Electronics Online Challenge 2020

Samsung POWERbot R7070 Robotic Cleaner

By Middle School Team:

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Final Summary Report

We disassembled a Samsung POWERbot electronic vacuum for the Texas Instruments Electronics Challenge. We chose to disassemble the vacuum because we would learn about more modern technology. Learning about modern technology would be more useful in the real world, because everything nowadays is more digital and less mechanical. We would also have a better chance of applying what we learned to build our own robots that do tasks.

There are buttons that control the menu screen and programs, and another for popping out filters. After we removed the battery to prevent electric shocks, we moved on to the roller brush. After unscrewing screws under the roller brush, we noticed the top and bottom coming loose, then tried to remove it. There were a few connected wires but we disconnected them.

The circuit board that was the LCD reacts to the buttons and allows you to control the robot. There were bumper sensors on the inside (Dongnan KW4A(S) switches). We then detached some wires and screws, then the wheels. The wheels had the label Samsung DJ63-01565A on the housing, and DJ92-00154A motors that powered the wheels, which had springs that allowed them to go over different surfaces and not get stuck. Some other wires connected to a Samsung DJ97-02492A motor which was used to create the vacuum's suction.

We found another circuit board after unscrewing the main circuit board, which controlled the dust shield at the front of the robot. We deduced that the shield retracts when vacuuming carpets, and extends when it's on harder floors for sweeping dust assistance. There was a plastic bumper that pressed the bumper sensors, and a funnel piece that collects dirt from the roller. After that, we discovered wires at the front circuit board connecting to parts that included sensors such as cliff and distance sensors, motors, cameras, and the main PCB. Behind the camera we found the Allwinner A20 CPU and an AXP209 PMU (power management unit) chip.

In total, we found 4 motors for the wheels, the brush, the fan, and the shield, 6 LED distance light sensors, one upward facing mapping camera, one forward camera, 5 cliff sensors, one sensor to detect when it's up/down, 1 main battery, 5 bumper sensors, one LCD control panel, one A20 CPU, and one dust bucket with filter. The only manufacturer names we saw were "Dongnan" on the bumper switches, "Atmel" LCD semiconductors, "Allwinner Tech" CPU, and "Samsung" PCBs.

From this experience, we learned that capacitors store strong but brief electrical charges and can shock you at high voltage, even when the battery is disconnected. We also learned that many machines today, like the POWERbot,

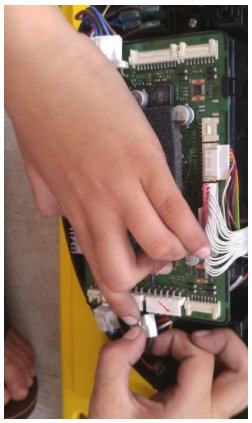
also have ports that connect the main circuit board to motors and sensors, just like in VEX IQ. Another thing learned was that many machines today use similar sensors that we use in VEX IQ, like bumper, distance, and LEDs.

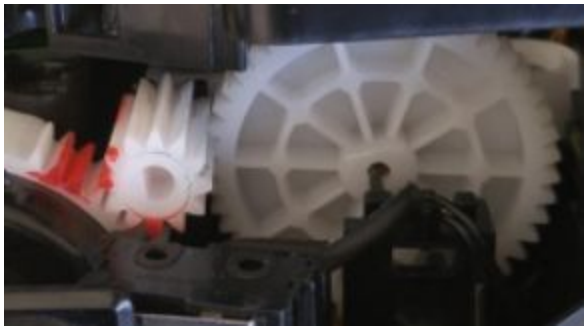
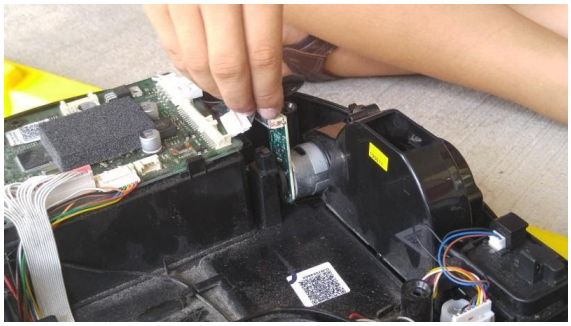
Total words: 481

