UNIVERSITY of York

BEng/MEng Degree Examinations 2019/20

DEPARTMENT OF COMPUTER SCIENCE

Embedded Systems Project (EMPR)

Open Group/Individual Assessment

Issued: Wednesday, Week2, Spring Term 2020

Submission and Feedback due:

Embedded Systems Project Software Submission [5%]
15th Jan → 15th Mar (Spr/2/Wed → Spr/10/Wed)
Marks & Feedback Due: 15th April

Project Demonstration [40%]
15th Jan → 13th Mar (Spr/2/Wed → Spr/10/Fri)
Marks & Feedback Due: 11th April.

Project Report [55%]
15th Jan → 29 April (Spr/2/Wed → Sum/3/Wed)
Marks & Feedback Due: 29th May

All electronic submission deadlines are 12 noon on the last day of the assessment period. Assessment by demonstration is to be held at a time slot allocated in Week 10 spring term.

All students should submit their work through the electronic submission system http://www.cs.york.ac.uk/student/assessment/submit/

Exam numbers should be the only identification used for work submitted electronically. Do not include names or names of team members in your submissions except where stated in this document *.

An assessment (or part of an assessment) submitted after this deadline will be marked initially as if it had been handed in on time, but the Board of Examiners will normally apply a lateness penalty to the whole assessment.

The feedback and marks date is guided by departmental policy but, in exceptional cases, there may be a delay. In these cases, all students expecting feedback will be emailed by the module owner with a revised feedback date. The date that students can expect to see their feedback is published on the module descriptor: http://www.cs.york.ac.uk/modules/

Your attention is drawn to the Guidelines on Mutual Assistance and Collaboration in the Departmental Statement on Assessment: http://www.cs.york.ac.uk/student/assessment/policies/#AcademicMisconduct

Any queries on this assessment should be addressed to Dr Crispin-Bailey, chrisb@cs.york.ac.uk Answers that apply to all students will be posted on the EMPR webpage.

* for example, for signed meeting minutes you can disregard this requirement, see also table-6 comments.

EMPR ASSESSMENT 2019-20

This year's EMPR assessment will be based on implementation on an MBED system board, PC, and a specialised X-Y-Z 3-axis sensor platform. The platform allows an RGB sensor to be scanned across a surface (e.g. a piece of paper), and the image content of that object to be analysed using that sensor. Surface scanning only requires X/Y axes, but a third Z-axis allows additional actions such as a retractable pen to be used. A system will be implemented which uses the described platform to scan sample images, and perform various tasks with the resulting data. A user interface will be implemented on the MBED board to control the system, and a PC based module will be required to provide a secondary interface. A significant degree of independent working is expected, researching operating requirements of components, finding and studying the most up-to-date datasheets, and so-on. The project goals are divided into two distinct working sections:-

- The **group** component, worth 30 demonstration marks, is to be undertaken in groups of three or four students, unless otherwise specified by the tutor (according to exceptional situations). Full cooperation and collaboration is permitted within the group for this task. Groups are expected to conduct themselves appropriately and professionally (Appendix 2).
- The **individual** component, worth 10 demonstration marks, is to be undertaken by each distinct team member as a personal endeavour. No collaboration is permitted on this component. Teams are allowed to cooperate in providing essential information about the main group component, where the individual component is to connect/interface to it. It is the team's responsibility to ensure sharing of resource access is appropriate.
- **Further guidance** :- Groups are allowed to agree a collective system specification that facilitates individual project interfacing, however any failure of the group to meet this specification is not to be considered to be a mitigating factor in limiting an individual's component outcome.

Assessment Marks (100 marks { 40 + 55 + 5 }) :-

The explicit project aims and objectives are set out in **Table-1 and Table-2**. The marks are broken into three main parts as noted below:-

Assessment by Demonstration (40 marks {30 + 10 }) :-

- Under normal circumstances, the total mark allocated for the group demonstration will be duplicated for each team member. For example, if Team-5 gains 28 marks in the group project, then each team member will be allocated 28 marks for that component.
- Each student should choose ONE individual component labeled IC1 to IC5.
- Assessment marks are allocated according to **Tables 3 and 4** for work demonstrated as fulfilling the group component and the individual component respectively.

