

Microsoft Makecode for Micro:bit based on Programming Experience Toolkit

A framework for creating programming interfaces for Micro:bit and extension in Typescript

Making Wonders

By Ashish Neupane, ECE '19

Introduction

Microsoft Programming Experience Toolkit (PXT) is a framework for creating special-purpose programming experiences for beginners focused on computer science education. PXT was written in C++ and TypeScript, which is a superset of Javascript used for application scale development. The Github repository is available open-source under the MIT License [1].

Microsoft Makecode is an open source web-based environment based on PXT for programming physical computing devices like the Micro:bit [2]. It allows for extensions to the interface in form of new blocks and features. The system runs entirely within the browser without any software installation. Similar to PXT, the Github repository is open-source under the MIT License [3].

These open source tools provide a platform for developers to build programming interfaces focused on computer science education with a goal of making programming fun and accessible for beginners.

Evolution

One of the key things to look out for when searching for a good open source tool is its maintenance history. PXT is well maintained by Microsoft and open source contributors on Github through issues and pull requests. The framework for *pxt-microbit* was first released in 2017 and after some beta-testing, patches, and updates, version 1 was released in October 26, 2018 [3].

Features

The framework hosts a number of features including a block-based code editor, text editor with IDE tools, converter from block code to Javascript, extensibility to

define new blocks, command line tools for developers, machine code emitter, and more[4].

Block Editor

The block editor is based on Google Blockly, which is a Javascript library for creating visual block programming editors. The popularity of Blockly means users familiar with any block based interface like *Scratch* can easily start coding in the web-based interface. Makecode also supports translation of block code to Javascript with a single click of a button, which can be extremely useful for beginners to transition from the intuitive block based platform to a more advanced text editor platform.

Text Editor

The text editor is based on Cloud9 ACE, which is a popular embeddable code editor in Javascript. It targets intermediate level users seeking a new challenge beyond block based coding to transition into text based coding. The editor supports the common features provided by modern Integrated Development Environment(IDE) including auto-suggest, auto-correct, auto-complete, parameter hints, and more.

Command Line Tools

PXT provides a command line interface to facilitate fast prototyping in an environment familiar to developers. Tools include installation to install the framework(*pxt install*), compilation of added extensions(*pxt build*), deployment to a local server for debugging(*pxt serve*), and package management to install packages written by open source contributors(*pxt staticpkg*).

Machine Code Emitter

With a click of the Download button, it compiles the block-based/Javascript code to binary machine code in a

‘.hex’ file, which can then be uploaded to the device via a USB port. The machine instruction set used is ARM Thumb compatible with Micro:bit. This allows developers to focus on the design of the interface.

Extensibility

Extensions can be added in the form of new blocks, or edits to the existing set of features tailored for the target extension. The extension should be in a public Github repository with code in typescript(Figure 1a), and a pxt.json file indicating the files to compile(Figure 1b). The extension can then be used by anyone by navigating to add extension under advanced in the Makecode editor.

```

//% weight=100 color=#0bc111 icon="🤖"
namespace <extensionName> {
  /* Block One hint
   * @param arg
   * //% block:"block description"
   * export function BlockOne(arg: Type): void {
   *   // do stuff
   * }
  /* Block Two hint
   * @param arg
   * @return output
   * //% block:"block description [input %arg]"
   * export function BlockTwo(arg: Type): Type {
   *   // do stuff
   * }
}
  
```

```

{
  "name": "Cue",
  "description": "Cue Robot extensions",
  "files": [
    "README.md",
    "*.ts"
  ],
  "icon": "icon.png",
  "public": true,
  "dependencies": {
    "core": "file:../core"
  },
  "installedVersion": "cueversion01"
}
  
```

Figure 1. (a) Sample Typescript code, (b) Sample json dictionary

What we are using it for

BBC’s Micro:bit has gained popularity in classrooms around Europe in the last few years. Wonder workshop, our sponsor, want to tap into that popularity by creating an experience for beginners in computer science using their product Cue as an extension to use with the Micro:bit. We used Makecode to build a common coding platform for the two physical devices (Figure 2).

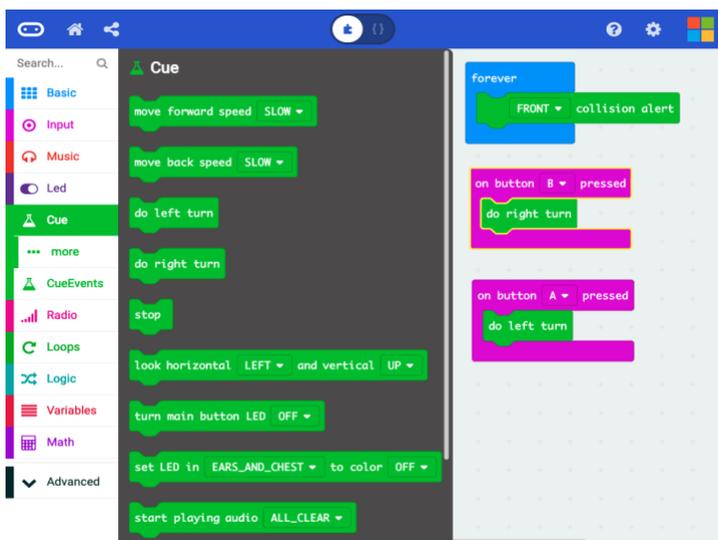


Figure 2. Interface built by extending Makecode Micro:bit for Cue Robot

Challenges

The framework has a small barrier of entry for developers familiarity with Javascript including coding in Typescript, and installing packages with node. The well documented installation page on the Github repository [3] makes sure of that. The features and functionalities are documented well in [4] and there is tutorials available from Lancaster University online. As with any API usage, one of the minor challenges is figuring out the most effective way to implement features without tapping into the underlying framework itself.

Conclusion

Microsoft Makecode is a simple open source tool to use for adding extensions to Micro:bit. The underlying framework PXT is another great tool to create programming experiences for beginners without having to worry about the nitty-gritty details of writing a programming language, which can be challenging if attempted without dependencies.

References

[1] Microsoft, “PXT - programming experience toolkit.” [Online]. Available: <https://github.com/Microsoft/pxt>

[2] T. Ball, J. Bishop, and J. Finney, “Multi-platform computing for physical devices via Makecode and CODAL,” in Proceedings of the 40th International Conference on Software Engineering: Companion Proceedings, ser. ICSE ’18. New York, NY, USA: ACM, 2018, pp. 552–553. [Online]. Available: <http://doi.acm.org/10.1145/3183440.3183463>

[3] Microsoft, “A blocks / Javascript code editor for the Micro:bit built on Microsoft Makecode.” [Online]. Available: <https://github.com/Microsoft/pxt-microbit>

[4] Microsoft, “Makecode(PXT) documentation.” [Online]. Available: <https://makecode.com/docs>