Photo Addendum:

Disassembly Procedure

	*Step 1: Team members unscrew the cover of vacuum*
	*Step 2: Lift upper casing to observing internal components*
	*Step 3: Remove wheels*

	*Step 4: Checking Printed Circuit Board (PCB)*
	*Step 5: Examin PCB, identify parts and ports*
	*Step 6: Team member disconnects a port on the main PCB and tries not to touch capacitors*

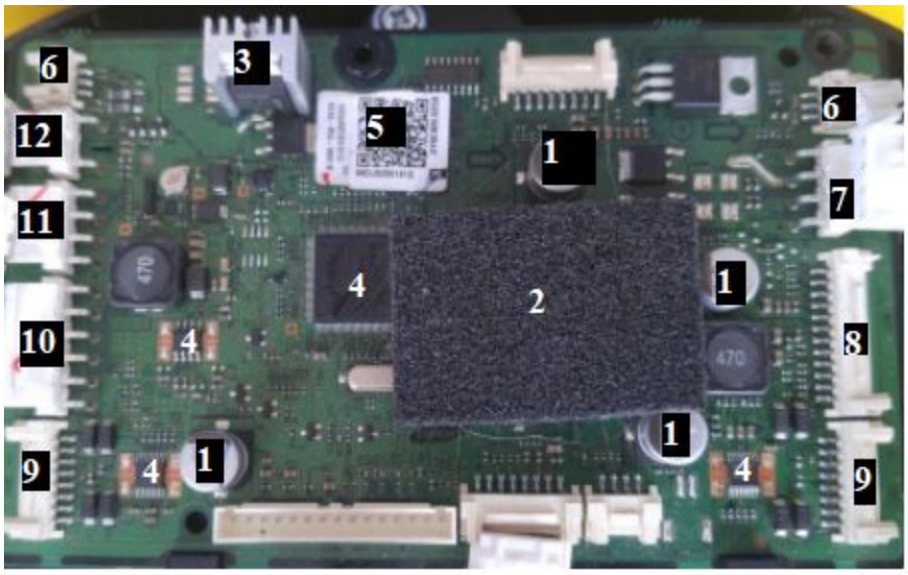
	*Step 7: Team sees gear ratio used in real life not only in Vex IQ robots*
	*Step 8: Team removes the parts next to the shield flaps*

Circuit Component Identification and Analysis

Circuit Boards

Figure 1.0 Motherboard/main PCU

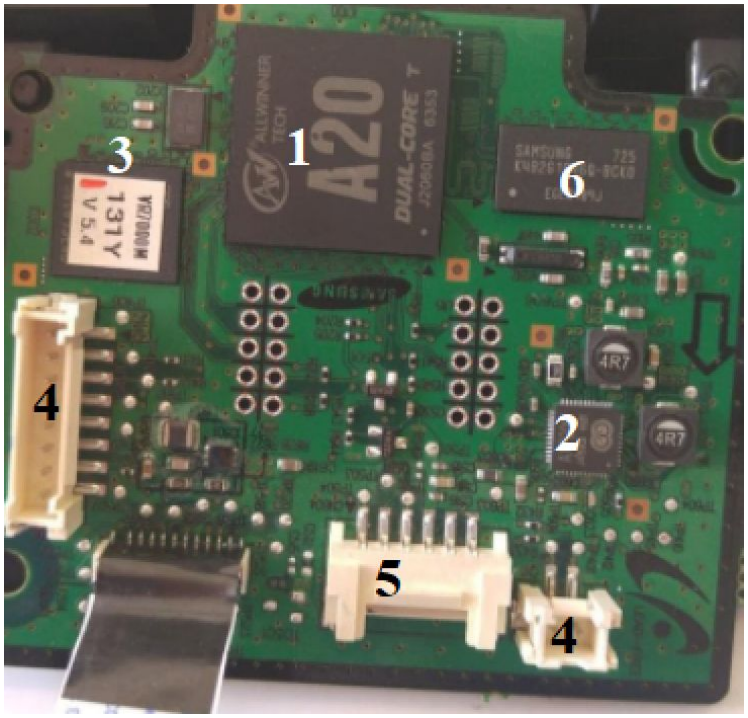
This circuit board is the motherboard that connects to the motors and the LCD. This board tells all the motors what functions to perform.