Assessment by Report (55 marks) :-

A written report will be submitted, according to the content and marks defined in **Table-5**. Note that whilst the group project is the larger part of the total marks for demonstration, the individual component is more prominently weighted in the written report.

Archive Submission (5 marks) :-

A fixed 5 mark award is allocated for each individual candidate when they personally upload a set of specified files (see **Table-6** for guidance) by the designated deadline in Spring Term. This includes all group solution code plus your individual code (or circuit diagrams etc. if relevant).

TABLE 1 – TEAM PROJECT SYSTEM REQUIREMENTS

IMPORTANT NOTE – All MBED coding is to be completed using the CMSIS libraries and tool chain. You are not allowed to use any other compiler platforms or libraries unless the tutor authorises this in writing by email or vle.

Care should be given to ensure you can DEMONSTRATE each feature. You will need to make sure you have a way to show each requirement actually works during the live demonstration.

X-Y-Z FUNCTIONALITY [20% OF GROUP PART]	
A1	**A scanning API should be written, to permit control of all three stepper motors. It should be possible to demonstrate its functionality by performing test patterns as defined below,** • *The stepper motors should be operated via the I2C ports provided,* • *Care should be taken to ensure that microswitch end-stops prevent motor overun and belt-strain at the edges of the scanning platform.* • *The X-Y functional test will include scan patterns:* • *(a) A full-size circle* • *(b) A square at the boundaries of the platform* • *(c) You should be able to demonstrate that Z axis can be moved up and down.* • *Tests should be selectable via a user interface on the MBED board.*
A2	**The X-Y Platform should perform a boundary detection setup procedure, such that the edges of the platform are determined automatically by stepping the motors and monitoring the microswitches.** • *The platform will explore the edge boundaries* • *The edge boundaries will be displayed on LCD at the end of the search.* • *Stepping resolution should be at least 16 distinct positions per X/Yaxis.*
A3	***'Manual Move Mode,' : the user should be able to use the keypad or another input device to move all three axes back and forth, whilst the position of each axis is displayed on the LCD panel.*** • *The user can move the x-y position using suitable inputs* • *The Z-axis can be controlled to at least two positions (Up/Down)* • *Response times should be fast enough for reasonable user interaction.*

OPTICAL SCANNING [20% OF GROUP PART]	
B1	**A second manual move mode (Manual Scan Mode) will be implemented, which displays the RGB values instead of XYZ positions during manual movements.** • Operates as per A3 but readout shows RGB values on LCD.
B2	**Raster Scan Mode: your platform will scan the X-Y grid using a raster scan pattern, and display the RGB data.** • RGB data will be displayed on LCD during scanning • RGB data will be sent to PC via USB (this needs to be able to be turned on or off by the user). • Note that you only have to show here that data is being sent. D1 deals with what happens to the data later.
B3	**Color Search: Allows a point in an image of a certain colour specification to be located.** • A raster scan will be performed, • The highest reading for R, G or B (as selected by user) will be located. • The head will move to that final position once it has been identified. For the demonstration you can scan a smaller region than the whole bed, a minimum of 2x2 inches, if a full scan may take an inconveniently long time.

IMAGE RECOGNITION [40% OF GROUP PART]	
C1	**FLAGS OF THE WORLD:** **Your solution must be capable of scanning a set of color flag cards and recognising the identity of the relevant country to which that flag pertains.** • Recognise at least 5 flags out of a set of 10 • Displays the country identity on LCD • recognises a flag within 30 seconds. • There are many options here to gain extra marks. Fast detection algorithms for instance, the range of flags detectable, the ability to deal with scale, and so-on.

