the monitor's power button to change the brightness and contrast.

Ensure that the SDcard on the underside of the Raspberry Pi is inserted all the way and that LED's are visible on the Raspberry Pi.

Check that the video wire from the Raspberry Pi is properly connected to the circuit board and that the video cable between the Raspberry Pi and custom circuit is plugged in. See reference images in <u>APPENDIX I: INSTALLATION</u>.

If the custom video cable is plugged into the circuit board and Raspberry Pi but there's still no video

The custom video cable may be too firmly pressed into the 3.5 mm video port on the Raspberry Pi. Try gently unplugging the custom video cable from this end and slowly reinserting it into the port. Watch the screen for any movement or flickering. If a video signal is acquired without the cable being pressed all the way into the 3.5 mm video port it is acceptable to leave it as long as it will not be easily dislodged.

If the motor seems to be jittering and stuck on something

Turn the piece off and check to see that the metal strip on the gear shaft is able to slide smoothly through the homing sensor. If necessary gently readjust the homing sensor so that this is possible. Look for any other movement restriction before turning the piece back on.

The software is behaving strangely or not displaying the piece

Switch the piece off by turning the switch on the underside of the circuit board to the labeled "off" position. Wait for the piece to properly power down, try securing all connections and then turn the piece back on to fully reboot it.

The piece is moving without anyone interacting with it

Check to see if the piece is near a potentially large heat source. If so, try moving the piece further away from those elements, turning it off for five minutes and then restarting the piece. Refer to the <u>Adjusting Reactivity</u> section of the manual for information on how to make the piece less reactive.

If the keyboard dongle is plugged into the raspberry pi but the keyboard is not working

Restart the Raspberry Pi to allow the operating system to recognize the USB dongle. If this does not resolve the issue make sure the keyboard has batteries and is properly turned on.

Troubleshooting Assistance

Prior to contacting the Antimodular Studio with a problem about your artwork, please ensure that you went through the preliminary troubleshooting steps outlined in the previous section.

The troubleshooting process will vary depending on the problem. In order to make the process easier, it is recommended that you collect and send the following information to the studio:

- Date and time when the problem first happened;
- Description of the problem;
- Actions taken so far and conclusions;
- Detailed photographs (or videos) displaying the problem;
- Detailed photographs (or videos) of the suspected faulty component;
- Detailed photographs (or videos) of the whole artwork and its surroundings;
- Personnel involved.

Support (Contact Us)

If you would like support for the piece, please feel free to call Lozano-Hemmer's studio in Canada:

Antimodular Research 4462 rue Saint-Denis Montréal, Québec, Canada H2J 2L1 Tel 1-514-597-0917 info@antimodular.com www.antimodular.com **APPENDIX I - INSTALLATION**

Description of Components

This artwork requires the following components:

Component	Description
Power Supply	Located under the metal stand, this unit feeds power to the custom circuit and whole artwork.
Metal Stand	The metal base and stand on which the metal head, display stand and display are connected.
Metal Head	Attaches to the stand and holds the stepper motor, IR sensor and related gear shafts, a custom circuit and a Raspberry Pi. The metal stand to hold the display in place is also attached to this section.
Raspberry Pi	Connects to the custom circuit and runs the software used in the piece.
Printed Circuit Board	Custom circuit controlling eight motion detectors, the IR Sensor and the rotation of the stepper motor.
Stepper Motor	Rotates the display.
CCTV Display	Cathode ray tube display used to show the poem for the piece.
Display Stand	Metal stand that bolts the display firmly into place.

Wiring Diagrams and Connections

In order for the piece to run properly, the components should be connected according to the following diagrams.



APPENDIX II - TECHNICAL DATA SHEETS

Power Supply

Power supply used for the entire piece. Is threaded through the hollow shaft of the stand and connects to the power port on the custom printed circuit board.