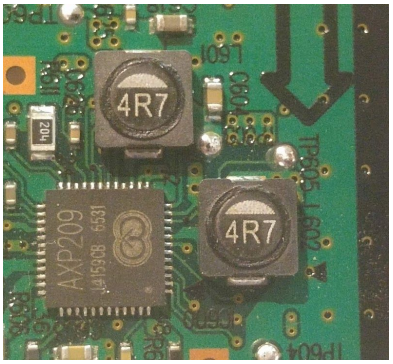


1) Capacitors
2) Circuit board pushing sponge
3) Heat vent
4) IC
5) QR code
6) Distance sensor ports
7) On/off switch port
8) LCD scree port
9) Wheel motor ports
10) Vacuum motor port
11) Battery port
12) Front-power port

Figure 1.1 Control Module behind the camera

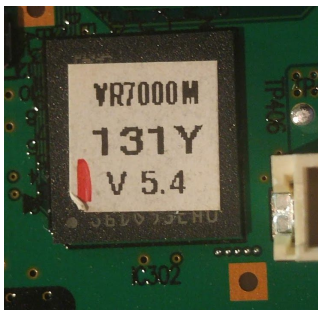
This Samsung circuit board contains the Allwinner A20 CPU that does all the logic and arithmetic of the robot and an AXP209 PMU.





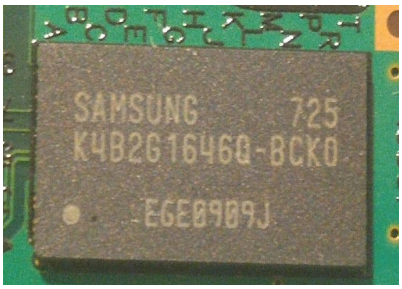
2. AXP209 PMU

It is interesting to see not all ports are connected (numbers 4 - 6 in the diagram below); team members think it might be used for upgrading models for future



3. Wireless modem

1. Allwinner A20 CPU



6.Samsung k4b2g1646q-bck0 semiconductor

Figure 1.2 Liquid Crystal Display Circuit Board

This circuit board connects to all the buttons on the screen and sends info to the motherboard