EXTERNAL PC FUNCTIONALITY [20% OF GROUP PART]	
D1	**PC DATA LOGGER** **The PC will be able to receive RGB data from the mbed board, along with**

	tracking of coordinate data. • The way coordinates are tracked may vary, you can send X,Y for every pixel, or use tags to indicate new line and number of pixels per line, for example. • You may choose not to transmit coordinates but track them on the PC.
D2	**PC Move and Measure:** **The PC will be able to send commands to MBED to move axes, and then receive a color data measurement from the new location.** • Minimum requirement is for a 16x16 grid resolution. • Color data should be displayed as RGB values on the PC.
D3	**PC Imager** **The PC will display an image of the scanned item on the screen.** • Data is read from the mbed board in whatever way you wish • Data is displayed by your PC code in a suitable visual format*. **If data is only viewable by creating a file (e.g. bmp) and then the user opening it manually with a standard utility then some partial marks will still be available.*

Additional comments:

Remember that meeting the core specs is required to gain the core marks. There are many variations and improvements you could make to each requirement to gain the additional 'technical knowledge and competence' marks. You can discuss this with the tutor if you want some guidance on the scope of what you can do. Consider holding a brain-storming session in your group, think about novel possibilities – ways to do things faster, improve accuracy, add user-friendly features, for instance.

Although a sensible plan for each requirement is to get the core functionality first, then try and add enhancements, where a core feature is missing, you can still gain marks by enhancing other parts of that item, if for example it is just too near to the deadline to fix a core issue, but small additions to other parts are viable in the remaining time.

1. **NOTES FOR PC based components:**

- PC programming may be undertaken using any language and tools.

- Use of significant predefined modules from third party libraries is permitted, but may detract from your overall marks (ask tutor if in doubt).

2. ADDITTIONAL HARDWARE DETAILS ARE GIVEN IN APPENDIX-1

BASIC TECHNICAL SPECIFICATION (INDIVIDUAL WORK COMPONENT)

Each team member should attempt one individual goal without assistance from their team members. Collaboration with respect to informing the candidate about any existing 'team solution' S/W and H/W interfaces is permitted where the work requires to interface to that resource. **Your Individual component must consist of ONE of the following :-**

TABLE-2 INDIVIDUAL COMPONENT OPTIONS

IC1	**QR CODES** **Implement a QR code format and reader using the platform. You can use a custom QR code if you wish but it must have at least 32 bits. Higher density of data will be considered as evidencing of additional technical expertise.** • *QR codes can be black and white* • *Multi-color QR codes can be used, and may allow high data densities.* • *The QR code should be decodable to a URL, text (or another data format agreed in advance with the tutor).*
IC2	**IMAGE RECOGNITION** **You can select 10 emoticons or beer mats as a possible source of images*. In each case your system should be able to recognise the identity of the image, in all four standard image rotations (0,90,180,270 degrees) on the bed.** * (other images sets can be approved by agreement with the tutor)
IC3	**OCR** The platform should be able to recognise the alphabet by presenting letter cards and scanning them. • There are a number of algorithms for character recognition. • Rotated cards need to be recognised (0,90,180,270 degrees).
IC4	**PHOTOCOPY** Your solution should be able to perform the following tasks, with or without PC assistance: • Scan an image. • Use the pen plotter and Z-Axis to draw a duplicate. • You will probably have to convert image to a grey-scale form and then use the pen to draw pixel blocks with different shading. • Alternatively, draw outlines of objects detected in the image using edge detection algorithm.
IC5	**STUDENT DEFINED SOFTWARE and/or HARDWARE** MUST BE APPROVED BY TUTOR BEFORE STARTING WORK Due to the likelihood of having to plan your IC work to fit into the base spec of the group implementation, and/or access to the system at points during the development, you will need to decide early on what your project will be, and get approval by submitting a proposal by email to the tutor. **This should be specified and approved no later than week 4.** Late proposals will only exceptionally be accepted at the discretion of the tutor, and only if the whole group agree they are happy with it.