Specification	Details
Input	120-240V 50/60Hz 1.0A
Output	12VDC 3.3A
Male Barrel Connector	Inner Diameter 2.1 mm / Outer Diameter 5.5, mm Positive lead on center



Metal Stand



Metal Head

A custom metal frame used to hold the stepper motor, gear shaft and IR sensor in place. The bottom plate measures 16cm in length and 9.2cm in width. The height of the frame including the gear shaft is 13.5cm.



Raspberry Pi and Software

At the time of writing this manual, the software operating on the Raspberry Pi is coded under openFrameworks' platform on version 0.9.0 linuxarmv7l release. The software version referred to in this manual is #46 04172024 and runs on a Raspberry Pi 2 Model B. The pinout for this Raspberry Pi can be seen below.

The software cardinal_pi is launched by the script runner.sh which will automatically attempt to restart the software every 10 seconds if it is exited for whatever reason.



Raspberry Pi 2 Model B

microSD Card

The Raspberry Pi contains a microSD card. It is flashed with an image of the Raspberry Pi GNU/Linux 7 Wheezy operating system and the Cardinal Directions software.

If a new microSD card is needed, ensure to use one that has the same amount of bytes or more, otherwise you won't succeed to write the disk image on the new microSD card.

Specification	Details
Manufacturer	Lexar
Model Name	LMSESXX032G-B5AAA
Minimal Capacity Required	32 000 000 000 bytes (32 GB)
Class	Class 10 / V10
File System	Windows FAT 32. If formatting a new card with an OSX computer, ensure to keep the card's partition map schemes as Master Boot Record, not GUID or Apple Partition Map.

Custom Video Cable

A custom cable connecting a female 2 pin Tyco connector to a 3.5 mm 4 pole male aux connector. This cable should not be replaced without first contacting the studio.



Custom Video Cable

Pinout

Specification	Details
Video signal	Video ring as seen in the image above labeled "pinout"
Ground	Ground as seen in the image above labeled "pinout"

Printed Circuit Board



Front

Back



Board circuitry

Schematics



BOM

Designator	Quantity	Description	Part Number						
POWER0,VIDEO _IN0	2	CONN HEADER VERT 2POS 2.54MM	Molex 0022232021						
SLIP0	1	CONN HEADER VERT 6POS 2.54MM	TE Connectivity AMP Connectors 640445-6						
HOME_SENSOR 0	1	CONN HEADER VERT 3POS 2.54MM	Molex 0022232031						
мотоо	1	CONN HEADER VERT 4POS 2.54MM	Molex 0022272041						
ENCODER0	1	CONN HEADER VERT 5POS 2.54MM	Molox 0022272051						
EPIR0,EPIR1,EPI R2,EPIR3,EPIR4, EPIR5,EPIR6,EPI R7	8	Sensor PIR (Passive Infrared) 275.6" (7m) Module	Zmotion ZEPIR0BAS02MODG						
PCB1	1	RASPBERRY_PI 2	Raspberry Pi SC1029						
PCB2	1	Easyfun stepper motor driver	Sparkfun Electronics ROB-12779						
DC-DC1	1	DC-DC CONVERTER 3.3 v	Murata Power Solution OKI-78SR-3.3						
DC-DC2	1	DC DC CONVERTER 5V 8W	Murata Power Solutions OKI-78SR-5/1						
DC-DC3	1	10W Step down adjustable switching regulator	Dimension Engineering DE-SWADJ						
U\$1	1	SWITCH-DPDT	Omron B3W-4055						
U\$2	1	SWITCH SLIDE DPDT 200MA 30V	E-Switch EG2210A						
R1	1	82K	Yageo RC0402JR-0710KL						
R2	1	100k	Yageo RC0402FR-07100KL						
R3	1	TRIMMER 100 KOHM 0.15W J LEAD TOP	Bourns TC33X-2-104E						
R7,R8	2	215	Yageo RC0402FR-07215RL						
R4,R5,R10,R11,R 20	4	1k	Yageo RC0805FR-071KL						
R11	1	2M	Yageo RMCF0805FT2M00						
R13	1	1M	Yageo RV0805FR-071ML						
R14,R9,R21,R6	4	10k	Yageo RC0402JR-0710KL						
F1	1	PTC RESET FUSE 6V 1.1A 0805	LittleFuse 0805L110SLYR						