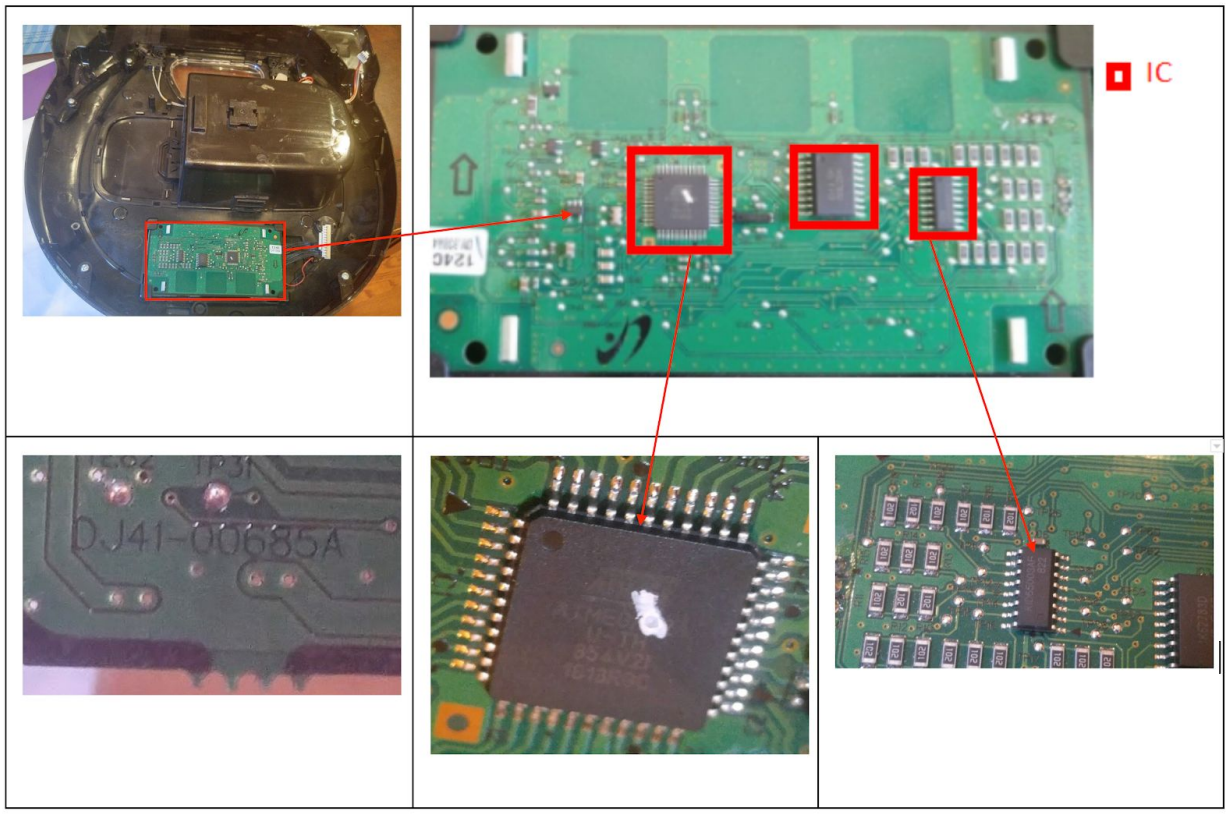
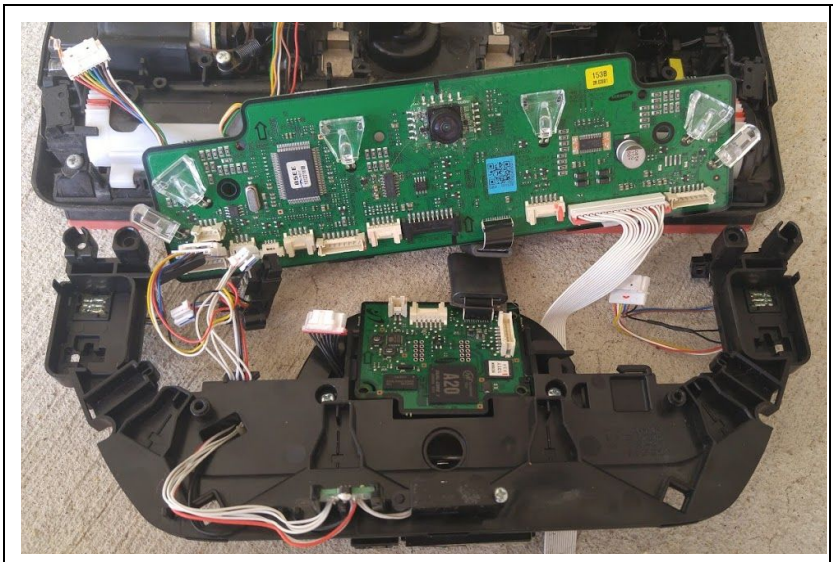
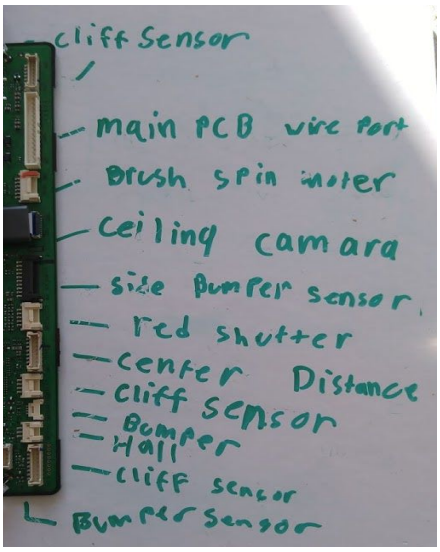
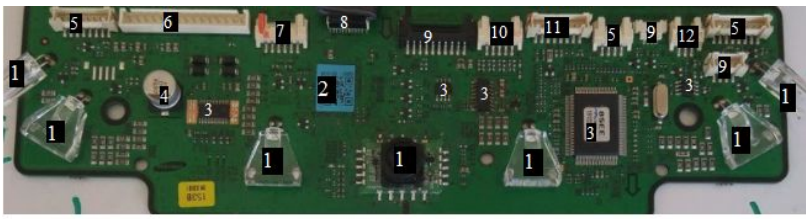