TABLE-3 ALLOCATION OF MARKS FOR DEMONSTRATION OF GROUP PROJECT WORK

GROUP MARKS AVAILABLE (TOTAL OF 30 MARKS)	Mark Range
BASIC TECHNICAL SPECIFICATIONS MET	0 – 12
ADDITIONAL TECHNICAL COMPETENCE	0 – 12 **[note a]**
EFFECTIVE GROUP WORKING AND MANAGEMENT *includes working arrangements and the impression of each member being able to highlight a balanced set of contributions at the demo.*	0 – 6

[note a] Goal indicators for this component are as follows :-

(0 – no evidence of technical skill/knowledge beyond the bare minimum)
(3 – Some degree of enhanced operation in some functions & technical knowledge of them)
(6 – Significantly enhanced implementation in some key functions & tech knowledge)
(9 – Significantly enhanced functionality in most functions & technical knowledge)
(12 – all areas undertaken with significantly enhanced technical outcomes & knowledge)

Marks awarded can be any value 0 through to 12 to reflect how closely the outcome aligns to the example indicators given above.

[note b] Group members who fail to attend the demo will automatically receive Zero for all above parts, and will be advised to make a mitigating circumstances request if appropriate to their situation.

[note c] Group members who repeatedly fail to engage and contribute to the group (even after tutor intervention) will be required to demo on their own and will be assessed only on their own specific contributions (using the scheme above).

TABLE-4 ALLOCATION OF MARKS FOR DEMONSTRATION OF INDIVIDUAL PROJECT WORK

INDIVIDUAL MARKS AVAILABLE (TOTAL OF 10 MARKS)	Mark Range
BASIC TECHNICAL SPECIFICATIONS MET *Based on the chosen goals and their successful demonstration, and explanations of technical detail (including any questions from the markers).*	0 – 6
TECHNICAL ACHIEVEMENT & KNOWLEDGE *Based on the chosen goals and their successful demonstration, and explanations of technical detail (including any questions from the markers).*	0 – 4 **[note d]**

[note d] Goal indicators for this component are as follows :-

(0 – no evidence of technical skill or knowledge)
(2 – Moderate Evidence of Technical expertise and/or knowledge)
(4 – Significantly technical achievement and knowledge demonstrated)

Marks awarded can be any value 0 through to 4 to reflect how closely the outcome aligns to the example indicators given above.

[note e] *The above marking scheme relates to a standard group of 3 or 4 students. Variations to the marking scheme are only likely in exceptional circumstances, this may include having to work in a smaller group due to divisibility of the students on the module, or where illness forces a group to reduce .*

TABLE-5 WRITTEN TECHNICAL REPORT – REQUIRED SECTIONS AND MARKS

NUM	SECTION TITLE	GUIDANCE	MARKS (55 total)
R1	Project Summary	half-page synopsis and review of the group and individual project goals, how the project went for the team, what the goals were, and what were the actual outcomes.	5
R2	Technical description of the group component implementation	Two pages + diagrams, describe the chosen design, discuss reasons for design choices and alternatives.	10
R3	Evidence of Testing of group implementation, and test strategy	One page tabulating the test actions, expected results and outcomes, plus ½ page summary narrative of the test philosophy. Use remaining ½ page for photos if desired.	5
R4	Technical Description of individual component implementation	Two pages + diagrams, describe the chosen design, discuss reasons for design choices and alternatives	15
R5	Evidence of testing of individual implementation	One page tabulating the test actions, expected results and outcomes, plus 1 page summary narrative of the test philosophy. Use up to two pages for photos.	10
R6	Professional Considerations	Half-page discussion of a professional, ethical, social or environmental issue associated with the use of your solution as a product.	5
R7	*Evidence of Project Management*	*You are required to generate the following team documentation :-* *1. Project workplan schedule* *2. SWOT analysis of team skills or of project elements* *3. Risk Register* *4. Weekly project meeting minutes (see appendix 2) minuted and signed off by team members. Photos or Scans of signed minutes are ok.*	5

ADDITTIONAL GUIDANCE

- Please ensure that you include ONLY the sections identified above, and use the designated section numbers R1,R2, etc. Markers can not accept responsibility for locating wrongly numbered sections, or mis-placed content, in order to award marks according to the scheme above.
- Page counts with, A4 11point text, are to be adhered to. Going over page limits may mean that the remaining pages in that section are not marked.
- This report is to be written individually (each group member writes their own report in their own words). Sharing of working diagrams, data print-outs, screenshots, and R7 content is acceptable.