Designator	Quantity	Description	Part Number								
C1	1	0.1 µF -20%, +80% 50V Ceramic Capacitor	Samsung CL21F104ZBANNNC								
C5	1	CAP ALUM 1UF 20% 50V RADIAL	Nichicon UVP1H010MDD								
D1,D2,D3	3	DIODE SCHOTTKY 40V 2A SMA	Diodes Incorporated B240A-13-F								
LED2,LED1	2 LED GREEN CLEAR 0805 SMD Visual Communications LSM0805452V										
Q1	1	N-Channel 60 V 4.1A (Ta) 2W (Ta) Surface Mount SOT-223-3	Diodes Incorporated DMN6068SE-13								
Q3	1	TRANS PNP 40V 0.6A SOT23-3	Onsemi MMBT4403LT1G								
Q4	1	TRANS NPN 40V 0.2A SOT23-3	Diodes Incorporated MMBT3904-7-F								
Q5	1	G3VM-61ER SSR	Omron G3VM-61ER								
	5	Female Header 1x2	Adam Tech RS1-02-G								
	1	Female Header 1x3	Sullins Connector Solutions PPPC031LFBN-RC								
	1	Female Header 1x4	Sullins Connector Solutions PPPC041LFBN-RC								
	1	raspberry pi header	SparkFun PRT-14017								
	1	headphone male end for video	Same Sky SP-3541								
	1	rca male plug	SwitchCraft 3501MX								

A ZMOTION $\ensuremath{\mathbb{R}}$ Detection Module II ZEPIR0BxS02MODG is used to detect when people are moving around the piece.



Figure 1. ZDMII Block Diagram (ZEPIR0BxS02MODG)

Figure 2 shows the right-angle version of the ZDMII Module.



Specification	Details
Manufacturer Number	ZEPIR0BxS02MODG
Manufacturer	Zilog
Input Voltage	3.3 VDC

Motor Driver

A Stepper, Bipolar 6 \sim 30V Supply 0.75A 30V Load used to drive the stepper motor. The pinout for this part can be found below.



Specification	Details
Manufacturer Number	ROB-12779
Input Voltage	6 ~ 30VDC (9VDC nominal)

Pin Descriptions

Let's take a look at all of the pins broken out from the A3967 IC on the Easy Driver.

Board Top Pins

If you look across the top of the board, you will see several pins.



They function as follows:

- Coil A+ H-Bridge 2 Output A. Half of connection point for bi-polar stepper motor coil A.
- Coil A- H-Bridge 2 Output B. Half of connection point for bi-polar stepper motor coil A.
- Coil B+ H-Bridge 1 Output A. Half of connection point for bi-polar stepper motor coil B.
- Coil B- H-Bridge 1 Output B. Half of connection point for bi-polar stepper motor coil B.
- PFD Voltage input that selects output current decay mode. If PFD > 0.6Vcc, slow decay mode is activated. If PFD < 0.21Vcc, fast decay mode is activated. Mixed decay occurs at 0.21Vcc
 PFD < 0.6Vcc.
- RST Logic Input. When set LOW, all STEP commands are ignored and all FET functionality is turned off. Must be pulled HIGH to enable STEP control.
- ENABLE -Logic Input. Enables the FET functionality within the motor driver. If set to HIGH, the FETs will be disabled, and the IC will not drive the motor. If set to LOW, all FETs will be enabled, allowing motor control.
- MS2 -Logic Input. See truth table below for HIGH/LOW functionality.
- GND Ground.
- M+ Power Supply. 6-30V, 2A supply.

Bottom Board Pins

There are also pins across the bottom of the board. Their functions are described below.