Figure 1.3 Sensor Array -*This circuit board contains some of the sensors that the robot uses to navigate its surroundings*







1) Sensors (listed below)
2) QR code
3) IC
4) Capacitor
5) Cliff sensor ports
6) Main PCB port
7) Brush motor port
8) Ceiling camera port
9) Bumper sensor ports
10) Red shutter motor port
11) Distance sensor port
12) Hall sensor port

Ceiling Camera used to map the room

Cliff Sensor to avoid falling down steps.

Product External

Figure 2.0 Top View 	*From above, we see the ceiling camera, Cycloneforce dust bin, and LCD control buttons.*
Figure 2.1 Bottom View 	*The bottom shows the wheels, the yellow switches that lock the roller in place, and the roller brush.*

Researching Process

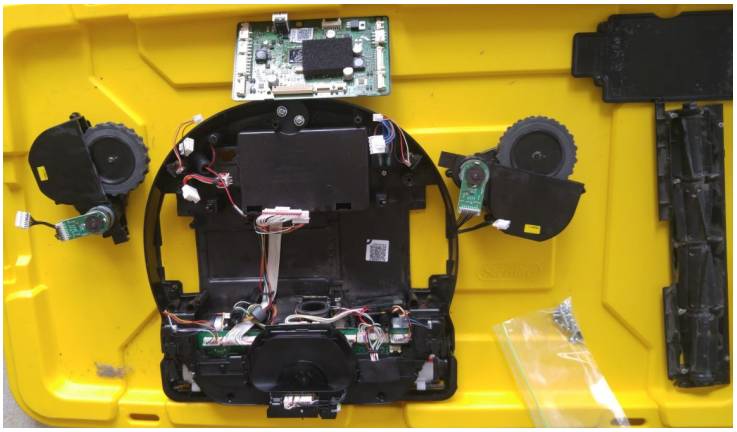
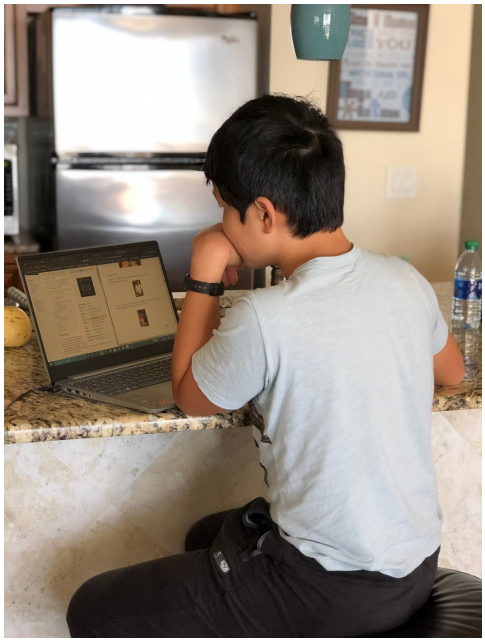
Figure 3.0 Removed individual components for observation and predicted the use 	*Team members take apart the vacuum robot.*
	*Internal robot parts all laid out for research process*

Figure 3.1 Researched part names and functions 	*A team member is researching information on the A20 CPU.*

Mechanical Parts

Figure 4.0 CycloneForce filter and dust holder cup 	*This is the filter that holds all the dust swept up.*
Figure 4.1 VCA-RBT71/XAA 10W POWERbot Battery 	*This piece is connected to the motherboard by a port clip and powers the robot.*
Figure 4.2 Outer Casing 	*This is like the frame of a robot that stabilizes and protects all the other parts.*