TABLE-6 :- SOFTWARE/DESIGN SUBMISSION CHECKPOINT

You are required to upload a zip file via electronic submission according to the hand-in-date stated on the front of this document.

Your zip file should include the following folders and content:-

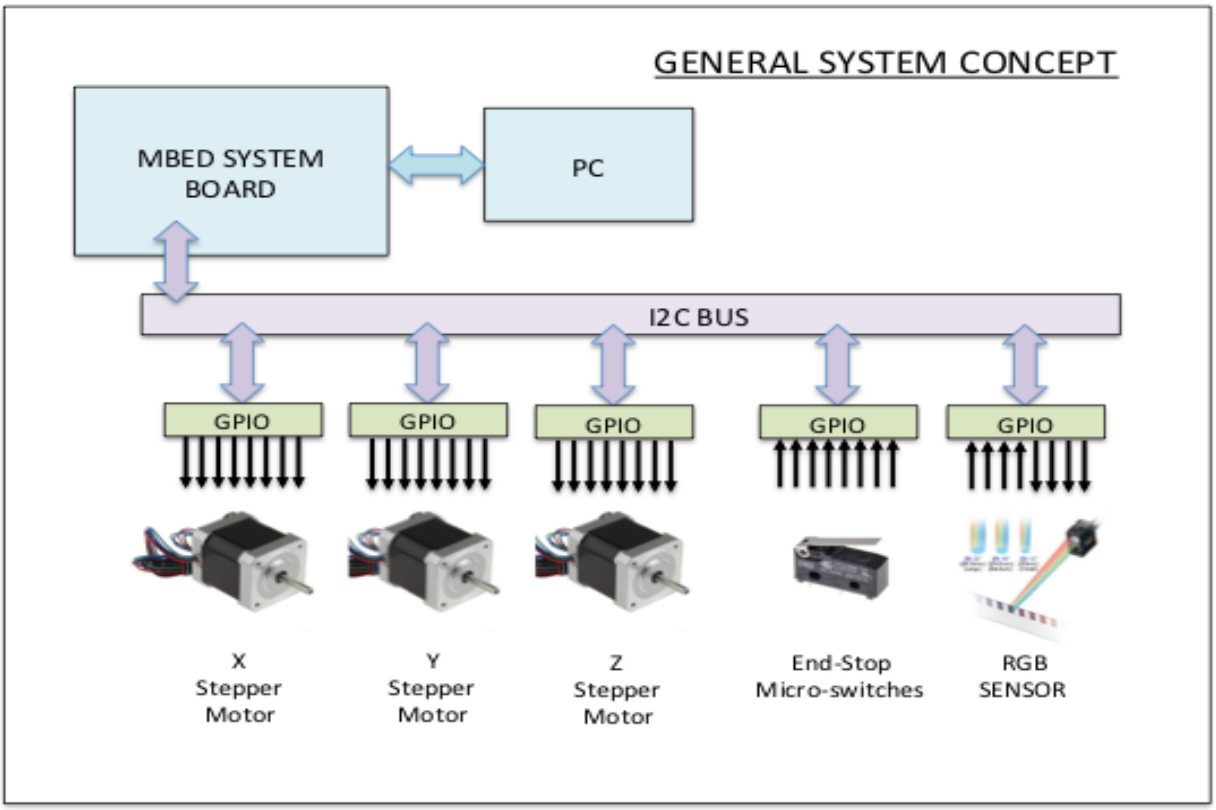
TOP FOLDER – NAMED BY YOUR USERNAME (eg. CB256),
containing subfolders:-

TABLE-6	CODE/DESIGN SUBMISSION
GROUPCODE	Folder containing the whole group component code as it stands at this hand-in date NOTE- If your group project has a significant hardware component, then include scans of sketches, working diagrams, or photos of the hardware that you may have.
MYCODE	Any code relating to your IC component as it stands at this hand-in date. NOTE- If your individual project component has a significant hardware component, then include scans of sketches, working diagrams, or photos of the hardware that you may have.