- GND Ground.
- 5V -Output. This pin can be used to power external circuitry. 70mA max is required for Easy Driver functionality.
- SLP Logic Input. When pulled LOW , outputs are disabled and power consumption is minimized.
- MS1 Logic Input. See truth table below for HIGH/LOW functionality.
 GND Ground.
- STEP -Logic Input. Any transition on this pin from LOW to HIGH will trigger the motor to step forward one step. Direction and size of step is controlled by DIR and MSx pin settings. This will either be 0-5V or 0-3.3V, based on the logic selection.
- DIR -Logic Input. This pin determines the direction of motor rotation. Changes in state from HIGH to LOW or LOW to HIGH only take effect on the next rising edge of the STEP command. This will either be 0-5V or 0-3.3V, based on the logic selection.

Stepper Motor

HT17-275 NEMA 17 High Torque Stepper Motor.



Specification	Details
Manufacturer	Applied Motion Products
Model Number	HT17-275
Maximum Radial Load	6.6 lbs
Weight	0.8 lbs
Shaft Diameter	0.2 in
Step Angle	1.8 deg

	APPROVED	J. KORDIK	J. KORDIK	J. KORDIK	J. KORDIK	J. KORDIK	J. KORDIK	J. KORDIK	L. LIU	K. KESLER													CW		 			_	NO		10TOR		
	DATE	8/28/09	12/10/09	3/10/10	1/26/16	6/6/16	4/22/19	7/3/19	6/15/21	01/18/24													VFI & C	RED/WHT			+		kwise) rotati He motor		STEPPER N		
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REV **_**

BIZE DWG. NO. HT17-275 SCALE: 1:1

E.MERINO

AP: 4611110029089

ALT DWG. NO. ALT SAP:

SHEET 1 OF 2



IR Interrupter

Small custom machined metal piece used to interrupt the IR sensor and allow the motor to return to the home position. Distances are in millimeters.





IR Sensor

Custom IR sensor circuit board using an Optical sensor slotted with PC pins.



Circuit Schematic



Completed Circuit

Specification	Details						
Manufacturer	Isocom Components 2004 LTD						
Part Number	H21A3						
Sensing Distance	3 mm.						
Sensing Method	Through-Beam						
Output Configuration	Phototransistor						
Current - DC Forward (If) (Max)	50 mA						
Current - Collector (Ic) (Max)	20 mA						
Response Time	8µs, 50µs						

IR Sensor Support Bracket



Custom 90 degree bracket that allows for the IR sensor to be adjusted slightly if needed.

Slip Ring

Allows the wires going to the display to be threaded through the custom hollow shaft and connected to the board.



Specification	Details
Manufacturer	Моод
Model Number	AC6023-6
Channels	6-channel
Number of Revolutions	250 RPM
Connection Cable Length	304.8mm

Custom Shaft

A hollow shaft through which the wires going to the display are threaded.

Specification	Details
Length	12.5 cm
Outer Diameter	12 mm
Inner Diameter	5.6 mm
Material	Steel

Gear Head

The gear head is part of the rotation mechanism in the metal head. It is attached to the custom shaft and looped around by the timing belt. One or two small holes are drilled into the face to secure the IR interrupter.



Specification	Details
Manufacturer	Martin
Part Number	48XL037
Material	Steel
Teeth	48
Pitch	0.2 in.
Belt Width	0.3750 in.
Bore Diameter	0.3125-1.1875 in.
Outer Diameter	3.036 in.

Timing Belt Pulley

A part of the rotation mechanism in the metal head. The timing belt pulley is attached to the motor shaft and used to secure the timing belt.



Specification	Details
Manufacturer	Martin
Part Number	28XL037
Material	Steel
Teeth	28
Pitch	0.2 in.
Belt Width	0.3750 in.
Bore Diameter	0.2500-0.9375 in.
Outer Diameter	1.763 in.