Figure 4.3 Roller blade 	*This piece rotates and picks up dust*
Figure 4.4 DJ63-01565A Wheel housing with DJ92-00154A circuit and motor.(Qty: 2 each) 	*The motor and wheel connect to the motherboard and allows the robot to move on two motorized wheels.*
Figure 4.5 DJ97-02492A Fan Motor 	*This fan motor creates the suction used for sucking up dust.*

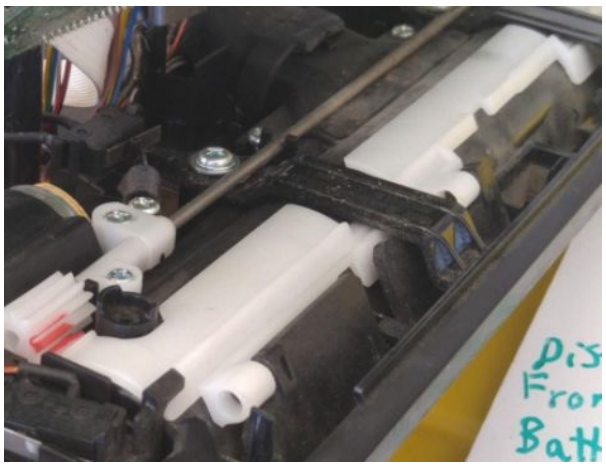
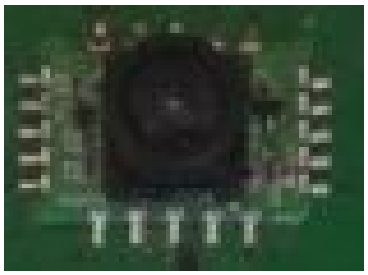
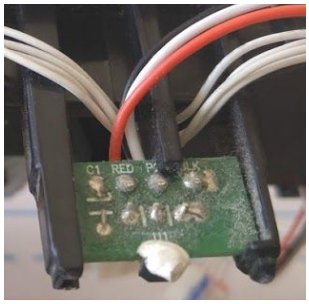
Figure 4.6 Bumper and small gear 	*The bumper, when pressed, presses one or more of five bumper sensors, telling the robot to turn. The gear controls the shield flaps.*
Figure 4.7 Dirt Funnel 	*The dirt is sucked up the funnel and passed through the filter*
Figure 4.8 Shield Flaps 	*Lowers or raises a red bar to detect carpet or hard surface cleaning.*

Figure 4.9 Electric Motor 	- *Drives the brush rollers that pick up the dust and dirt*

Sensors

Figure 5.0 Dongnan KW4A(S) Bumper Switch(Qty: 5) 	*Is connected to the plastic bumper piece and tells the robot to turn when it hits and object*
Figure 5.1 Big LED distance sensor (Qty: 4) 	*LED distance sensors allow the robot to gauge how far it is away from a wall and sends info to the CPU to be processed.*
Figure 5.2 Small LED distance sensor (Qty: 2) 	*See Fig. 5.1*

Figure 5.3 Ceiling Camera 	*Helps the robot map the room.*
Figure 5.4 Front mapping sensor and cliff sensor (Qty: 5) 	*The map sensor maps ceilings and lets the robot operate more smoothly. Cliff sensors tell the robot if it's on an edge to avoid falls.*
Figure 5.5 Hall Sensor 	*Senses if the red brush bar is up or down so it knows if it is on carpet or hard floor.*

Citations

Processor

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http://www.allwinnertech.com/uploads/pdf/20190404102543df.pdf

Power management chip

https://linux-sunxi.org/AXP209

Switch

https://www.switch-china.com/product/9.html

Motors

https://www.tvserviceparts.com/Samsung-DJ97-02492A.html
https://www.ebay.com/itm/Samsung-Powerbot-R7xxx-Vacuum-Wheel-Assembly-RIGHT-Wheel-DJ92-00154A/203091290166?hash=item2f492f2836:g:WogAAOSwVOBfSUok

Battery
https://www.amazon.com/Samsung-Electronics-VCA-RBT71-XAA-POWERbot/dp/B0793FPL8G

Integrated Circuit
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