A MINDSTORMS Bug That Will Bug You No More

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The much anticipated LEGO MINDSTORMS EV3 came out in fall 2013. A few months into using the product, FIRST LEGO League teams, such as ours, began running into an unusual error message. The most common symptom was that the robot would suddenly stop, emit an error sound, and display "VM Program Instruction Break" on the screen.

There was no documentation available on this error and, therefore, no easily implementable solution. For us, the error first emerged when combining multiple smaller programs into a menu system. We reported the error on the FIRST LEGO League forum in fall 2013. It was followed by others also reporting the same error. Everyone started speculating as to the cause of the error. For those familiar with programming on the EV3, the cause was generally attributed to having too many named loop blocks or too many My Blocks in the code. However, this did not fit our own situation or those reported by many others. We continued to see this error message every once in a while.

Dozens of FIRST LEGO League and WRO (World Robot Olympiad) teams, and individual robot builders, continued to report this error e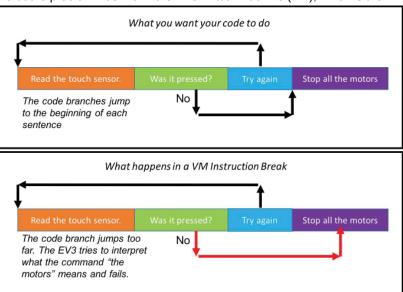ven in 2015. There was no concrete solution available. Whenever the error cropped up, programmers mostly resorted to trial-and-error changes to their code to make it go away.

In the summer of 2016, there was renewed interest investigating the underlying causes of the "VM Instruction Break". Several MINDSTORMS Community Partners (MCPs), including David Gilday (mindcuber), Michael Dobson (6-axis Robot Arm), and Thomas Madeya (Tower of Hanoi remix) had all encountered this error in projects they were working on. MCPs Asha Seshan and Martyn Boogaarts were both familiar with FIRST and WRO teams in the community who had encountered this error. Led by David Gilday, they gathered sample code with the error. The code was used to find similarities and isolate the cause of the error.

The term "VM Program Instruction Break" suggested that the problem was within the EV3 Virtual Machine (VM), which is the part of the EV3 firmware that actually runs your downloaded code. However, the problem was actually in the software running on the personal computer that generated the code. Using the samples, Gilday was able to narrow down the problem to how branches, which make code jump to a new location, were generated. The image above illustrates a simplified view of what was going wrong. In the top example, the code moves correctly to the start of each sentence. In the bottom example, the branch jumps too far, making the next sentence incomprehensible to the EV3.

By working together, MINDSTORMS Community Partners, FIRST teams, WRO teams, active builders in the community, LEGO and National Instruments were able to identify the error and provide a solution. It is expected that LEGO's newest version of the EV3 software (v.1.2.2) will eliminate this error.
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