Timing Belt

A part of the rotation mechanism of the metal head. The belt is looped around the timing belt pulley and the gear head and pulled taut by the belt tightener. It is a PowerGrip® 9257-1373 Industrial Timing Belt - XL - Extra Light Duty



Specification	Details
Manufacturer	Gates
Part Number	136XL037
Material	Neoprene
Teeth	68
Pitch	0.2 in.
Width	0.375 in.
Length	13.6000 in.

Belt Tightener

A part of the rotation mechanism of the metal head. The belt tightener sits on the Metal Head and puts tension on the timing belt. It is constructed from the following components.

- Ball Bearings
 - These allow the belt to slide smoothly and are NSK 626Z Deep Groove Ball Bearings
- Screw
 - This is the shaft of the belt tightener and is a .25-28 3.5cm stainless steel tensile strength 70. 30 mm in length.
- Nuts
 - Secures the belt tightener on the top and bottom of a metal lip in the metal head. There are two nuts, both 25-28 3.5cm stainless steel tensile strength 70.



Belt Tightener highlighted on the fame

Display

A 5.5 inch cathode ray tube display screen model number MO557111B. In normal operation the power button should always be pressed inwards, while the camera input switch, mode switch and day/night mode switch should be in the "off" position not pressed inwards. The contrast and brightness knobs can be adjusted based on lighting conditions.



Specification	Details
Input Voltage	12-32 VDC
Power Consumption	10.5 W
CRT tube dimensions	5.5" diagonal

Car Rear Viewer

Operating Instruction



5.5-Inch Car Rear Viewer



System Features

5.5" Military-type Phosphor Cathode Ray Tube(CRT) Wide voltage input adaptability: 11~32V DC 2 channels of audio/video input, 1 channel of audio/video composite output Power/Stand-by mode option Normal/Mirror image switch Day/Night lightness option Near Sunlight-readability Double-sided PCB board for efficiently increasing anti-vibration ability (6.8G) Contrast, brightness and volume adjustment Built-in speaker Adjustable Mounting Bracket

Sun shield included

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SYSTEM INSTALLATION GUIDE

This monitor can be mounted by embedding to the dash area, hanging from the truck roof or seating to any position which is suitable to the driver to observe the images.

Mounting monitor

- 1. Select a position to mount the monitor
- 2. Well position the monitor support, mark the fixing hole position and drill fixing holes
- 3. See Fig.1, put spring lockwasher on mounting screw to fix the monitor support
- 4. See Fig.2, fix the monitor to the support with 4 angle adjustment screws
- 5. See Fig.3, connect cables according to port connection diagram

Connecting power cable

- 6. See Fig.4, Connect one end of the power cable(wire) to the right position on the dashboard
- 7. connect the other end of the power cable(plug) to the monitor

System connecting

8. See Fig.4, connect the monitor and the camera with the system connecting cable.

You can link the monitor with at most 2 channels of cameras and 1 channel of video/audio output

(AV signal cable can be selective purchase)

WARNING

Electrical shock or fire hazard. Do not try to service this unit yourself. Service should be handled by qualified technicians.

PORT CONNECTION DISPLAY



- 1. Video output
- 2. Camera1 input
- 3. Camera2 input
- 4. Audio output
- 5. To exterior speaker
- 6. Normal/Mirror image switch

Detail of ports



① GND (ground) 2 Power of camera ③ Video input ④ Audio input



Turn the switch from up to down can switch the image

Port 6/MIRROR



Port7/POWER

display from mirror to normal.