If you do not clearly organise files into the two categories you will lose marks. We will not investigate code content or filenames to try and guess which is which if it is not clear.

Appendix-1

TECHNICAL COMPONENTS & INFORMATION



- All scanning platform components are based upon I2C interfacing modules.
- You can add additional components via I2C or using other I/O interfaces if you wish.
- Always **read all** of the data sheets thoroughly, **check for updated data sheets** and errata sheets issued by manufacturers.
- General Information about the platform including I2C address maps and datasheets:

  https://www-users.cs.york.ac.uk/~pcc/Circuits/scanner/scanner.html

Stepper Motors: Start by looking at https://en.wikipedia.org/wiki/Stepper_motor to understand how these devices actually work. Check which motors are used on the platform (should have product labels). Identify their main characteristics.

RGB SENSOR: TCS3472 sensor IC, mounted in the Adafruit TCS34725 sensor board

IC: https://www-users.cs.york.ac.uk/~pcc/Circuits/scanner/data/TCS3472.pdf

BOARD: https://www.adafruit.com/product/1334

Read both the sensor IC datasheet and the pcb documentation (they may have different levels of information).

Microswitches: Standard components with open/closed circuit state, you need to check if these are normally open or normally closed.

Appendix 2
GROUP CONDUCT AND MANAGEMENT

- You should form into groups of 3 or 4 during the first week of the project. Groups of 3 may be required to accept an extra group member nominated by the tutor, where that member does not have a group. Any student not in a group will be allocated to one by the tutor. There is no overall advantage in having a smaller or larger group. You will be allocated a working area in the lab and should retain that location throughout the assessment for your team.

- From the point of the handout release, you will be undertaking in-lab work towards an assessment. The tutor, lab leaders, and GTA helpers, are not there to provide solutions to assessment questions. They can however advise you on ways to understand and identify problems, and provide limited guidance. Do not expect staff to write code, modify your hardware or tell you how to solve the project tasks in significant detail. We will do our best to guide you within the constraints of assessment practice.

- Teams should undertake to work effectively together for the full term and also to reasonably facilitate information they hold on the group project work when requested by a group member up until the written report hand in date has expired.

- Teams should hold weekly progress meetings, which are minuted, and have a chairperson and a minute taker (secretary). These roles should be rotated so that all team members perform each role at least once. Meetings should have an agenda, review tasks due for completion, and allocate new tasks.

- Meeting minutes should be signed off by each team member attending a meeting, and copies distributed to each team member (on paper or electronically). These must be submitted as part of the written report (See section R6 of report).

- Inevitably, some groups will encounter difficulties in team management. Illness and lack of engagement are the two key concerns which tend to occur. Teams are responsible for highlighting issues as they occur and not at the end of term in retrospect.

- Teams will be required to fill in a joint review sheet at the assessed demonstration session, and all team members are expected to declare that they have contributed fairly to the team work.

- Team members who repeatedly fail to engage at the group level (not responding to tutor interventions) should be aware that they may receive significantly lower marks for the group. (mitigating circumstances should be addressed to the MC committee).

- Teams who do not highlight team management issues as they occur will not be able to seek any leeway in the final mark allocation and are likely to get a low mark or zero for 'evidence of effective team management/working'.

- **NOTE:** Attendance fraud has been identified on previous occasions, and we have methods to identify this behaviour. Failing to conduct oneself properly in this regard will be considered a serious matter – remember the whole term and the tutored lab sessions are an ongoing assessment process. Not only is it detrimental to the individual, but impacts upon the team, and interferes with the tutor monitoring of progress of teams and the cohort.

- If you have genuine issues that might impact upon attendance patterns, please discuss these with the tutor in confidence, or ask your personal supervisor to do so.