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(5) Black to ground (GND) 6 Red to power supply Orange to reversing light [®] White to dimmer



TECHNICAL SPECIFICATIONS

The technical specification of monitor is listed below

Serial Number	Item	Specifications
+	Display device	5.5" CRT
2	Deflection angle	70°
3	Input voltage	11~32V(DC)
4	Output voltage	10V(DC)
5	Power consumption	Max.1A
9	Scanning frequency	CCIR:(H)15625Hz/ (V) 50Hz EIA:(H)15750Hz/ (V) 60Hz
7	Video input	Composite video signal 1Vp-p 750hm
8	Video output	Composite video signal 1Vp-p 750hm
6	Horizontal resolution	420 TV lines at maximum
10	Field resolution	420 TV lines at maximum
11	Anti-vibration capability	6.8G
12	Camera port	4-pin DIN socket
13	AV port	RCA socket
14	Storage temperature	-25° C~+70° C
15	Operating temperature	-0° C~+60° C
16	Dimensions	160(W)x147(H)x143(L)mm (without support and sun shield)
17	Parking dimensions	293(W)x268(H)x200(L)mm

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NOTICE

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NOTICE The manufacturer reserves the right to change the specifications without notice.

TROUBLESHOOTING

Solve problems according to the table below

Symptom	Cause	Solution
Rolling image	Monitor(horizontal control)	Replace monitor
Shrunk & Unstable image	Monitor improper voltage	check the voltage of power supply
Black image	Monitor improper voltage	if ok, check fuse->check power cable, wires or connector(loose or broken?) If all above item are ok, replace monitor
White image	Monitor/Camera	Check main system cable. Make sure all connectors are connected properly. If ok, check 4 pin DIN monitor cable. If ok, replace camera
Blurred image	Fog, mud, water or ice on camera lens or porthole moisture in camera	Clean camera porthole. If condensation or moisture is visible inside camera, initiate device immediately.
Engine noise or Static lines	Monitor	Make sure ground and +12V DC source is in solid connection. Call tech-support for assistance
No light displayed on monitor	Broken fuse or low bright- ness level	Check whether the fuse is broken or brightness adjustment has been turned to the lowest level
No image	Improper plugging in connector or broken system connecting cable	plug the connector properly or replace the system connecting cable

If you still can not solve the problems, contact our tech-support engineer for assistance.

WARNING

Electrical shock or fire hazard. Do not try to service this unit yourself. Service should be handled by qualified technicians.

6

Display Stand

The custom support system for the display screen model number MO557111B. Comes with monitor support and adjustment screws.





APPENDIX III - ASSEMBLY OF THE PIECE



Close up of the Display, Display stand, metal head and circuit not connected to the stand.



Close up of the video cable and the metal head connected to the stand.

Cardinal Directions is powered by a single 12 VDC, 3 Amp, 120-240V auto switching power supply. Consult the wiring diagram in <u>APPENDIX I - INSTALLATION</u> for a general idea of how the elements connect.

When installing, ensure that the <u>Placement Instructions</u> have been followed carefully. If not already in place, fish the power cable ending in a female 2 pin Tyco header through the hollow shaft of the metal stand.

Once a spot has been selected you may need to attach the custom circuit to the metal head. If this is necessary consult the images in <u>Printed Circuit Board</u> to identify the relevant connection points for the various wires from the metal head. Using the reference images below, carefully attach each connector.



View of the Encoder Connector

View of Video Connectors



Side view of connectors.

Once the metal head is ready to be placed on the stand donn gloves and carefully place the ends of the large screws through the holes in the top plate on the metal stand. Consult the images below for reference. Once firmly situated, tighten the endcaps firmly so that no rattling or movement is observed when the motor is running.





Top plate on metal stand

Endcaps of metal head

APPENDIX IV - REPAIRS/ADVANCED MAINTENANCE

If the Raspberry Pi is unable to successfully boot up when power is supplied it may be necessary to reimage the microSD card. A backup image can be found on a collector USB or by contacting the studio. Any standard imaging software can be used to reapply the image to the microSD card. Upon restarting with a newly flashed image the software should begin functioning automatically.

APPENDIX V - PACKING

When packing this piece for shipment the metal head and display should be detached and packed separately from the metal stand. The display in particular is delicate and should be foam packed and wrapped in antistatic plastic. View the image below as an example.

*** Note that some previous versions of the artwork got packed as a whole, with support for the head. In such a case, you can use the original packing methods or choose to pack the head separately as described here.***



The metal head and display foam-packed separately.